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Economics of Education and Sustainable Development

Edited by
Tin-Chun Lin

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Editor

Tin-Chun Lin

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Editor
Tin-Chun Lin
School of Business and
Economics
Indiana University - Northwest
Gary
United States

Editorial Office
MDPI
St. Alban-Anlage 66
4052 Basel, Switzerland

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Contents

About the Editor

Tin-Chun Lin

Dr. Tin-Chun Lin received his Ph.D. in Economics from Pennsylvania State University, USA. He is a Full Professor of Economics at Indiana University–Northwest, USA. He serves as an Editor-in-Chief for *International Journal of Economic Issues*, for *Asian Journal of Arts, Humanities and Social Studies*, for *Asian Journal of Economics and Finance*, and for *Studies in Economics*, and as a Guest Editor for *Sustainability* and an Academic Editor for *British Journal of Education, Society & Behavioral Science* and for *Applied Economics and Policy Analysis*. He is an Associate Member of the Center for East Asian Studies at the University of Chicago, and an Honorary Member at the Asian School of Management and Technology. He has received numerous distinguished teaching awards and outstanding research awards. His research mainly focuses on economics of education, economic education, and consumer economics. He has published a number of articles in highly qualified journals.

Preface to "Economics of Education and Sustainable Development"

This book investigates and discusses the relationship between economics of education and sustainable development; that is, how education economics plays an important role in sustainable development. Economics of education is the study of economic issues relating to education (such as education policy and finance, human capital production and acquisition, and the returns to human capital); while sustainable development is the study of a system (a human society) operating and growing continuously, which includes environment, economy, industry, business, agriculture, etc. This book particularly focuses on the economy –how an economy continuously and steadily develops and grows. Authors are from different disciplines, such as economics, education, social science, and other disciplines related to economics of education and sustainable development. All authors provide economic theoretical or empirical models and economic analysis, and significantly contribute to the area and literature.

Tin-Chun Lin
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Article

The Impact of Higher Education on Economic Growth in ASEAN-5 Countries

Paravee Maneejuk [1,2,*] and Woraphon Yamaka [1,2]

[1] Faculty of Economics, Chiang Mai University, Chiang Mai 50200, Thailand; woraphon.econ@gmail.com
[2] Center of Excellence in Econometrics, Chiang Mai University, Chiang Mai 50200, Thailand
* Correspondence: mparavee@gmail.com

Abstract: This study analyzed the nonlinear impacts of education, particularly higher education, on economic growth in the ASEAN-5 countries (i.e., Thailand, Indonesia, Malaysia, Singapore, and the Philippines) over the period 2000–2018. The impacts of education on economic growth are assessed through various education indicators, consisting of public expenditure on tertiary education per student, enrolment rates of primary, secondary, and tertiary levels, educated workforce, and the novel indicator of unemployment rates with advanced education. This study establishes nonlinear regression models—the time-series kink regression and the panel kink regression—to investigate the kink effects of education on the individual country's economic growth and the ASEAN-5 region, respectively. There are three main findings. Firstly, the nonlinear effects of the government expenditure per tertiary student on economic growth are confirmed for the ASEAN-5 region. However, the impacts do not follow the law of diminishing returns. Secondly, our findings reveal that an increase in unemployment of advanced educated workers can positively or negatively impact economic growth, which requires an appropriate policy to handle the negative impacts. Lastly, secondary and higher education enrollment rates can contribute to the ASEAN-5's economic growth (both the individual and regional levels). However, the regional analysis reveals that higher education impacts become twice as strong when the enrollment rates are greater than a certain level (a kink point). Therefore, we may conclude that secondary enrollment rates positively affect economic growth; however, higher education is the key to future growth and sustainability.

Keywords: education; higher education; economic growth; nonlinear; kink regression; ASEAN-5

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1. Introduction

Economists have shown renewed interest in the role of human capital in economic growth in recent years. Previous studies usually consider education to be a simple measurement of human capital and attempt to examine the impacts of education on economic growth. While the education–growth linkage is widely discussed, many recent studies pay further attention to higher education levels and attempt to investigate its economic growth impact. This is because higher education is considered one of the key factors driving economic growth and competitiveness for every country. Basic education (both primary and secondary levels) may suffice for the simple production of goods and services and allows workers to use technology in the workplace. On the other hand, higher education is more likely to produce graduates that are equipped with the potential to invent new technology and that will become working persons helping transform the country into a knowledge-based economy. Higher education provides technology and innovation and delivers high-skilled workers to the labor market, thereby enhancing economic growth.

Many economists have shown evidence supporting the potential impact of higher education in both developing and developed economies (e.g., [1–3]). However, relatively few studies focus on how higher education is expanded and utilized [4,5]. According to the literature, some previous studies measure the influence of higher education through research and development (see, [6–8]). However, in this study, the relationship between

higher education and economic growth is reinvestigated. We attempt to fill the literature gap by introducing a workforce with higher education degrees—as a proxy for higher-education expansion—in our analysis. This study also introduces a new measurement of higher-education utilization: unemployment with an advanced level of education as we believe that the contribution of higher education to the economy may relate to jobs available for the graduates. Employment is a platform where the high-skilled workers can show their potential for driving the economy to future growth. On the other hand, if there is no opportunity for those who invest in skills to get a good job, it may lead to a deadweight loss.

Besides the measurement issue, this study also highlights how education's impacts on growth are modeled. Most of the existing literature usually employs the linear model, which may be a good approximation and conform to the theories. However, the relationship between education and economic growth may be nonlinear [8]. The investigation of the nonlinear relationship between these two variables is quite limited. Only a few studies focus on nonlinearities [9–13]. One of the recent works on this issue, Maneejuk, Yamaka, and Sriboonchitta [14] points out that the linear model may overlook a significant nonlinear relationship. Therefore, in this study, the potentially nonlinear relationships will be examined by kink regression.

In the regression kink model, the regression function is continuous, but the slope has a discontinuity at a kink point. This kink point is simply a turning point, which occurs when there is a structural change in the relationship between variables. Our analysis shows that the impacts of education through several indicators may not be linear or constant over time. The impacts may increase after reaching a certain level of development or decrease due to the diminishing returns. Therefore, this study can illustrate the economic prospect resulting from the structural change after the education indicators have reached the kink point. We would need to go beyond the classical linear model to provide a new explanation of the impacts of education on economic growth under different education regimes. This study also shows whether education positively affects or discourages economic growth. To estimate this model, the ridge estimation is conducted to address the multicollinearity and sample size issues in our education–growth model. The discussion and the reasons for using the ridge estimator will be explained in the next section.

This study gives a special concern to the ASEAN-5 countries, consisting of Thailand, Indonesia, Malaysia, Singapore, and the Philippines. These five countries are considered the leading countries of the group due to the size of GDP and the relatively high economic development level. They have different cultures, lifestyles, and languages. However, the ASEAN-5 countries emphasize education in driving economic growth. Therefore, they have planned to improve the educational system and quality altogether and attempted to bring every member country's level of education into the same standard. However, the educational quality is still substantially different and unequal across countries. In the related literature, only a few studies investigated education's role, particularly of higher education, in the ASEAN-5 economies. Therefore, it could be a challenge to produce evidence on this issue and draw a conclusion on the impacts of higher education on economic growth in this area.

The major focus of this paper is to analyze the nonlinear impact of higher education on the economic growth in ASEAN-5. The main contributions of our study to the existing literature are essentially three-fold. First, this study considers the expansion of higher education along with the stock of education and investment. Second, although the impacts of higher education on economic growth have been considered, few studies use a nonlinear model to analyze this issue; while no studies have explored the kink effects of each education indicator on economic growth. Therefore, this study employs the kink regression model to investigate the kink effects of education indicators on economic growth in ASEAN-5 countries, in an attempt to fill the gap in the literature. Thirdly, this is the first attempt to apply the ridge estimator to fit the kink regression model for solving the problems of data limitation and multicollinearity in our empirical model.

The organization of this paper is as follows. After the introduction, Section 2 provides the literature review on the measurement of education and its impact on the economic growth. Then, the econometric methodology is explained in Section 3. Section 4 provides the description of the data. Section 5 shows the empirical results and discussion. Finally, Section 6 provides the conclusions and policy recommendations.

2. Literature Review

2.1. Human Capital, Education, and Higher Education: A Measurement Issue

Modern human capital theory introduced by Schultz [15] provides fundamental support for analyzing the influence of education on economic growth. Subsequently, Mincer [16] focuses primarily on labor economics and the role of human capital in the production process. The term human capital refers to the stock of skills, education, and other competencies embedded in labor. Therefore, every unit of labor hour supplied by different individuals may have a different level of efficiency depending on how much the individuals invest in their skills. However, the objective of this study is to investigate how human capital can influence the process of economic growth. One of the main theoretical approaches that explain the relationship between human capital and economic growth is the augmented Solow growth model. This model regards labor, physical capital, and human capital as inputs augmented by the total factor productivity known as the Solow residual, which drives the productivity of inputs [17]. The endogenous growth model has explicitly included human capital—as measured by education, innovation, research, and development—in the growth model (see, [18,19]). Later, Mankiw, Romer, and Weil [20] have empirically proved the augmented Solow growth model and showed that human capital could play a vital role for the long-term economic growth. It can lead to a creation of innovation and appropriate adoption of technology from abroad [21].

A possible mechanism explaining the effect of education on economic growth includes (i) the rise of productive efficiency, and (ii) the improvement of quality of the output. Note that these two mechanisms are existed due to the improved competencies following higher education levels, and consequently justifying higher labor wages [22]. Saviotti, Pyka, and Jun [23] mentioned that these two mechanisms lead to a higher purchasing power, thereby stimulating demand and growth of the production.

Even though human capital is an undoubtedly essential factor in increasing output levels and enhancing economic growth, there is still an important issue left: how human capital should be measured. Many studies in the economic growth literature have considered education as the measurement of human capital. However, the indicator for education—as a measurement of human capital—can also be separated into many aspects. Holland, Liadze, Rienzo, and Wilkinson [2] explained that measures of education can be separated into four groups: (i) stock of human capital usually measured by the average years of schooling, (ii) human capital flows proxied by school enrolment rates, (iii) investment in human capital, which is usually measured by personal and/or public expenditures on education as a share of GDP, and (iv) education system and educational quality proxied by international test scores, especially math and science [24]. Among all groups, the stock of human capital is usually considered in the empirical analysis. For example, Cohen and Soto [25] collected the data on the years of schooling and examined the impact on economic growth in OECD. This paper reveals a significantly positive impact of education on economic growth, which conforms to many studies that use years of education as a proxy (see, e.g., [1,26]). Besides, many studies also consider the school enrollment rate as a proxy of human capital flows. Starting from the influential paper of Barro [21], which studied ninety-eight countries across the world and found that economic growth is significantly related to school enrollments—as a proxy of human capital. Barro explains that higher human capital or higher school enrollment rate can bring about lower fertility rates and higher physical investment to the economy and thereby enhancing economic growth. Later, many studies have followed Barro's work and empirically proved his finding using data of many countries. For example, Wobst [27] showed a significantly positive impact of school

enrollment on growth in Tanzania. In addition, many studies have also focused on the role of investment in education and the educational quality. For example, Keller [8] and more recently Liao, Du, Wang, and Yu [13] have considered the role of educational investment in economic growth. They examined this hypothesis in Guangdong, China and found that personal financial investment in education has a positive role in enhancing economic growth, but the magnitude of the impact can vary in different areas.

Several studies in the literature confirmed the positive impact of both stocks of education and investment in education on economic growth. However, a different education level may contribute to economic growth to a different degree. So, the further question is which education level can productively enhance economic growth. Keller [8], one of the most cited works on this issue, examined the impact of human capital flows (enrollment rates) and investment in education, each for primary, secondary, and higher education, on economic growth. Her finding reveals that enrollment rates in secondary and higher education can significantly raise economic growth, while the expenditure on education appears better allocated toward primary and secondary levels rather than higher. Many studies have attempted to re-investigate this issue. However, according to the literature, higher education appears to be one of the main factors enhancing economic performance. Volchik, Oganesyan, and Olejarz [1] examined this hypothesis in EU countries and found that higher education significantly affects economic performance of the EU countries especially during the period of globalization and digitalization. This result was confirmed by the empirical work of Habibi and Zabardast [22] who revealed that education plays a vital role in generating essential knowledge for technological progress and innovation. Hence, the high level of education could contribute to the digitalization which results in economic development. The studies of Lin [28,29] investigated the impact of education on economic growth in Taiwan from 1965 to 2000 and confirmed the important role of education on Taiwan's economic development. Holland, Liadze, Rienzo, and Wilkinson [2] also investigated the role of graduates in economic growth in the UK and found that higher education really plays an important role in the UK economy. The increase in the share of workforce with higher education degree can raise the economic growth. In addition, based on the growth accounting framework, graduates' skills can contribute to about 20 percent of the UK GDP growth during the period 1982–2005. Achim [30] also confirmed that the development of education could shift the labor productivity and responds to the labor market's needs, thereby satisfying the increased demands of the new evolving and diversifying economy.

Besides the evidence from developed countries, Gyimah-Brempong, Paddison, and Mitiku [3] investigated the impact of higher education on economic growth in Africa and found it to be positive and statistically significant in African countries. Moreover, some studies have revealed a positive relationship between higher education and growth from the world's perspective. For example, Valero and Van Reenen [5] studied the economic impact of universities in seventy-eight countries around the world and suggested that an increase in the number of universities could lead to an increase in economic growth in the future. However, they further suggested that the expenditure of universities does not directly drive economic growth. Still, the universities are likely to drive the economy by expanding knowledge and being a human capital supplier. This suggestion is in line with the argument of Holmes [4] which claimed that higher education might not necessarily lead to a higher economic growth; it depends on the expansion and the utilization of the higher education sector. Holmes [4] used the number of employed researchers in the economy as a proxy for the higher education expansion, but he failed to find a significant effect on economic growth. He explained that the undesirable results might happen due to poor data quality and measurement error problems. However, recently, many studies in the literature have paid attention to the expansion of higher education. For example, Holland et al. [2] and Volchik et al. [1] considered workforce with university degree and employment with higher education as proxies for the expansion of higher education, respectively, and analyzed the linkage between them and economic growth.

To sum up, most of the previous studies have no doubt on the essential role of education in economic growth. Besides, many recent studies have paid attention to higher education and attempted to investigate its impact using several datasets and model specifications. On the other hand, some papers have argued that both university enrolment and higher education expenditure appear to be less important than how the higher education is expanded and utilized [4,5]. However, relatively few studies considered the impact of the expansion of higher education on economic growth. Our study considers this gap and attempts to fill it by including workforce with higher education degree—as a proxy of the higher education expansion—in our econometric analysis. This study also introduces a new measurement of the higher-education utilization: unemployment with advanced level of education. The question on how much the higher education sector can contribute to the economy also depends on how many jobs are available for the graduates. Therefore, increasing unemployment with a high-level degree is expected to produce a negative impact on the growth of the country.

2.2. Education and Economic Growth: Modeling Issue

In the recent decade, the existing literature has broadly discussed the relationship between education and economic growth. Many investigations have revealed that education has a potential effect on economic growth (see, e.g., [10–13]). Existing studies mainly use linear models of education's impacts on economic growth, which may be a good approximation and conform with many theoretical approaches. However, the relationship between education and economic growth may be nonlinear due to diminishing returns [8]. With respect to the linear model, Ganegodage and Rambaldi [10] used the Autoregressive Distributed Lag (ARDL) model to investigate the effect of the investment in education on Sri Lanka's economic growth during the period 1959–2008. They found a weak positive effect of the returns on investment in education on economic growth when compared to other developing countries. Likewise, using the same model, Merca and Sezer [11] studied the impact of education expenditure on the economic growth of Turkey and found that education expenses contribute a positive and significant effect to economic growth. Jin, and Jin [12] applied the linear regression model to investigate the effects of Internet education on economic growth using a cross-section of 36 high-income countries. They indicated that the frequent usage of internet education could promote economic growth.

On the contrary, Zhu [31] employed the panel regression to verify the effect of various education factors on the economic growth of China's 30 provinces from 2000 to 2010. He found that special education graduates, primary school graduates, high school graduates and junior middle-school graduates have no significant impact on economic growth. Abu, Haseeb and Azam [32] and Liao et al. [13] attempted to find the causal relationship between education and economic growth in China and Malaysia, respectively, using cointegration and causality methods. The results showed a bidirectional causality between these two variables. Interestingly, Liao et al. [13] revealed that the bi-directional relationship between these two variables has occurred only in the short run, but there is unidirectional causality of educational investment on Chinese economic growth in the long run. This evidence has also been found in the work of Sylweste [33] which revealed that education spending harms economic growth in the short term, but it plays a positive role in the long run.

According to the above literature review, the inconclusive impact of education on economic growth is found. Many studies indicated that education has a positive impact on economic growth, some studies argued that there is no significant contribution of education to economic growth, and other studies mentioned that there are heterogeneous effects in the short run and long run. Since previous research works did not reach a consistent conclusion, we doubt that the impact of education on economic growth may be nonlinear. The linear specification may oversimplify the education–growth nexus when the nonlinear link between dependent and independent variables exists. Generally speaking, the impact of education on economic growth may not be fixed over time. Considering this fact, some studies began to examine the nonlinear mechanism between education and

economic growth. The nonlinear education–growth nexus was first examined by Krueger and Lindahl [34]. They divided their sample of countries into three subsamples based on their initial human capital endowment, and heterogeneous results were obtained. They found that education contributed a positive and a negative effect to economic growth in the subsample of countries with the lowest and highest educational levels, respectively. For the group of countries in the middle of the education level, they found that some education factors have a negative effect on economic growth, while other factors have no effect on growth. Jalil and Idrees [35] investigated the impact of education on the economic growth of Pakistan. They collected the data over the period from 1960 to 2010 and used the nonlinear regression model (estimated by the nonlinear two-stage least-square method) to fit these data. They pointed out that different levels of education contribute to the different magnitude of positive effects on the economic growth in Pakistan. Recently, Marquez-Ramos and Mourelle [36] tested the existence of a nonlinear relationship between education and economic growth of Spain using the smooth transition regression model. They considered enrolment ratio in secondary education and enrolment ratio in tertiary education as the threshold variables. They revealed a negative and significant effect of the enrolment ratio of tertiary education on economic growth in two regimes: when enrolment ratio tertiary education is greater or less than 5.2%.

This analysis enables us to shed light on the question posed by the existing literature about the nonlinear impact of education on economic growth. Consequently, based on the empirical results, this study innovates by using kink regression [37] to investigate the kink or nonlinear effects of education on economic growth in ASEAN-5. The advantages of the kink regression over the traditional nonlinear models (threshold regression, smooth transition regression, and Markov-switching regression models) include that it allows us to contain both linear and nonlinear effects of explanatory variables in the outcome variable. In addition, it is unlike the threshold and smooth transition regression models, which use only one threshold variable to determine the structural change of the model. We suspect that one threshold variable may be inadequate to describe the nonlinear effect causing the regime change. It would be more convincing if all explanatory variables can be threshold variables, thereby having their own kink points [14,38,39]. Therefore, the kink regression, which allows each independent variable to switch between the regimes, is employed in this empirical study.

In our empirical analysis, we incorporate several education variables as well as control variables that are related to economic growth. However, we are concerned that these explanatory variables may be highly correlated and lead to the multicollinearity problem. Several studies have mentioned the relationship between education factors. For example, Chen and Wu [40] provided evidence that the development of education is beneficial to the decrease in the unemployment rate. Abdullah [41] highlighted the relationship between secondary and tertiary education in Malaysian datasets. Birchler and Michaelowa [42] emphasized the relationship between primary and secondary education aids and education enrolment.

Due to the multicollinearity problem in the existing literature, the correlated education factors, as well as correlated control variables, cannot be considered jointly in the growth model. Thus, many scholars suggested removing one or more of these correlated explanatory variables to solve this problem. However, if the dropped variables are relevant to the economic growth, the traditional least-squares kink regression can produce biased and inconsistent estimates, which accounts for the name omitted variable bias. Mason and Brown [43] mentioned that the omitted variable bias could produce severe difficulties in subsequent theoretical interpretation of social science data. In this study, both omitted variable bias and multicollinearity problems are the matters of concern; we thus suggest the ridge estimation of Hoerl and Kennard [44] to fit the kink regression model. When multicollinearity occurs, least-squares estimation is unbiased, but their variances are large and thereby generate the higher variance in the parameter estimates. By adding a degree of bias to the regression estimates, the ridge estimator could decrease the standard errors of

the coefficients [45]. Perez Melo and Kibria [46] compared the performance of least-squares and ridge estimations and revealed that mean square error (MSE) for the ridge estimator is lower than the variance of the least-squares. Another advantage of the ridge estimator is that it still performs well in a situation where the number of explanatory variables is larger than the number of observations. Consequently, the limitation of our ASEAN-5 education and economic data is not a severe problem in our study.

To the best of our knowledge, most studies are based on linear regression analysis, while few studies emphasize the nonlinear structure as well as country difference. Another point is the negligence of the problems brought about by the omitted variable bias and multicollinearity. Generally speaking, the model could suffer from omitted variable bias if we omit relevant independent variables from the model. However, if the additional explanatory variable is correlated with other explanatory variables, the model would suffer from multicollinearity. So, which one is more important? It can sometimes be challenging to deal with both omitted variable bias and multicollinearity problems. Moreover, using the classical least-squares method without data inspection can lead to unreliable results. Thus, we also contribute to the methodology literature by extending the ridge regression estimator to ridge kink regression.

3. Methodology

3.1. Kink Regression

Our two-regime kink regression model takes the form:

$$Y_t = \beta_1^-(x_{1,t} - \gamma_1)_- + \beta_1^+(x_{1,t} - \gamma_1)_+ + , \ldots , + \beta_K^-(x_{K,t} - \gamma_K)_- + \beta_K^+(x_{K,t} - \gamma_K)_+ + \alpha Z_t + \varepsilon_t \quad (1)$$

where Y_t is the continuous dependent variable at time t, $x_{k,t}$ is the continuous independent variable k at time t, and Z_t denotes the $(1 \times Q)$ vector of the regime independent exogenous variables at time t. The linear relationship appears between Y_t and Z_t while the relationship between Y_t and $x_{k,t}$ is nonlinear, due to the relationship of Y_t and $x_{k,t}$ changes at the unknown location called the threshold or the kink point γ_k. However, the kink regression model is continuous in the variables $x_{k,t}$ and Z_t, but the slope with respect to $x_{k,t}$ is discontinuous at the threshold or kink point γ_K. Then, β is a matrix of $(T \times K \times 2)$ coefficients of unknown parameters and consist of $(\beta_1^-, \ldots, \beta_K^-)$ and $(\beta_1^+, \ldots, \beta_K^+)$ with respect to variable $x'_{k,t}$ for the values of $x'_{k,t} \leq \gamma_k$ and $x'_{k,t} > \gamma_k$, respectively. According to Hansen [37], the regressor variables are subject to regime-change at the kink point $(\gamma_1, \ldots, \gamma_K)$ thus, these regressors can be separated into two regimes. α is the $(Q \times 1)$ vector of linear parameters. ε_t is the error term at time t with normal distribution and $E(\varepsilon_t) = 0$. Traditionally, the least-square estimation is used to estimate $\boldsymbol{\beta} = (\beta_0, \beta_1^-, \ldots, \beta_K^-, \beta_1^+, \ldots, \beta_K^+, \alpha)$ and $\boldsymbol{\gamma} = (\gamma_1, \ldots, \gamma_K)$, and the estimation is given by

$$S_T(\boldsymbol{\beta}, \boldsymbol{\gamma}) = \frac{1}{T}\sum_{t=1}^{T}\left(Y_t - \boldsymbol{\beta}'\mathbf{X}_t(\gamma)\right)^2, \quad (2)$$

where

$$\mathbf{X}_t(\boldsymbol{\gamma}) = \begin{bmatrix} (x_{1,t} - \gamma_1)_- \\ \vdots \\ (x_{K,t} - \gamma_K)_- \\ (x_{1,t} - \gamma_K)_+ \\ \vdots \\ (x_{K,t} - \gamma_K)_+ \\ Z \end{bmatrix} \quad (3)$$

The least-square estimators $\widehat{\boldsymbol{\beta}}, \widehat{\boldsymbol{\gamma}}$ are the joint minimizer of $S_T(\boldsymbol{\beta}, \boldsymbol{\gamma})$:

$$(\widehat{\boldsymbol{\beta}}, \widehat{\boldsymbol{\gamma}}) = \underset{\boldsymbol{\beta}, \boldsymbol{\gamma}}{\operatorname{argmin}}(S_T(\boldsymbol{\beta}, \boldsymbol{\gamma})) \quad (4)$$

3.2. Ridge Kink Regression Estimator

As the least square is not applicable when the regressor variables are highly correlated and large in number, the ridge estimator is applied to fit the kink regression. According to Hoerl and Kennard [44], they proposed the ridge, which minimizes the residual sum of squares under a constraint on the $\ell^2 -$ norm of the coefficient vector. We then apply this estimator to estimate the kink regression model and the estimator of $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ in the model (1) takes the form

$$S_T(\boldsymbol{\beta}, \boldsymbol{\gamma}, \lambda) = \frac{1}{T}\sum_{t=1}^{T}\left(Y_t - \boldsymbol{\beta}'\mathbf{X}_t(\boldsymbol{\gamma})\right)^2 + \lambda\sum\boldsymbol{\beta}^2, \tag{5}$$

and $\lambda \geq 0$ is a non-negative regularization parameter. The additional term $\lambda\sum\boldsymbol{\beta}^2$ is the ridge penalty function, which shrinks kink regression coefficients towards zero as λ increases. In the view of Equation (5), we penalize only $\boldsymbol{\beta}$ and opt not to penalize $\boldsymbol{\gamma}$ since it is worth nothing when $\boldsymbol{\gamma}$ is shrunk to zero. It is important to note that $\lambda \to \infty$ ridge penalty function approaches infinity and yields an empty ridge estimation whereas when $\lambda \to 0$, the ridge penalty function approaches zero, and the ridge kink regression estimator is reduced to least-square regression estimator (Equation (2)). The role of the regularization parameter λ is essential in the estimation process. However, the loss function (Equation (4)) is quadratic in $\boldsymbol{\beta}$ but nonconvex in λ. Thus, it is computationally convenient to view this parameter as the tuning parameter for controlling the overall penalty level, and in this study, we consider the extended Bayesian information criterion (EBIC) to find the optimal ridge parameters for our estimation.

Similar to the least-square estimator, given the candidate $\widetilde{\lambda}$, ridge kink regression estimator $(\widehat{\boldsymbol{\beta}}, \widehat{\boldsymbol{\gamma}}, \lambda)$ is the joint minimizer of $S_n(\boldsymbol{\beta}, \boldsymbol{\gamma}, \widetilde{\lambda})$:

$$(\tilde{\boldsymbol{\beta}}, \tilde{\boldsymbol{\gamma}}, \widetilde{\lambda}) = \underset{\boldsymbol{\beta}\in R^p, \boldsymbol{\gamma}\in\Gamma}{\operatorname{argmin}} S_n(\boldsymbol{\beta}, \boldsymbol{\gamma}, \widetilde{\lambda}) \tag{6}$$

Then, the optimal $\widetilde{\lambda}$ can be easily determined by minimization of the concentrated sum of the squared errors Equation (5). In other words, the optimal $\widehat{\lambda}$ is obtained at the lowest EBIC. Once the optimal $\widehat{\lambda}$ is defined, we can estimate $\widehat{\boldsymbol{\beta}}$ and $\widehat{\boldsymbol{\gamma}}$ using standard penalized least-squares of Y_t on $\mathbf{X}_t(\widehat{\boldsymbol{\gamma}})$ with the additional penalty function $\widehat{\lambda}\sum\boldsymbol{\beta}^2$.

3.3. Testing for the Time Series Kink Effect

As the nonlinear relationship between education and economic growth is considered in this study, it is crucial to examine the kink effect. Additionally, it is vital to learn which independent variable has a nonlinear impact on economic growth. Hence, we firstly define a test of no kink effect against the presence of kink effect for each pair of dependent variables and the covariate k. That is, the null and alternative hypotheses for each covariate k are that

$$\begin{array}{l} H_0 : \beta_k^- = \beta_k^+ \\ H_a : \beta_k^- \neq \beta_k^+. \end{array} \tag{7}$$

To test this hypothesis, Hansen [37] recommended using the F-test:

$$F_k^* = \frac{\left(SSE_0^k - SSE_1^k(\widehat{\boldsymbol{\gamma}})\right)}{SSE_1^k(\widehat{\boldsymbol{\gamma}})/(T-1)}, \tag{8}$$

where

$$SSE_0^k = \sum_{t=1}^{T}\left(Y_t - \hat{\beta}_k x_{k,t}\right)^2 \tag{9}$$

$$SSE_1^k = \sum_{t=1}^{T}\left(Y_t - \widehat{\beta}_k^{-}\left(x_{k,t} - \widehat{\gamma}_k\right)_{-} - \widehat{\beta}_k^{+}\left(x_{k,t} - \widehat{\gamma}_k\right)_{+}\right) \quad (10)$$

Hansen [37] mentioned that this F-test might not have a standard distribution; thus, he suggested using the bootstrap method to generate asymptotically first-order corrected *p*-values. Zhang and Cheng [47] mentioned that the *p*-value yielded from the bootstrap could be employed to validate the existence of a nonlinear relationship. Thus, in this study, we follow the traditional criteria; the null hypothesis of the kink effect is rejected if the *p*-value is less than the desired critical value, e.g., 0.10, 0.05, and 0.01.

4. Data

This section introduces the data used in our analysis and provides a brief description of each variable and the sources of the data. We use time-series and panel data of ASEAN-5 countries, namely Thailand, Indonesia, Malaysia, Singapore, and the Philippines. The data cover the period of 2000–2018 as many variables are available for this period while the data after the year 2019 have not been updated yet. Economic growth measured by GDP per capita is the dependent variable perceived to be influenced by six education indicators and the control variables. This study considers primary, secondary, and university enrollment rates, education expenditure per student in the tertiary level, and the expansion of higher education measured by the workforce with high degree and the share of unemployment of high-skilled workers. Furthermore, the five control variables considered are trade openness, foreign direct investment (FDI), research and development, inflation rate, and capital stocks. Description of the variables is presented in Table 1.

Table 1. Variable description.

Variable	Variable	Description	Source
Dependent variable	GDP	Real GDP per capita	CEIC
Education variable	EXPSTU	Education expenditure per student refers to the average annual goverment expenditure per student in the tertiary level. It is calculated by dividing the total government expenditure on tertiary education by the number of students at the tertiry level (unit: US dollar)	National Statistical Office of Thailand; Department of statistics Singapore; Department of statistics Malaysia; Philippines Statistics Authority; the Central Bureau of Statistics, Indonesia; and International Labour Organization
	Primary Secondary Tertiary	Primary, Secondary, and Tertiary stand for the enrollment rate of primary, secondary, and tertiary levels, respectively. The enrollment rate is measured by the ratio of total enrollment to the population having the age officially corresponds to the level of education (unit: % gross).	
	WORK	Workforce with education refers to the working-age population with a higher level of education (or university degree) who are in the labor force, that is, the number of a highly educated workforce (unit: thousand persons).	
	UNEM	Unemployment with higher education refers to the labor force with an advanced level of education who are unemployed. Advanced education consists of bachelor's degree, master's degree, and doctoral degree (unit: % of total unemployment).	World Bank
Control variable	OPEN	Trade openness measures how much a country is engaged in the world trade. It is measured by the ratio of the sum of exports and imports to GDP (unit: times of GDP).	
	FDI	Foreign direct investment (unit: % of GDP).	CEIC
	RD	Research and Development expenditure refers to gross domestic expenditure on research and development of, for example, business, non-profit organization, government, and education sector (unit: % of GDP).	
	INF	Inflation rate (unit: %).	
	K	Capital stock refers to the net capital stock, the market value of total fixed assets in the economy, reflecting the country's overall wealth (unit: thousand US dollars).	

Note: CEIC is the is the global economic database. Available online: https://www.ceicdata.com.

A brief statistical description of the variables is provided in Table A1, Appendix A. According to this table, we can highlight several characteristics of our variables. All the education variables present a positive mean value from 2000 to 2018 for all countries. The mean of the logarithm of real GDP per capita is positive across countries and ranges from the lowest of 8.677 for the Philippines to the highest of 11.490 for Singapore. In terms of education expenditure per tertiary student (lnEXPSTU), Singapore has the highest while the Philippines has the lowest. Comparing the enrollment rates, we observe that primary education has the highest enrollment rate, followed by secondary and tertiary education, respectively, for all countries, except for Singapore where the level of secondary education shows the highest average enrollment rate compared to the primary and the tertiary education.

Furthermore, Thailand is among the highest in terms of working-age population with a higher level of education (lnWORK), with an average of 10.521, while Singapore has the lowest average of lnWORK (6.216). Thailand is also among the lowest for the labor force with an advanced level of education who are unemployed (lnUNEM) with an average of 0.102, while the Philippines shows the highest average of lnUNEM (2.335). For the control variables, the mean values of control variables across countries are mostly positive in our sample, except for research and development (RD). We find that the average of the logarithm of research and development is negative for Thailand, Malaysia, Indonesia, and the Philippines, indicating that these four countries have a low percentage of research and development expenditure in their GDP.

It is important to note that the log transformation of our variables may be suitable for direct estimation. Nevertheless, the spurious relationship or pseudo regression may occur due to the nonstationarity problem in our time series. Thus, before focusing on the impact of education on economic growth, we need to test the stationarity of our data. By doing this, we use the Augmented Dickey–Fuller (ADF) test. The test results are also presented in Table A1, Appendix A, revealing that all variables are nonstationary at the level and stationary at first difference. This means the spurious relation may exist in the case of our empirical study. However, this study aims to save the number of observations and keep the logarithm transformation. We, then, still proceed with our study using these nonstationary data. Once the model is estimated, we will use the cointegration test of Engle and Granger [48] to confirm the long-term relationship between the dependent variable and independent variables in our model. If the long-term relationship is confirmed by the cointegration test, our regression model becomes non-spurious.

As our empirical model contains various independent variables, it is worth investigating the collinearity among the independent variables to test the multicollinearity problem. This problem occurs when a linear relationship exists between two or more of the independent variables. The problem leads to unreliable parameter estimates and large standard errors. Radu [49] suggested that the cause of the multicollinearity problem is usually the limitation of the data rather than the specification of the model. In this study, we also have a concern over this problem because the data available for analyzing the ASEAN-5 counties are not in the same form and are missing in some variables.

The correlation matrices of all independent variables are shown in Tables A4–A7, Appendix A. To simplify the results, we highlight the strength of the correlation in color for the absolute values of the correlation ranging between 0 and 0.30 (green), between 0.31 and 0.80 (yellow), and between 0.81 and 1.0 (orange) which indicate the weak, moderate, and strong correlation, respectively. Tables A4–A7 reveals the existence of a strong correlation (larger than 0.80), a rule of thumb [12] in many pairs of independent variables (orange color) for all countries, indicating that our model may encounter the multicollinearity problem. However, as the ridge estimator is employed to estimate the kink regression, we, therefore, claim that the multicollinearity problem may not be serious in our empirical model.

5. Empirical Results and Discussion

5.1. Results of the Kink Effect Test

The kink parameters could govern the nonlinear relationship between the dependent and each independent variable. Thus, in this section, we conduct the kink test of Hansen [37] for testing the existence of the kink effect between each independent variable and the dependent variable. That is, the kink effect on the relationship between the dependent variable and its covariate is examined as a single equation. Table 2 presents the test results for five empirical models (Thailand, Singapore, Malaysia, Indonesia, and the Philippines). The kink effect tests for education variables are presented in rows 2 to 6, while rows 8 to 12 present the kink tests for the control variables. The F-test statistics and their *p*-values are reported and summarized, as in the following presentation. (1) The null hypothesis of no kink effect is rejected in lnEXPSTU, lnWORK, how much a country is engaged in the world trade (lnOPEN), lnFDI, and inflation rate (INF) for all countries using the 10% significance level as the critical level, indicating a linear impact of these variables on the economic growth of all ASEAN-5 countries. (2) The alternative hypothesis of the kink effect is accepted for four education variables: lnPrimary, lnSecondary, lnTertiary, and lnUNEM and two control variables: lnRD and caital wealth (lnK) in some countries. Specifically, lnPrimary is found to have a nonlinear effect only for the case of Thailand. lnSecondary is found to have a nonlinear impact in Thailand, Indonesia, and the Philippines, lnTertiary presents kink effects on Thailand, Singapore, and Indonesia, while lnUNEM shows the kink effects on economic growth for all countries. Moreover, two control variables have a significant kink effect on growth. lnRD shows a statistically significant kink effect on Thai economic growth, while lnK has a significant nonlinear impact on the economic growth of Thailand, Indonesia, and the Philippines. According to these results, we can observe the kink effects of education factors on economic growth of ASEAN-5 countries, whereas Thailand displays a decisive nonlinear impact as four out of the six education variables have a statistically significant kink effect. In contrast, the weakest nonlinear impact of education is found in Malaysia.

Table 2. Kink effect test: F_k^*.

Country	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK
Thailand	1.783	**8.540**	**9.368**	**19.496**	**13.253**	7.2680
	(0.491)	**(0.031)**	**(0.021)**	**(0.000)**	**(0.000)**	(0.110)
Singapore	4.402	0.825	1.614	**12.886**	**8.623**	1.012
	(0.766)	(0.994)	(0.584)	**(0.000)**	**(0.021)**	(0.854)
Malaysia	10.043	10.354	6.578	6.610	**15.702**	2.886
	(0.541)	(0.515)	(0.744)	(0.761)	**(0.051)**	(1.000)
Indonesia	10.517	5.861	**22.497**	**27.494**	**26.964**	5.548
	(0.261)	(0.755)	**(0.021)**	**(0.000)**	**(0.000)**	(0.767)
Philippines	0.942	3.664	**12.139**	5.709	**15.348**	6.333
	(0.961)	(0.641)	**(0.023)**	(0.343)	**(0.000)**	(0.294)
	lnOPEN	lnFDI	lnRD	INF	lnK	
Thailand	1.598	0.144	**6.423**	1.378	**21.033**	
	(0.231)	(0.911)	**(0.051)**	(0.522)	**(0.000)**	
Singapore	0.912	0.386	0.511	0.645	1.458	
	(0.999)	(1.000)	(1.000)	(1.000)	(0.601)	
Malaysia	4.027	6.397	9.949	7.587	12.511	
	(0.866))	(0.735)	(0.573)	(0.675)	(0.361)	
Indonesia	3.762	7.221	10.588	6.492	**29.739**	
	(0.843)	(0.643)	(0.253)	(0.658)	**(0.000)**	
Philippines	7.679	8.020	7.261	4.133	**19.379**	
	(0.197)	(0.140)	(0.211)	(0.487)	**(0.000)**	

Note: The values in parentheses () are the *p*-values. A bold number indicates a significant kink effect.

5.2. Main Results of Kink Ridge Kink Regression

After testing the presence of the kink effect, the next step is to build the kink regression model for each country and estimate the regressors and their corresponding kink parameters. However, to ensure the reliability of our kink model, we compare this type of model with the ridge linear regression model, as presented in Table 3. The EBIC is used to achieve our comparison. The EBIC values of linear regression and kink regression models are reported in the last row of Tables 3 and 4, respectively. It is found that our kink models outperform the linear model for all countries, implying that the kink regression is appropriate for this analysis, that is, the nonlinear impacts of education on the economic growth of all five ASEAN countries.

Table 3. Ridge linear regression results for all five countries.

Variable	Thailand	Singapore	Malaysia	Indonesia	Philippines
			Estimate		
intercept	1.872 ***	4.713 ***	3.451 ***	10.370 ***	8.544 ***
	(0.125)	(1.202)	(1.311)	(2.112)	(2.184)
lnEXPSTU	0.150 ***	0.059	0.090 ***	0.033	0.107 **
	(0.036)	(0.042)	(0.026)	(0.057)	(0.044)
lnPrimary	−0.023	0.065	0.129 ***	−0.061	−0.091 ***
	(0.035)	(0.052)	(0.035)	(0.045)	(0.031)
lnSecondary	0.179 ***	0.078 **	0.029	0.280 ***	0.179 ***
	(0.042)	(0.038)	(0.026)	(0.064)	(0.036)
lnTertiary	0.036 *	0.115 **	0.079 **	0.175 ***	0.091 **
	(0.019)	(0.047)	(0.034)	(0.059)	(0.042)
lnUNEM	0.191 ***	−0.039	0.179 ***	−0.102	−0.2007 ***
	(0.039)	(0.049)	(0.028)	(0.064)	(0.034)
lnWORK	0.180 ***	0.246 ***	0.078 **	0.088 *	−0.006
	(0.035)	(0.052)	(0.035)	(0.049)	(0.023)
lnOPEN	−0.060 ***	−0.013	−0.043	−0.101	−0.024
	(0.022)	(0.057)	(0.036)	(0.068)	(0.415)
lnFDI	0.027	0.103 **	0.014	0.011	0.024
	(0.018)	(0.040)	(0.021)	(0.042)	(0.031)
lnRD	0.090 **	0.032	0.134 ***	0.051	0.218 ***
	(0.038)	(0.039)	(0.032)	(0.041)	(0.036)
INF	0.036	0.010	0.003	0.059	0.003
	(0.030)	(0.039)	(0.023)	(0.046)	(0.026)
lnK	0.181 ***	0.157 ***	0.112 ***	0.139 ***	0.158 ***
	(0.039)	(0.042)	(0.022)	(0.047)	(0.030)
EBIC	−91.141	−109.957	−126.293	−114.201	−123.421
$Adj - R^2$	0.9874	0.9352	0.9665	0.9514	0.9689
McKinnon ADF test	0.0211	0.0000	0.0001	0.0031	0.0000

Note: The values in parentheses () show the standard error. ***, **, * indicates the significance level of 1%, 5% and 10%, respectively.

Table 4. Ridge kink regression results for all five countries.

Thailand		Singapore		Malaysia		Indonesia		Philippines	
Variable	**Estimate**	**Variable**	**Estimate**	**Variable**	**Estimate**	**Variable**	**Estimate**	**Variable**	**Estimate**
intercept	4.929 *** (1.166)	intercept	6.148 *** (2.255)	intercept	3.581 *** (1.010)	intercept	12.725 *** (1.194)	intercept	12.694 *** (2.113)
lnEXPSTU	0.174 *** (0.022)	lnEXPSTU	−0.057 (0.031)	lnEXPSTU	0.092 *** (0.026)	lnEXPSTU	0.041 (0.046)	lnEXPSTU	0.100 *** (0.024)
$(\text{lnPrimary} - 4.641)_-$	−0.015 (0.026)	lnPrimary	0.061 * (0.033)	lnPrimary	0.127 *** (0.031)	lnPrimary	−0.055 (0.033)	lnPrimary	−0.079 *** (0.016)
$(\text{lnPrimary} - 4.641)_+$	−0.020 (0.023)	lnSecondary	0.071 *** (0.023)	lnSecondary	0.034 (0.026)	$(\text{lnSecondary} - 4.269)_-$	0.171 *** (0.043)	$(\text{lnSecondary} - 4.420)_-$	0.093 *** (0.017)
$(\text{lnSecondary} - 4.406)_-$	0.097 *** (0.022)	$(\text{lnTertiary} - 4.161)_-$	−0.019 (0.037)	lnTertiary	0.079 ** (0.031)	$(\text{lnSecondary} - 4.269)_+$	0.188 *** (0.045)	$(\text{lnSecondary} - 4.420)_+$	0.061 *** (0.023)
$(\text{lnSecondary} - 4.406)_+$	0.081 *** (0.026)	$(\text{lnTertiary} - 4.161)_+$	0.160 *** (0.033)	$(\text{lnUNEM} - 1.038)_-$	0.061 *** (0.029)	$(\text{lnTertiary} - 3.124)_-$	0.003 *** (0.001)	lnTertiary	0.079 *** (0.021)
$(\text{lnTertiary} - 3.902)_-$	0.001 (0.024)	$(\text{lnUNEM} - 0.970)_-$	−0.126 *** (0.033)	$(\text{lnUNEM} - 1.038)_+$	−0.058 ** (0.025)	$(\text{lnTertiary} - 3.124)_+$	0.171 *** (0.042)	$(\text{lnUNEM} - 2.334)_-$	−0.201 *** (0.022)
$(\text{lnTertiary} - 3.902)_+$	0.044 ** (0.022)	$(\text{lnUNEM} - 0.970)_+$	−0.016 (0.028)	lnWORK	0.167 *** (0.023)	$(\text{lnUNEM} - 2.135)_-$	−0.024 (0.050)	$(\text{lnUNEM} - 2.334)_+$	−0.055 (0.015)
$(\text{lnUNEM} - 0.102)_-$	0.077 *** (0.023)	lnWORK	0.156 *** (0.026)	lnOPEN	−0.044 (0.034)	$(\text{lnUNEM} - 2.135)_+$	−0.018 (0.018)	lnWORK	0.017 (0.017)
$(\text{lnUNEM} - 0.102)_+$	−0.095 *** (0.022)	lnOPEN	−0.024 (0.033)	lnFDI	0.015 (0.019)	lnWORK	0.042 (0.048)	lnOPEN	−0.052 * (0.020)
lnWORK	0.098 *** (0.015)	lnFDI	0.093 *** (0.029)	lnRD	0.130 *** (0.029)	lnOPEN	−0.094 * (0.054)	lnFDI	0.002 (0.021)
lnOPEN	−0.054 ** (0.024)	lnRD	0.029 (0.027)	INF	0.002 (0.021)	lnFDI	0.006 (0.035)	lnRD	0.127 *** (0.018)
lnFDI	0.026 * (0.015)	INF	0.048 * (0.028)	lnK	0.103 *** (0.019)	lnRD	0.041 (0.036)	INF	0.011 (0.018)
$(\text{lnRD} - (-1.054))_-$	0.003 (0.028)	lnK	0.133 *** (0.023)			INF	0.067 * (0.039)	$(\text{lnK} - 12.904)_-$	0.125 *** (0.012)
$(\text{lnRD} - (-1.054))_+$	0.065 ** (0.026)					$(\text{lnK} - 14.122)_-$	0.150 *** (0.033)	$(\text{lnK} - 12.904)_+$	0.109 *** (0.014)
INF	0.037 (0.024)					$(\text{lnK} - 14.122)_+$	0.087 * (0.045)		
$(\text{lnK} - 13.492)_-$	0.131 *** (0.018)								
$(\text{lnK} - 13.492)_+$	0.106 ** (0.026)								
EBIC	−132.882		−115.463		−132.551		−122.991		132.229
$Adj - R^2$	0.9952		0.9878		0.9987		0.9854		0.9913
McKinnon ADF test	[0.0015]		[0.0000]		[0.0020]		[0.0051]		[0.0000]

Note: The values in parentheses () represent standard error and [] denotes *p*-value. ***, **, * indicates the significance level of 1%, 5% and 10%, respectively.

The empirical results for the ASEAN-5 countries obtained from the ridge kink regression model are provided in Table 4. As some of our variables are stationary at the first difference I(1), the spurious regression result is likely. Thus, we conduct the cointegration test of Engle and Granger [48] to confirm the long-run term relationship between the dependent variable and independent variables of our empirical models above. According to Engle and Granger [48], the absence of cointegration can be confirmed by the stationarity of the residuals of the model. Therefore, we use the McKinnon ADF test to investigate the cointegration in our kink model. This analysis is implemented in two steps. First, we estimate our kink regression model, and then the ADF test is applied to the error term series, obtained from the kink regression model, for unit root test. If the error is nonstationary or has a unit root, the null hypothesis of the existence of the cointegrating relationship can be rejected. The results of the cointegration test (McKinnon ADF test) for all empirical models are reported in the last row of Table 4. We observe that the p-values of the McKinnon ADF test are less than 0.10 for all models. Thus, we can confirm the existence of long-runterm relationships in our empirical models.

According to Table 4, the results demonstrate different coefficient values that could indicate differences in the way education affects growth in different countries. Furthermore, all regime-dependent variables exhibit a different sign or value of the education effect on growth when the variation in values is above/below their corresponding kink parameters. We note that lnEXPSTU, lnPrimary, lnSecondary, lnTertiary, lnUNEM, lnWORK refer to the education variables, while lnOPEN, lnFDI, INF, and lnK are control variables. Overall, we observe that most of the education variables significantly affect the ASEAN-5 countries. lnEXPSTU shows a significant and positive coefficient of 0.174, 0.092, and 0.100 on the economic growth of Thailand, Malaysia, and the Philippines, respectively. The positive impact of higher education expenditure on growth can conform to the literature. Higher education is more likely to bring about the invention of new technology and the spillover effects from new knowledge relative to the secondary and primary education levels, but the higher stages of learning require more resources. However, our finding shows that more investment for higher education can finally bring about economic growth in Thailand, Malaysia, and the Philippines.

We also observe a significant linear effect of lnPrimary on economic growth in Singapore, Malaysia, and the Philippines. The primary school enrollment variable shows only a negative impact on the economic growth of the Philippines, an insignificant effect for Indonesia and Thailand (both two regimes), but a positive effect for Singapore and Malaysia. The positive impact of primary education enrollment on growth was found in many previous studies. Primary enrollment rates can attract investment in the physical capital, thereby promoting economic growth. On the other hand, the findings of a negative impact of primary education on the economic growth of the Philippines and an insignificant effect in Thailand and Indonesia are not new. These results are consistent with the findings of Abbas and Nasir [50]. Primary education is the first and basic level of education before continuing to the higher stages. Thus, primary education may not produce a direct and short-term effect on the economy. Still, it is important for long-term economic growth and lowered fertility rates. Moreover, Pritchett [51] suggested that primary educational quality might be too low to improve the cognitive skills or productivity of the labor, thereby creating no human capital. The estimates of the impact of secondary enrollment rates are found to be significant and positive in most of the countries, except Malaysia. Besides, the impact appears to be nonlinear for the case of Thailand, Indonesia, and the Philippines. In Singapore, a 1% increase in the enrollment rate of secondary education would result in an approximately 0.071% increase in the economic growth. For the cases of Thailand, Indonesia, and the Philippines, similar results are obtained in that secondary education shows a significant and positive nonlinear impact on their economic growth. The estimated kink results indicate if lnSecondary is less than the kink point of 4.406 (exp(4.406) = 81.941%) for Thailand, 4.161 (exp(4.269) = 71.450%) for Indonesia, and 4.420 (exp(4.420) = 83.096%) for the Philippines, then a 1% increase in lnSecondary can contribute to a 0.097%, 0.171%,

and 0.093% increase in economic growth of Thailand, Indonesia, and the Philippines, respectively. However, if lnSecondary is larger than their kink points, a 1% increase in lnSecondary can contribute to 0.081%, 0.188%, and 0.061% increase in economic growth of Thailand, Indonesia, and the Philippines, respectively. It is noticed that the magnitude of the lnSecondary's effect on the economic growth of Thailand and Indonesia will become smaller, reflecting the operation of the law of diminishing returns of secondary education to economic growth. However, it can also be observed that the coefficient of lnSecondary effect for Indonesia is a bit higher in regime 2 (lnSecondary > 4.420) than in regime 1 (lnSecondary < 4.420). This indicates that the enrolment rate in secondary education has made a substantial contribution to the economic growth of Indonesia after the enrolment rate in secondary education increased beyond the kink point (4.406 or 83.096%).

While basic education can enhance economic growth, higher education measured by the tertiary enrollment rates can also play a vital role in economic growth in the ASEAN-5 countries. The results indicate that the estimated coefficients of lnTertiary are positive and significant for all ASEAN-5 countries. The impact of this variable on Thailand, Singapore, and Indonesia are distinguished into two regimes: regime 1 (lnTertiary $\leq \gamma_{lnTertiary}$) and regime 2 (lnTertiary $> \gamma_{lnTertiary}$). It is observed that, in the case of Thailand and Singapore, tertiary education has a significantly positive impact in regime 2 but this impact is insignificant in regime 1. The results imply that if the enrollment rates in tertiary education are high enough—particularly greater than the kink point—it will significantly increase economic growth in these two countries. We have estimated the kink points for the enrollment rates and found that the significant kink points of Thailand and Singapore are 3.902 (exp(3.902) = 49.501% for estimated enrollment rates) and 4.161 (exp(4.161) = 64.135%), respectively. In addition, the tertiary enrollment rates positively impact growth in both regimes 1 and 2 for Indonesia, and the impact is more substantial when the enrollment rates are above the kink point. Even though Malaysia and Indonesia fail to find a nonlinear effect, the sign of the impact is steadily positive.

Apparently, there exists a kink effect of unemployment with advanced education in every country. However, not all the countries can observe significant impacts in both regimes 1 and 2. Thailand and Malaysia have similar results, that is, an increase in the share of the unemployed workers with advanced education will increase economic growth if the percentage share is not over the kink points (exp(0.102) = 1.107% for Thailand and exp(1.038) = 2.823% for Malaysia). However, if the share is greater than those kink points, it may harm economic growth. Besides, the results of Singapore and the Philippines are similar. We find that a lower share of unemployment with a higher degree can increase economic growth, but only for any level of the share of unemployment less than the kink point. However, the estimated impacts are insignificant in regime 2. It is not surprising when our findings indicate a negative relationship between high-skilled unemployment and economic growth as a high-skilled workforce is considered key to long-term economic growth. Therefore, an increase in the share of unemployment with a high degree will reduce the opportunity to transfer knowledge from universities to the other economic units, thereby impeding economic growth. On the other hand, we find a surprising result in a positive relationship between high-skilled unemployment and economic growth in Thailand and Malaysia (in regime 1). The possible explanation for the positive impact of unemployment on growth may refer to the Schumpeterian models of growth through creative destruction [52]. Quality-improving innovations drive economic growth by new entrants that make existing firms and jobs antiquated [53]. This is to say, the outmoded or old-fashioned firms will soon be replaced by the new tech companies and the workers employed in the no longer profitable firms are likely to lose their jobs entirely. So, the workers who do not have sufficient skills to work with the new technology are likely to lose their jobs, but that may lead to the overall economic growth due to technological development. This result is consistent with the finding of Fanati and Manfredi [54] and Vo and Ho [55]. Considering the lnWORK variable, only Thailand, Singapore, and Malaysia show a positive relationship between workforce education and economic growth. Among

all countries, Malaysia's highly educated workforce has the most apparent effect on its economy, whereas Singapore takes second place, followed by Thailand.

With respect to the control variables, there is evidence of the linear effects of lnOPEN, lnFDI, lnRD, INF, and lnK on the economic growth of five countries (except for lnRD of Thailand, and lnK of Thailand, Indonesia, and the Philippines). We observe that lnOPEN of Thailand, Indonesia, and the Philippines have a negative and significant coefficient suggesting that the more liberalized the economies are, the less the impact on economic growth will be. The negative impact of trade openness on economic growth supports the previous findings of Belloumi and Alshehry [56]. The contribution of lnFDI to economic growth in Thailand and Singapore, in terms of the coefficients, are 0.026 and 0.093, respectively. The contribution of foreign direct investment to economic growth in Singapore is relatively higher than in Thailand. For the variable INF, we find that its elasticity is positive and significant for Singapore, Indonesia, and the Philippines.

Regarding the nonlinear effect variables namely lnRD of Thailand, and lnK of Thailand, Indonesia, and the Philippines; lnRD is positive and statistically significant only in regime 2 ($\ln RD > \gamma_{\ln RD}$) or when lnRD is higher than -1.054 ($\exp(-0.1054) = 0.348\%$ of GDP), while lnK shows a significant positive impact on economic growth in both the two regimes. However, as lnK continues to expand and exceeds the kink point, its role in the economies of Thailand, Indonesia, and the Philippines slows down. This implies that the scale of the capital has not only a kink effect but also a diminishing marginal efficiency effect on economic growth.

In essence, the impact of education on the economic growth of ASEAN-5 countries is obviously nonlinear as some indicators, in particular, lnTertiary, lnSecondary, and lnUNEM, show a significant kink effect, and the magnitudes of the impact are different between the two regimes. Evidently, the expenditure on education, the enrolment rates of secondary education, and tertiary education are important factors that result in boosting the economic growth of ASEAN-5 countries. However, the percentage of the unemployed labor with advanced education is a vital factor harming the economic growth in all countries except for Thailand and Malaysia. The result shows a positive effect of the unemployment rate on the economic growth of Thailand and Malaysia when its value is less than 1.107% and 2.823%, respectively. This indicates that when the unemployment rate is low, the increase in the unemployment rate, because of squeezing out of inefficient workers, could lead to the higher economic growth of Thailand and Malaysia. Furthermore, there is evidence that the major contributors to economic growth are the expenditure on education in Thailand, the enrollment rate of tertiary education (regime 2) in Singapore, the enrollment rate of primary education in Malaysia, the enrollment rate of secondary education (regime 2) in Indonesia, and the enrollment rate of secondary education (regime 1) in the Philippines.

5.3. Result at the ASEAN-5 Region Level

To investigate the overall impacts of education factors on the ASEAN-5's economic growth, this study further constructs the panel data analysis. In this section, the kink regression with ridge estimator is used in our analysis. Because the panel data are used, the kink regression model in Equation (1) can be rewritten into the form below:

$$Y_{it} = \beta_1^-(x_{1,it} - \gamma_1)_- + \beta_1^+(x_{1,it} - \gamma_1)_+ + \ldots + \beta_K^-(x_{K,it} - \gamma_K)_- + \beta_K^+(x_{K,it} - \gamma_K)_+ + \alpha Z_{it} + u_i + e_{it}, \quad (11)$$

where Y_{it} is the dependent variable of country i at time t. X_{it} denotes nonlinear independent variables, Z_{it} is a linear independent variable, u_i indicates the individual effect of each country, and e_{it} is the random standard error of country i at time t. To estimate the model, the fixed effect (FE) with ridge estimation is employed in this study. This estimation is preferable to the simple ridge alternative, as it includes the individual specific effect in the model to control for any unobserved country-specific effects in different countries and

also to address the heterogeneity among countries. To deal with the unobserved u_i, all variables are transformed as follows:

$$\widetilde{Y}_{it} = Y_{it} - \frac{1}{N}\sum_{i=1}^{N} Y_{it}, \tag{12}$$

$$\widetilde{X}_{it} = X_{it} - \frac{1}{N}\sum_{i=1}^{N} X_{it}, \tag{13}$$

$$\widetilde{Z}_{it} = Z_{it} - \frac{1}{N}\sum_{i=1}^{N} Z_{it}, \tag{14}$$

$$\widetilde{e}_{it} = e_{it} - \frac{1}{N}\sum_{i=1}^{N} e_{it}. \tag{15}$$

Then, we can rewrite our panel model (Equation (11)) as

$$\widetilde{Y}_{it} = \beta_0 + \beta_1^-(\widetilde{X}_{1,it} - \gamma)_- + \beta_1^+(\widetilde{X}_{1,it} - \gamma)_+ + \ldots + \beta_K^-(\widetilde{X}_{K,it} - \gamma_K)_- + \beta_1^+(\widetilde{X}_{K,it} - \gamma_K)_+ + \alpha\widetilde{Z}_{it} + \widetilde{e}_{it} \tag{16}$$

Then, we can use the ridge estimation (Section 3.2) for estimating $\boldsymbol{\beta} = (\beta_0, \beta_1^-, \ldots, \beta_K^-, \beta_1^+, \ldots, \beta_K^+, \alpha)$ and $\boldsymbol{\gamma} = (\gamma_1, \ldots, \gamma_K)$ of this fixed-effect model specification. Again, prior to conducting the panel analysis for the ASEAN-5 region, we need to test whether the kink effect exists for each variable. We use the F-statistic and bootstrap p-value as explained in Section 3.3. Table 5 presents the empirical results of the panel kink test for the ASEAN-5 region, which show that lnEXPSTU, lnSecondary, lnTertiary, lnUNEM, lnOPEN, lnFDI, lnRD have nonlinear effects on the ASEAN-5's economic growth. After the panel kink test, we analyze the impacts of education on the economic growth of the ASEAN-5 from 2000 to 2018. Finally, we obtain the results of the panel kink regression as reported in Table 6.

Table 5. Panel kink effect test: F_k^*.

	lnEXPSTU	**lnPrimary**	**lnSecondary**	**lnTertiary**	**UNEM**	**lnWORK**
ASEAN-5	**6.380 (0.091)**	4.612 (0.231)	**8.263 (0.000)**	**6.131 (0.055)**	**14.181 (0.000)**	3.421 (0.544)
	lnOPEN	lnFDI	lnRD	INF	lnK	
ASEAN-5	**12.980 (0.000)**	**12.988 (0.000)**	**7.340 (0.000)**	5.327 (0.451)	4.597 (0.511)	

Note: The values in parentheses () are p-values. Bold number indicates significant kink effect.

Table 6 shows that between the education variables and economic growth, there is a nonlinear relationship. The nonlinear impacts of lnSecondary, lnTertiary, and lnUNEM are found in the individual country (see Section 5.1) and also appear in the panel analysis. The only difference is that the variables, namely lnEXPSTU, lnOPEN, and lnFDI, also have nonlinear impacts on the ASEAN-5 region's economic growth, which we will discuss in the following paragraph. Note that in this study, heterogeneity is controlled by a fixed effect. However, the fixed effect reflects only the heterogeneity in intercepts [57]; therefore, taking into account fixed effects is still restrictive in estimating the panel data model [58]. Specifically, the fixed effect estimation handles heterogeneity in the intercept, but not heterogeneity in the slope parameters. Therefore, the results from time-series and panel data could be inconsistent. This indicates that the nonlinear effects of these three variables are due to the heterogeneous characteristics of the countries.

Moreover, it is noteworthy to compare our ridge-fixed effect estimation with other methods to prove the robustness of our estimation adopted for application in the panel education–growth model.

Table 6. Empirical results of the ASEAN-5 region obtained from the panel kink and the panel linear regressions.

	Panel Kink Regression				Panel Linear Regression		
Variable	**Ridge-Fixed Effect**	**Fixed Effect**	**Pooled OLS**		**Ridge-Fixed Effect**	**Fixed Effect**	**Pooled OLS**
intercept	8.947 **	6.311 **	7.554 **	intercept	7.183 ***	5.5241 ***	6.351 ***
	(0.981)	(1.235)	(1.556)		(1.244)	(2.1254)	(2.3121)
$(\ln EXPSTU - 6.872)_-$	0.066 ***	0.031	0.022	lnEXPSTU	0.038 *	0.042 *	0.040 *
	(0.027)	(0.031)	(0.004)		(0.015)	(0.016)	(0.017)
$(\ln EXPSTU - 6.872)_+$	0.186 ***	0.201 ***	0.239 ***	lnPrimary	0.443 ***	0.459 ***	0.598 **
	(0.031)	(0.038)	(0.054)		(0.156)	(0.211)	(0.306)
lnPrimary	0.059	0.024	0.022	lnSecondary	0.058	0.097	0.066
	(0.140)	(0.145)	(0.137)		(0.216)	(0.331)	(0.354)
$(\ln Secondary - 4.425)_-$	0.128	0.094	0.084	lnTertiary	0.685 ***	0.703 ***	0.689 ***
	(0.174)	(0.201)	(0.214)		(0.031)	(0.058)	(0.042)
$(\ln Secondary - 4.425)_+$	0.894 ***	0.944 ***	0.997 ***	lnUNEM	0.579 ***	0.504 **	0.588 **
	(0.130)	(0.208)	(0.258)		(0.218)	(0.225)	(0.301)
$(\ln Tertiary - 3.633)_-$	0.051 ***	0.031 ***	0.028 *	lnWORK	0.256 ***	0.121 ***	0.116 **
	(0.011)	(0.014)	(0.017)		(0.026)	(0.043)	(0.053)
$(\ln Tertiary - 3.633)_+$	0.749 ***	0.541 ***	0.587 ***	lnOPEN	0.459	0.368	0.549
	(0.020)	(0.103)	(0.233)		(0.341)	(0.368)	(0.401)
$(\ln UNEM - 1.316)_-$	0.874	0.778	0.651	lnFDI	0.148	0.012	0.034
	(0.753)	(0.711)	(0.783)		(0.161)	(0.222)	(0.235)
$(\ln UNEM - 1.316)_+$	−1.265 ***	−1.002 ***	−1.115 **	lnRD	1.443 ***	1.511 ***	1.124 ***
	(0.194)	(0.201)	(0.241)		(0.254)	(0.268)	(0.254)
lnWORK	0.301 ***	0.416 ***	0.497 ***	INF	−0.001	−0.001	−0.001
	(0.021)	(0.103)	(0.201)		(0.002)	(0.003)	(0.002)
$(\ln OPEN - 0.020)_-$	−0.402 *	−0.398 *	−0.518 *	lnK	0.031	0.026	0.013
	(0.231)	(0.264)	(0.298)		(0.035)	(0.042)	(0.051)
$(\ln OPEN - 0.020)_+$	0.738 **	0.722 **	0.601				
	(0.326)	(0.268)	(0.401)				
$(\ln FDI - 1.083)_-$	0.048	0.059	0.068				
	(0.084)	(0.089)	(0.101)				
$(\ln FDI - 1.083)_+$	0.756 **	0.561 **	0.439				
	(0.251)	(0.259)	(0.278)				
$(\ln RD - (-0.947))_-$	0.405 *	0.428 *	0.305				
	(0.199)	(0.214)	(0.206)				
$(\ln RD - (-0.947))_+$	0.958 ***	1.205 ***	1.358 ***				
	(0.215)	(0.365)	(0.554)				
INF	−0.089	−0.115	−0.126				
	(0.100)	(0.121)	(0.189)				
lnK	0.395 *	0.348 *	0.331				
	(0.235)	(0.254)	(0.267)				
EBIC	−439.350	−412.896	−359.35		−408.880	−398.684	−304.68
$Adj - R^2$	0.9944	0.9901	0.9899		0.9874	0.9887	0.9543

Note: The values in parentheses () represent standard error. ***, **, * indicates the significance level of 1%, 5% and 10%, respectively.

Therefore, we also consider the other two methods of estimation, namely fixed-effects and pooled OLS estimations, to test the robustness of the panel kink regression model. The results of kink and linear model estimations from the fixed-effects and pooled OLS variants are also reported in Table 6. The coefficients of the estimated variables from the fixed-effects model in the ridge regression framework are consistent with those from the fixed-effect and the pooled OLS alternatives. This result indicates that the ridge-fixed effect model has a good robustness. Moreover, we compare the performance of the ridge-fixed effect panel kink regression with other models using the EBIC. The results reported in the second-last row of Table 6 indicate a higher performance of our panel kink regression with a ridge-fixed effect. Therefore, we will interpret the results from the ridge-fixed effect panel-kink regression model (located in the second column of Table 6).

Now we turn to presenting the estimation of the panel kink regression with ridge-fixed effect. We find that the coefficients of lnPrimary and lnWORK are linear and positive. A highly educated workforce can positively affect the ASEAN-5's economic growth, while the enrollment rates of primary education do not signal direct benefits to the growth. This finding is in line with Keller [8], who revealed that primary enrollment rates do not directly affect economic growth globally, among developing and developed country subsamples (1960–2000). Nevertheless, primary enrollment rates can raise the secondary enrollment rates, which can significantly improve economic growth in this study.

Consider other education variables, lnEXPSTU, lnSecondary, lnTertiary, and lnUNEM. These variables are found to have nonlinear impacts on the economic growth. Firstly, public education expenditure per student at the tertiary level (lnEXPSTU) shows a positive slope for low lnEXPSTU with a significant kink point around (exp(6.872) = 964.876 USD per tertiary student), switching to a steeply positive slope for the lnEXPSTU beyond that kink value. The results imply that the higher expenditure on tertiary education, the more economic growth in the ASEAN-5 region. However, the positive impacts appear to be stronger when the expenditure is beyond the kink point (964.876 USD per tertiary student). Expenditure per tertiary student also includes grants/loans for higher-education students. Increased expenditure per tertiary student may increase the opportunity for poorer students to access the tertiary education. As a result, highly educated workers are supplied more to the labor market.

Secondly, the results show that the impacts of lnSecondary and lnTertiary are statistically significant and positive. When lnSecondary and lnTertiary exceed their kink points of 4.425 and 3.633, the contributions of the secondary and tertiary enrollment rates to the ASEAN-5's economic growth are 0.894 and 0.749, respectively. However, when lnTertiary is below its kink point, its contribution decreases to 0.051 while lnSecondary is statistically insignificant. There is no doubt that both levels of education can contribute substantially to economic growth. Interestingly, the magnitude of lnSecondary is slightly larger than lnTertiary (0.894 > 0.749) in regime 2. The result implies that secondary education can provide better economic returns or contribute more to the economy than higher education. The importance of secondary education, therefore, deserves our consideration. Secondary education enables workers to produce goods and services and use technology in their workplace. As the majority of the labor force in the ASEAN-5 region usually have secondary education, we might conclude that, so far, the ASEAN-5's economic growth has mainly been driven by secondary-school educated workers. However, the impacts of secondary and tertiary education levels are indistinguishable. According to the PISA surveys, the quality of secondary education can positively affect the efficiency of the tertiary education systems. Secondary-school students who have solid skills will be more likely to succeed when advancing to tertiary education than those with poorer skills. Hence, secondary education may indirectly enhance economic growth through its spillover effects on tertiary education. Thirdly, unemployment with advanced education (lnUNEM) has significant negative impacts on economic growth in ASEAN-5, as shown by a significant and negative coefficient of −1.265. However, the estimated result of regime 1 is not significant. The negative coefficient of lnUNEM indicates that for any level of the share of unemployment with advanced education in the total unemployment larger than the kink point (exp(1.316) = 3.728%), an increase in lnUNEM by 1% will lead to a decrease in the economic growth of the ASEAN-5 region by 1.265%.

Lastly, we turn into the control variables. The nonlinear relationships exist between trade openness, FDI, and RD. All the nonlinear control variables are relevant factors boosting economic growth in the regional analysis, except for the trade openness in regime 1. We observe that when the trade openness is below its kink point (exp(0.020) = 1.020 times the GDP), the higher trade openness does not lead to a substantial increase in economic growth, but the impact is rather negative. The result also reports that inflation has an estimated insignificant effect, while capital is positive and significant in the ASEAN-5 region. Besides, our findings reveal that RD is productivity enhancing. The impacts

of RD on the ASEAN-5's economic growth are larger when RD expenditure increases. In particular, the increases are twofold—in terms of the size of the coefficient—if RD expenditure is greater than the kink point (exp(0.947) = 2.578% of GDP).

Besides, to illustrate an overview of the nonlinear effects of some education indicators as well as some control variables on the ASEAN-5's economic growth, we depict the kink regression lines (red) in Figure 1. The horizontal axis is the nonlinear independent variable, while the vertical axis is economic growth (lnGDP). We can see that the coefficient slopes change when the education variables exceed their kink points. The regression line switches from the positive slope to the negative slope for the lnUNEM variable, from the negative slope to the positive slope for lnOPEN and lnFDI, and from weak positive to more substantially positive for lnEXPSTU, lnSecondary, lnTertiary, and lnRD. This illustration proves that there are nonlinear impacts of education on the economic growth in ASEAN-5.

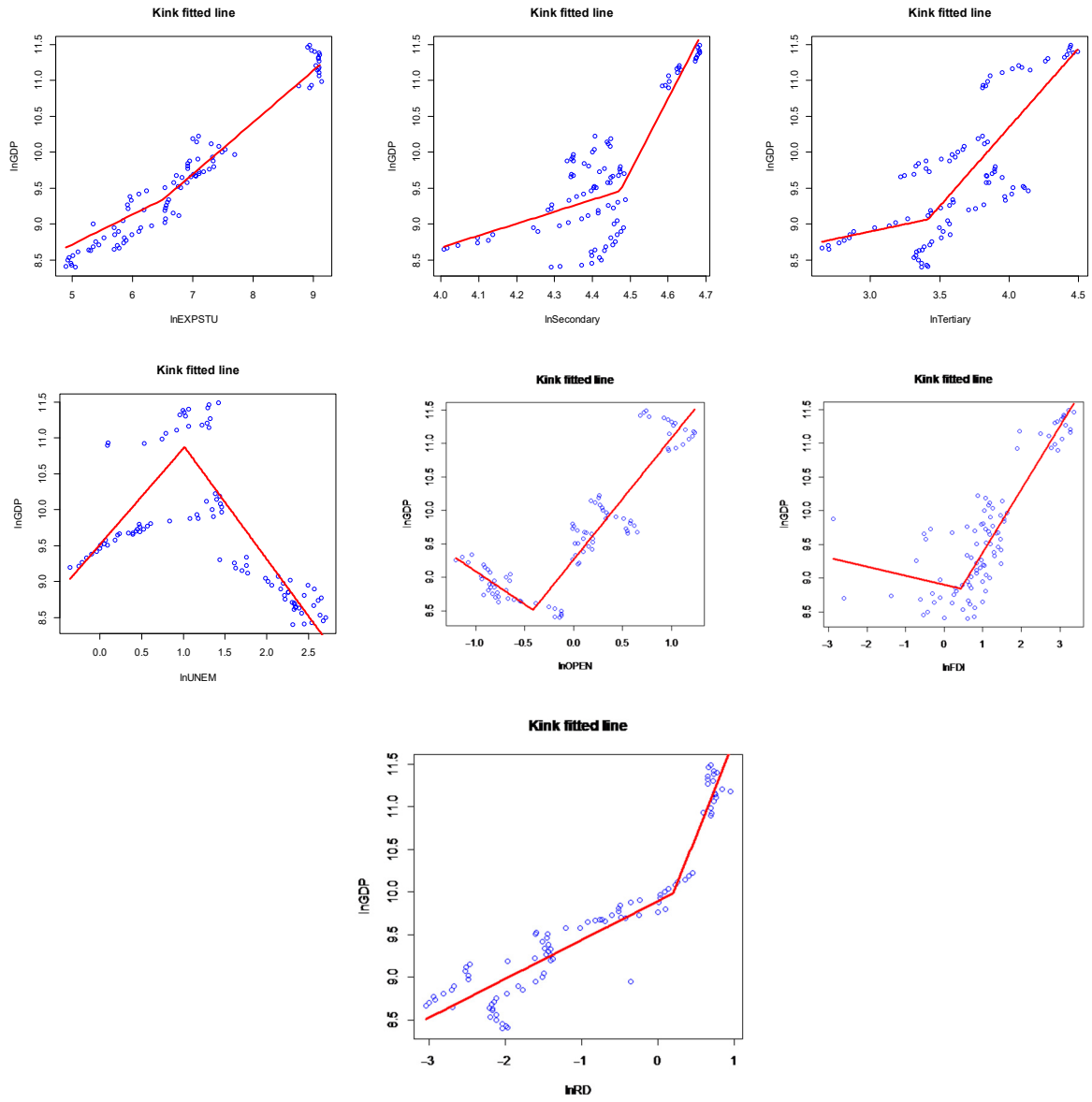

Figure 1. Panel kink regression lines between ASEAN-5 economic growth and its nonlinear covariates.

6. Conclusions

This study explored the nonlinear impacts of education (especially higher education) on economic growth in ASEAN-5 countries (i.e., Thailand, Indonesia, Malaysia, Singapore,

and the Philippines) over the period 2000–2018. The influences of education are evaluated through public expenditure on tertiary education per student, enrolment rates of primary, secondary, and tertiary levels, educated workforce, and the novelty of unemployment rates with advanced education along with the control variables: trade openness, FDI, research and development, inflation rate, and capital stocks. To perform the empirical analysis, we use the time-series kink regression and the panel kink regression to examine the nonlinear impacts of education on economic growth. Firstly, the time-series kink regression is estimated using the ridge estimation to examine the kink effect on the relationship between economic growth and each education variable as well as the control variables for all five countries in ASEAN-5 separately. Secondly, the panel kink regression estimated by the ridge estimator is conducted to examine and confirm the overall nonlinear education–growth nexus in the ASEAN-5 region. Note that this study considers the ridge estimation as many education variables are considered, while the ASEAN-5 data are limited. The multicollinearity problem and the problems of a small dataset are, respectively, of concern. Therefore, the ridge estimation is employed to fit the kink regression model for both time-series and panel cases.

The overall results suggest that the impacts of education on the ASEAN-5's economic growth do not indicate a linear relationship, but rather appear in line with the kink effect. The analyses of the individual country (time series) and the ASEAN-5 region (panel) are almost consistent and coherent, and they confirm the nonlinear impacts of some education indicators—especially the enrollment rates of secondary and tertiary education—on economic growth. It is evident that the magnitude of the education impacts is different depending on whether the coefficient value of the education variable is below or above its kink point. Considering individual country (time series) analysis, enrollment rates of secondary and tertiary education and the unemployment with advanced education have nonlinear impacts on economic growth in most ASEAN-5 countries. The number of unemployed graduates shows a negative impact on the economic growth in all countries except for Thailand and Malaysia which can be positive, while enrollment rates in secondary and tertiary education can significantly generate higher economic growth in most of the countries. However, the enrollment rates in tertiary education greater than the kink points (49.5%, 22.4%, and 64.14%) can generate larger impacts on economic growth in Thailand, Indonesia, and Singapore, respectively. Lastly, the results from the panel analysis reveal that the impacts of public expenditure per tertiary student on the ASEAN-5's economic growth are nonlinear, so are the enrollment rates of secondary and tertiary education, and unemployment with advanced education. Our findings show that the higher expenditure on the tertiary student, the greater the economic growth in the ASEAN-5 region. Additionally, secondary school enrollment can have significant and positive impacts on the growth if the enrollment rates are above the kink point, 83.513%. However, the impact of the enrollment rates of tertiary level can become twice as strong if the enrollment rates are greater than the kink point, 37.826%.

Policy Recommendations

Based on the empirical results, the following recommendations can be made to foster economic growth further.

First, this study finds that the secondary and tertiary enrollment rates are significant for the ASEAN-5's economic growth (both individual country and region). However, our analysis shows that there exist significant kink points of these education variables. Secondary education in terms of enrollment rates can only contribute to economic growth if the enrollment rates are greater than the kink point. Besides, the impacts of tertiary education in terms of the enrollment rates can become larger if the rates are beyond its kink point. Therefore, the government should pay attention to the kink values and impose the education policy that can help increase or at least maintain the enrollment rates of these two education levels in the ASEAN-5 region.

Second, the results of the individual country analysis and the regional analysis demonstrate the importance of the public expenditure per tertiary student. In particular, the regional analysis shows that the impacts of the expenditure on economic growth tend to increase when the expenditure is larger than the kink value (964.876 USD per tertiary student). This is the estimated result for the average ASEAN-5 region. However, according to the obtained data, most of the countries in ASEAN-5 have higher expenditure per tertiary student than the kink value, except for Indonesia and Malaysia which have lower expenditure than the estimated kink value. Some previous studies suggested that expenditure per student is beneficial for the economy in the early stage, but after that the impacts will be reduced due to the diminishing returns at higher expenditure levels. However, our findings reveal that this might not be true for the expenditure per student at the advanced education levels. There are higher returns on the investment at tertiary education. Unlike the skills obtained from basic education, technology and knowledge obtained from the universities never stop developing due to further research and development. Investment in tertiary education can bring about greater productivity, more innovation, and more creativity, which are the key to the knowledge-based economy.

Lastly, the unemployment rates with advanced education are considered a novelty in this study. We presume that the relationship between unemployment with advanced education and economic growth should be negative. The estimated results can conform to our hypothesis in many ASEAN-5 countries, except for Thailand and Malaysia. An increase in the share of the unemployment of advanced educated workers in the total unemployment appears to affect positively the economic growth of Thailand and Malaysia when the shares are below the kink values, 1.107% and 2.823%, respectively. However, when the shares of unemployment with advanced education in the total unemployment of these two countries exceed the kink values, the negative impacts on the growth are found. Hence, the governments of these two countries need to provide an appropriate policy to maintain the share of the unemployment with advanced education of Thailand and Malaysia at levels lower than 1.107% and 2.823%, respectively.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Descriptive statistics for five countries (Time series data).

Statistic	lnGDP	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	FDI	RD	INF	lnK
						Thailand						
Mean	9.523	6.627	4.642	4.406	3.921	0.102	10.521	0.081	0.934	−1.054	2.089	13.493
Maximum	9.803	7.355	4.663	4.484	4.135	0.475	10.582	0.196	1.480	0.098	5.469	13.984
Minimum	9.192	5.925	4.619	4.283	3.709	−0.357	10.404	−0.013	−0.474	−1.605	−0.900	12.816
Std. Dev.	0.185	0.498	0.013	0.066	0.119	0.261	0.054	0.075	0.577	0.549	1.769	0.421
ADF-Level	0.985	0.984	0.112	0.999	0.813	0.865	0.898	0.101	0.307	0.912	0.277	0.999
ADF-1st diff	0.000	0.099	0.000	0.021	0.001	0.094	0.040	0.000	0.000	0.084	0.000	0.071
						Singapore						
Mean	11.212	9.033	4.594	4.643	4.161	0.970	6.216	0.997	2.899	0.726	1.623	13.142
Maximum	11.490	9.139	4.624	4.683	4.494	1.423	6.735	1.239	3.364	0.954	6.628	13.747
Minimum	10.896	8.762	4.558	4.585	3.807	0.086	5.500	0.682	1.895	0.597	−0.532	12.459
Std. Dev.	0.189	0.095	0.024	0.036	0.258	0.385	0.373	0.172	0.404	0.078	1.971	0.473
ADF-Level	0.999	0.639	0.893	0.977	0.999	0.941	0.999	0.303	0.903	0.690	0.109	0.990
ADF-1st diff	0.020	0.000	0.000	0.000	0.021	0.006	0.074	0.000	0.000	0.000	0.000	0.089
						Malaysia						
Mean	9.923	7.155	4.613	4.388	3.536	1.038	7.860	0.411	0.943	−0.135	2.240	12.978
Maximum	10.223	7.703	4.663	4.448	3.845	1.459	8.391	0.653	1.624	0.457	5.441	13.584
Minimum	9.659	6.731	4.571	4.332	3.219	0.337	7.232	0.175	−2.870	−0.757	0.583	12.212
Std. Dev.	0.178	0.260	0.031	0.042	0.201	0.419	0.372	0.153	1.030	0.398	1.196	0.506
ADF-Level	0.999	0.801	0.995	0.800	0.990	0.861	1.000	0.142	0.157	0.999	0.637	0.978
ADF-1st diff	0.094	0.000	0.015	0.002	0.006	0.000	0.100	0.008	0.000	0.009	0.000	0.100
						Indonesia						
Mean	9.039	6.341	4.679	4.312	3.202	2.065	9.161	−0.903	0.325	−2.180	3.925	14.327
Maximum	9.339	6.772	4.700	4.488	3.596	2.653	9.681	−0.655	1.070	−0.355	8.200	14.914
Minimum	8.699	5.753	4.660	4.046	2.695	1.435	8.491	−1.202	−2.602	−2.996	0.700	13.057
Std. Dev.	0.199	0.328	0.014	0.145	0.315	0.392	0.365	0.152	0.928	0.730	1.905	0.615
ADF-Level	0.999	0.987	0.498	0.999	0.999	0.186	0.925	0.951	0.126	0.123	0.170	0.981
ADF-1st diff	0.075	0.003	0.000	0.003	0.016	0.000	0.015	0.000	0.000	0.000	0.000	0.098

Table A1. *Cont.*

Statistic	lnGDP	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	FDI	RD	INF	lnK
						Philippines						
Mean	8.677	5.296	4.686	4.421	3.426	2.335	9.213	−0.518	0.356	−1.982	3.908	12.905
Maximum	9.050	5.844	4.728	4.483	3.573	2.708	9.267	−0.124	1.185	−1.492	8.260	13.332
Minimum	8.402	4.904	4.644	4.291	3.315	1.988	9.155	−0.869	−0.623	−2.207	0.674	12.295
Std. Dev.	0.205	0.310	0.024	0.052	0.087	0.208	0.037	0.301	0.554	0.232	1.824	0.403
ADF-Level	0.845	0.918	0.680	0.987	0.925	0.230	0.613	0.815	0.528	0.976	0.272	0.980
ADF-1st diff	0.054	0.000	0.023	0.012	0.000	0.006	0.000	0.007	0.000	0.002	0.000	0.008

Note: *p* values are reported in parentheses.

Table A2. Descriptive statistics for ASEAN-5 (panel data).

Statistic	lnGDP	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	lnFDI	lnRD	INF	lnK
Mean	9.695	6.908	4.642	4.438	3.664	1.277	8.576	0.043	1.117	−0.884	2.719	13.338
Median	9.578	6.790	4.647	4.432	3.604	1.308	9.146	0.098	1.055	−0.968	2.591	13.315
Maximum	11.490	9.139	4.728	4.683	4.494	2.708	10.582	1.239	3.364	0.954	8.260	14.914
Minimum	8.402	4.904	4.558	4.046	2.695	−0.357	5.500	−1.202	−2.870	−2.996	−0.900	12.212
Std. Dev.	0.908	1.293	0.042	0.134	0.400	0.880	1.511	0.689	1.191	1.184	1.964	0.690
Skewness	0.609	0.441	−0.177	−0.089	0.040	−0.070	−0.411	−0.040	−0.256	0.039	0.534	0.520
Kurtosis	2.276	2.212	2.190	3.508	2.783	1.815	2.074	1.918	4.150	1.645	2.997	2.834
LLC-Level	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: *p* values are reported in parentheses.

Table A3. Correlations for Thailand.

Variable	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	lnFDI	lnRD	INF	lnK
lnEXPSTU	1.000										
lnPrimary	−0.820	1.000									
lnSecondary	0.911	−0.861	1.000								
lnTertiary	−0.048	−0.023	0.166	1.000							
lnUNEM	0.925	−0.939	0.918	−0.032	1.000						
lnWORK	0.845	−0.714	0.943	0.219	0.781	1.000					
lnOPEN	−0.078	0.134	0.113	0.291	−0.159	0.264	1.000				
lnFDI	−0.601	0.458	−0.462	0.211	−0.600	−0.373	0.227	1.000			
lnRD	0.758	−0.845	0.647	−0.229	0.860	0.447	−0.431	−0.487	1.000		
lnINF	−0.289	0.283	−0.110	0.401	−0.348	−0.011	0.843	0.401	−0.447	1.000	
lnK	0.956	−0.817	0.974	0.080	0.900	0.950	0.121	−0.493	0.647	−0.111	1.000

Note: To simplify the results, we highlight the strength of the correlation in color for the absolute values of the correlation ranging between 0− and 0.30 (green), between 0.31− and 0.80 (yellow), and between 0.81− and 1.0 (orange) which indicate the weak, moderate, and strong correlation, respectively.

Table A4. Correlations for Singapore.

Variable	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	lnFDI	lnRD	INF	lnK
lnEXPSTU	1.000										
lnPrimary	0.215	1.000									
lnSecondary	0.187	0.966	1.000								
lnTertiary	0.106	0.933	0.981	1.000							
lnUNEM	0.176	0.621	0.668	0.678	1.000						
lnWORK	0.131	0.876	0.949	0.967	0.796	1.000					
lnOPEN	0.523	−0.507	−0.617	−0.663	−0.313	−0.618	1.000				
lnFDI	0.119	0.409	0.501	0.462	0.373	0.466	−0.352	1.000			
lnRD	0.224	−0.126	−0.085	−0.044	0.332	0.056	0.362	−0.297	1.000		
INF	0.454	0.256	0.112	0.067	0.101	0.059	0.446	−0.258	0.339	1.000	
lnK	0.121	0.920	0.968	0.988	0.741	0.979	−0.635	0.421	0.033	0.140	1.000

Note: To simplify the results, we highlight the strength of the correlation in color for the absolute values of the correlation ranging between 0− and 0.30 (green), between 0.31− and 0.80 (yellow), and between 0.81− and 1.0 (orange) which indicate the weak, moderate, and strong correlation, respectively.

Table A5. Correlations for Malaysia.

Variable	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	lnFDI	lnRD	INF	lnK
lnEXPSTU	1.000										
lnPrimary	0.393	1.000									
lnSecondary	0.073	0.719	1.000								
lnTertiary	0.535	0.859	0.591	1.000							
lnUNEM	0.687	0.749	0.331	0.868	1.000						
lnWORK	0.568	0.889	0.568	0.975	0.911	1.000					
lnOPEN	−0.654	−0.806	−0.444	−0.955	−0.897	−0.947	1.000				
lnFDI	0.017	0.075	0.117	0.082	0.162	0.102	0.027	1.000			
lnRD	0.487	0.896	0.536	0.966	0.862	0.973	−0.947	0.010	1.000		
INF	0.005	0.057	0.063	0.065	0.337	0.144	−0.057	0.371	0.054	1.000	
lnK	0.678	0.859	0.466	0.932	0.959	0.974	−0.939	0.142	0.931	0.181	1.000

Note: To simplify the results, we highlight the strength of the correlation in color for the absolute values of the correlation ranging between 0− and 0.30 (green), between 0.31− and 0.80 (yellow), and between 0.81− and 1.0 (orange) which indicate the weak, moderate, and strong correlation, respectively.

Table A6. Correlations for Indonesia.

Variable	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	lnFDI	lnRD	INF	lnK
lnEXPSTU	1.000										
lnPrimary	−0.505	1.000									
lnSecondary	0.963	−0.627	1.000								
lnTertiary	0.947	−0.696	0.976	1.000							
lnUNEM	−0.822	0.719	−0.824	−0.900	1.000						
lnWORK	0.792	−0.604	0.837	0.860	−0.687	1.000					
lnOPEN	−0.724	0.599	−0.807	−0.808	0.704	−0.787	1.000				
lnFDI	0.674	−0.414	0.676	0.612	−0.452	0.432	−0.442	1.000			
lnRD	0.211	−0.372	0.304	0.304	−0.136	0.196	−0.077	0.213	1.000		
INF	−0.433	0.208	−0.458	−0.445	0.449	−0.493	0.746	−0.170	0.305	1.000	
lnK	0.977	−0.608	0.985	0.959	−0.816	0.777	−0.757	0.729	0.312	−0.380	1.000

Note: To simplify the results, we highlight the strength of the correlation in color for the absolute values of the correlation ranging between 0− and 0.30 (green), between 0.31− and 0.80 (yellow), and between 0.81− and 1.0 (orange) which indicate the weak, moderate, and strong correlation, respectively.

Table A7. Correlations for Philippines.

Variable	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	lnFDI	lnRD	INF	lnK
lnEXPSTU	1.000										
lnPrimary	0.628	1.000									
lnSecondary	0.758	0.343	1.000								
lnTertiary	0.809	0.692	0.561	1.000							
lnUNEM	−0.803	−0.405	−0.445	−0.733	1.000						
lnWORK	0.037	0.024	0.032	−0.053	−0.249	1.000					
lnOPEN	−0.878	−0.601	−0.782	−0.669	0.764	−0.123	1.000				
lnFDI	0.400	0.018	0.239	0.548	−0.599	0.180	−0.192	1.000			
lnRD	0.610	0.310	0.403	0.829	−0.639	−0.091	−0.351	0.788	1.000		
INF	−0.363	−0.525	−0.308	−0.438	0.294	0.121	0.333	−0.293	−0.351	1.000	
lnK	0.904	0.461	0.843	0.719	−0.818	0.144	−0.955	0.357	0.482	−0.277	1.000

Note: To simplify the results, we highlight the strength of the correlation in color for the absolute values of the correlation ranging between 0− and 0.30 (green), between 0.31− and 0.80 (yellow), and between 0.81− and 1.0 (orange) which indicate the weak, moderate, and strong correlation, respectively.

Table A8. Correlations for ASEAN-5.

Variable	lnEXPSTU	lnPrimary	lnSecondary	lnTertiary	lnUNEM	lnWORK	lnOPEN	lnFDI	lnRD	INF	lnK
lnEXPSTU	1.000										
lnPrimary	−0.944	1.000									
lnSecondary	0.935	−0.888	1.000								
lnTertiary	−0.261	0.242	−0.073	1.000							
lnUNEM	0.474	−0.379	0.643	−0.016	1.000						
lnWORK	−0.812	0.876	−0.649	0.290	0.078	1.000					
lnOPEN	0.792	−0.842	0.672	−0.204	−0.089	−0.966	1.000				
lnFDI	0.717	−0.814	0.568	−0.225	−0.196	−0.966	0.944	1.000			
lnRD	0.928	−0.963	0.822	−0.355	0.384	−0.856	0.782	0.781	1.000		
INF	−0.292	0.272	−0.189	0.425	−0.334	0.160	0.052	−0.062	−0.361	1.000	
lnK	−0.083	0.251	0.158	0.234	0.742	0.637	−0.568	−0.686	−0.274	0.012	1.000

Note: To simplify the results, we highlight the strength of the correlation in color for the absolute values of the correlation ranging between 0− and 0.30 (green), between 0.31− and 0.80 (yellow), and between 0.81− and 1.0 (orange) which indicate the weak, moderate, and strong correlation, respectively.

References

1. Volchik, V.; Oganesyan, A.; Olejarz, T. Higher Education as a Factor of Socio-Economic Performance and Development. *J. Int. Stud.* **2018**, *11*, 326–340. [CrossRef] [PubMed]
2. Holland, D.; Liadze, I.; Rienzo, C.; Wilkinson, D. *The Relationship between Graduates and Economic Growth across Countries*; BIS Research Paper 110; Department for Business Innovation & Skills: London, UK, 2013.

3. Gyimah-Brempong, K.; Paddison, O.; Mitiku, W. Higher Education and Economic Growth in Africa. *J. Dev. Stud.* **2006**, *42*, 509–529. [CrossRef]
4. Holmes, C. Has the Expansion of Higher Education Led to Greater Economic Growth? *Natl. Inst. Econ. Rev.* **2013**, *224*, R29–R47. [CrossRef]
5. Valero, A.; Van Reenen, J. The Economic Impact of Universities: Evidence from across the Globe. *Econ. Educ. Rev.* **2019**, *68*, 53–67. [CrossRef]
6. Szarowská, I. Does Public R&D Expenditure Matter for Economic Growth? *J. Int. Stud.* **2017**, *10*, 90–103.
7. Carrillo, M. Measuring and Ranking R&D Performance at the Country Level. *Econ. Sociol.* **2019**, *12*, 100–114.
8. Keller, K.R. Investment in Primary, Secondary, and Higher Education and the Effects on Economic Growth. *Contemp. Econ. Policy* **2006**, *24*, 18–34. [CrossRef]
9. Bilan, Y.; Mishchuk, H.; Roshchyk, I.; Kmecova, I. An Analysis of Intellecutal Potential and its Impact on the Social and Economic Development of European Countries. *J. Compet.* **2020**, *12*, 22. [CrossRef]
10. Ganegodage, K.R.; Rambaldi, A.N. The Impact of Education Investment on Sri Lankan Economic Growth. *Econ. Educ. Rev.* **2011**, *30*, 1491–1502. [CrossRef]
11. Mercan, M.; Sezer, S. The Effect of Education Expenditure on Economic Growth: The Case of Turkey. *Procedia Soc. Behav. Sci.* **2014**, *109*, 925–930. [CrossRef]
12. Jin, L.; Jin, J.C. Internet Education and Economic Growth: Evidence from Cross-Country Regressions. *Economies* **2014**, *2*, 78–94. [CrossRef]
13. Liao, L.; Du, M.; Wang, B.; Yu, Y. The Impact of Educational Investment on Sustainable Economic Growth in Guangdong, China: A Cointegration and Causality Analysis. *Sustainability* **2019**, *11*, 766. [CrossRef]
14. Maneejuk, P.; Yamaka, W.; Sriboonchitta, S. Does the Kuznets Curve Exist in Thailand? A Two Decades' Perspective (1993–2015). *Ann. Oper. Res.* **2019**, 1–32. [CrossRef]
15. Schultz, T.W. Investment in Human Capital. *Am. Econ. Rev.* **1961**, *51*, 1–17.
16. Mincer, J. *Schooling, Experience, and Earnings*; Columbia University Press: New York, NY, USA, 1974.
17. Solow, R.M. Technical Change and the Aggregate Production Function. *Rev. Econ. Stat.* **1957**, *39*, 312–320. [CrossRef]
18. Lucas, R.E., Jr. On the Mechanics of Economic Development. *J. Monet. Econ.* **1988**, *22*, 3–42. [CrossRef]
19. Romer, P. Endogenous Technological Change. *J. Political Econ.* **1990**, *99*, S71–S102. [CrossRef]
20. Mankiw, N.G.; Romer, D.; Weil, D.N. A Contribution to the Empirics of Economic Growth. *Q. J. Econ.* **1992**, *107*, 407–437. [CrossRef]
21. Barro, R.J. Economic Growth in a Cross Section of Countries. *Q. J. Econ.* **1991**, *106*, 407–443. [CrossRef]
22. Habibi, F.; Zabardast, M.A. Digitalization, Education and Economic Growth: A Comparative Analysis of Middle East and OECD Countries. *Technol. Soc.* **2020**, *63*, 101370. [CrossRef]
23. Saviotti, P.P.; Pyka, A.; Jun, B. Education, Structural Change and Economic Development. *Struct. Chang. Econ. Dyn.* **2016**, *38*, 55–68. [CrossRef]
24. Hanushek, E.A.; Woessmann, L. How Much Do Educational Outcomes Matter in OECD Countries? *Econ. Policy* **2011**, *26*, 427–491. [CrossRef]
25. Cohen, D.; Soto, M. Growth and Human Capital: Good Data, Good Results. *J. Econ. Growth* **2007**, *12*, 51–76. [CrossRef]
26. Barro, R.J.; Lee, J.W. A New Data Set of Educational Attainment in the World, 1950–2010. *J. Dev. Econ.* **2013**, *104*, 184–198. [CrossRef]
27. Wobst, P.H.S.A. The Impact of Increased School Enrollment on Economic Growth in Tanzania. *Afr. Dev. Rev.* **2005**, *17*, 274–301. [CrossRef]
28. Lin, T.C. Education, Technical Progress, and Economic Growth: The Case of Taiwan. *Econ. Educ. Rev.* **2003**, *22*, 213–220. [CrossRef]
29. Lin, T.C. The Role of Higher Education in Economic Development: An Empirical Study of Taiwan Case. *J. Asian Econ.* **2004**, *15*, 355–371. [CrossRef]
30. Achim, M.V. The New Economy-Asking for New Education Approaches. Evidence for Romania and Other Post-communist European Countries. *Procedia Econ. Finance* **2015**, *32*, 1199–1208. [CrossRef]
31. Zhu, X. The Effect of Education on Economic Growth—An Empirical Research Based on the EBA Model. *J. Interdiscip. Math.* **2014**, *17*, 67–79. [CrossRef]
32. Abu, B.N.; Haseeb, M.; Azam, M. The Nexus between Education and Economic Growth in Malaysia: Cointegration and Toda-Yamamoto Causality Approach. *Actual Probl. Econ.* **2014**, *162*, 131–141.
33. Sylwester, K. Income inequality, education expenditures, and growth. *J. Dev. Econ.* **2000**, *63*, 379–398. [CrossRef]
34. Krueger, A.B.; Lindahl, M. Education for Growth: Why and for Whom? *J. Econ. Lit.* **2001**, *39*, 1101–1136. [CrossRef]
35. Jalil, A.; Idrees, M. Modeling the Impact of Education on the Economic Growth: Evidence from Aggregated and Disaggregated Time Series Data of Pakistan. *Econ. Model.* **2013**, *31*, 383–388. [CrossRef]
36. Marquez-Ramos, L.; Mourelle, E. Education and Economic Growth: An Empirical Analysis of Nonlinearities. *Appl. Econ. Anal.* **2019**, *27*, 21–45. [CrossRef]
37. Hansen, B.E. Regression Kink with an Unknown Threshold. *J. Bus. Econ. Stat.* **2017**, *35*, 228–240. [CrossRef]
38. Pipitpojanakarn, V.; Maneejuk, P.; Yamaka, W.; Sriboonchitta, S. Expectile and Quantile Kink Regressions with Unknown Threshold. *Adv. Sci. Lett.* **2017**, *23*, 10743–10747. [CrossRef]

39. Maneejuk, N.; Ratchakom, S.; Maneejuk, P.; Yamaka, W. Does the Environmental Kuznets Curve Exist? An International Study. *Sustainability* **2020**, *12*, 9117. [CrossRef]
40. Chen, Z.; Wu, Y. The Relationship between Education and Employment: A Theoretical Analysis and Empirical Test. *Front. Econ. China* **2007**, *2*, 187–211. [CrossRef]
41. Abdullah, A.J. Education and Economic Growth in Malaysia: The Issues of Education Data. *Procedia Econ. Finance* **2013**, *7*, 65–72. [CrossRef]
42. Birchler, K.; Michaelowa, K. Making Aid Work for Education in Developing Countries: An Analysis of Aid Effectiveness for Primary Education Coverage and Quality. *Int. J. Educ. Dev.* **2016**, *48*, 37–52. [CrossRef]
43. Mason, R.; Brown, W.G. Multicollinearity Problems and Ridge Regression in Sociological Models. *Soc. Sci. Res.* **1975**, *4*, 135–149. [CrossRef]
44. Hoerl, A.E.; Kennard, R.W. Ridge Regression: Biased Estimation for Nonorthogonal Problems. *Technometrics* **1970**, *12*, 55–67. [CrossRef]
45. Weissfeld, L.A.; Sereika, S.M. A Multicollinearity Diagnostic for Generalized Linear Models. *Commun. Stat. Theory Methods* **1991**, *20*, 1183–1198. [CrossRef]
46. Perez Melo, S.; Kibria, B.M. On Some Test Statistics for Testing the Regression Coefficients in Presence of Multicollinearity: A Simulation Study. *Stats* **2020**, *3*, 40–55. [CrossRef]
47. Zhang, J.; Cheng, L. Threshold Effect of Tourism Development on Economic Growth Following a Disaster Shock: Evidence from the Wenchuan Earthquake, PR China. *Sustainability* **2019**, *11*, 371. [CrossRef]
48. Engle, R.F.; Granger, C.W. Co-integration and Error Correction: Representation, Estimation, and Testing. *Econom. J. Econom. Soc.* **1987**, *55*, 251–276. [CrossRef]
49. Radu, M. The Impact of Political Determinants on Economic Growth in CEE Countries. *Procedia Soc. Behav. Sci.* **2015**, *197*, 1990–1996. [CrossRef]
50. Abbas, Q.; Nasir, Z.M. Endogenous Growth and Human Capital: A Comparative Study of Pakistan and Sri Lanka. *Pak. Dev. Rev.* **2001**, *40*, 987–1007. [CrossRef]
51. Pritchett, L. Where Has All the Education Gone? *World Bank Econ. Rev.* **2001**, *15*, 367–391. [CrossRef]
52. Aghion, P.; Howitt, P. Growth and Unemployment. *Rev. Econ. Stud.* **1994**, *61*, 477–494. [CrossRef]
53. Aghion, P.; Akcigit, U.; Deaton, A.; Roulet, A. Creative Destruction and Subjective Well-Being. *Am. Econ. Rev.* **2016**, *106*, 3869–3897. [CrossRef] [PubMed]
54. Fanati, L.; Manfredi, P. Population, Unemployment and Economic Growth Cycles: A Further Explanatory Perspective. *Metroeconomica* **2003**, *54*, 179–207. [CrossRef]
55. Vo, D.H.; Ho, C.M. Does Financial Integration Enhance Economic Growth in China? *Economies* **2020**, *8*, 65. [CrossRef]
56. Belloumi, M.; Alshehry, A.S. The Impact of International Trade on Sustainable Development in Saudi Arabia. *Sustainability* **2020**, *12*, 5421. [CrossRef]
57. Wang, Q. Fixed-Effect Panel Threshold Model Using Stata. *Stata J. Promot. Commun. Stat. Stata* **2015**, *15*, 121–134. [CrossRef]
58. Miao, K.; Li, K.; Su, L. Panel Threshold Models with Interactive Fixed Effects. *J. Econ.* **2020**, *219*, 137–170. [CrossRef]

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Do Emotional Competencies Influence Students' Entrepreneurial Intentions?

Krystian Bigos * and Adam Michalik

Department of International Trade, Cracow University of Economics, 31-510 Cracow, Poland; michalia@uek.krakow.pl

* Correspondence: bigosk@uek.krakow.pl

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Abstract: Entrepreneurship is one of the critical determinants of economic development. In this research area, many scientists are trying to identify the competencies that influence later decisions about starting a business—so-called entrepreneurial intentions. The subject of the research contained in this article is the relationship between emotional competencies and declared entrepreneurial intentions, which, according to the authors, constitute an added value supporting research in the field of education for entrepreneurship. The article contributes to developing behavioral theories and solves the problem of identifying essential competencies to start a business. The survey was conducted among 209 students at Cracow University of Economics. Based on a binomial logistic regression model applied in the study, a statistically significant correlation between self-awareness and self-motivation and the students' entrepreneurial intentions was demonstrated. In contrast, the statistically significant influence of self-regulation, empathy, and social skills on the formation of these intentions was not confirmed. Therefore, to shape entrepreneurial intentions, the education process should support developing these two key factors: self-awareness and self-motivation of young people. Decision-makers should formulate the syllabuses to develop the students' emotional competencies, which, in turn, are a source of entrepreneurial intentions.

Keywords: entrepreneurial intentions; emotional competencies; behavioral competencies; entrepreneurial education

1. Introduction

Entrepreneurship is one of the critical determinants of the economic growth of countries [1–3]. It is assumed that nearly 99.8% of the total number of enterprises in the European Union are micro, small, and medium-sized, which employ just over 66% of productive-age people and generate 57% of added value in the EU economy [4]. Due to the dynamic nature of economic changes globally, it is crucial to support education in entrepreneurship, which must meet new challenges [5], especially in identifying and developing essential skills and attitudes of future managers [6]. The number of publications published in recent years shows that entrepreneurship education is one of the fastest-growing research areas [7–13]. In this research area, many scientists are trying to identify the competencies that influence later decisions about starting a business—the so-called entrepreneurial intentions (It is worth mentioning here that Ajzen [14,15] was the forerunner of entrepreneurial intentions research) [16–19]. Their characteristic feature is the fact that they must meet the expectations of a dynamically developing market.

Many scientific publications draw attention to the fact that a comprehensive educational process, the aim of which should primarily be to shape entrepreneurial attitudes, is a determinant of the proper participation of individuals in social and economic life and is essential for the development of the competitiveness of enterprises and the economy [20–22].

The topics we address fit into the current research on entrepreneurship education, which indirectly links to almost all of the new 2013 Agenda's Sustainable Development Goals of the United Nations (SDG) [23,24]. In the face of persistently high unemployment levels among young people [25], it is essential to proactively support actions to increase (self-)employment among these people by undertaking broadly defined inclusive actions. In this way, at least two out of 17 goals of the SDG can be achieved, mainly goal 4 of the SDG relating to ensuring inclusive and equitable education by promoting lifelong learning opportunities, and goal 8 of the SDG relating to the promotion of sustainable, full, and productive employment and decent work for all [23]. Education for sustainable development should aim at developing competencies that mainly enable individuals to reflect on their own activities. The UNESCO report entitled "Education for sustainable development goals. Learning objectives" lists eight critical competencies for sustainability [26]: (1) systems thinking competency, (2) anticipatory competency, (3) normative competency, (4) strategic competency, (5) collaboration competency, (6) critical thinking competency, (7) self-awareness competency, and (8) integrated problem-solving competency. This type of competence also includes emotional competence, which is known as a set of behaviors that individuals use to recognize and manage their own and others' emotions.

In this study, we examine whether emotional competencies impact the entrepreneurial intentions of students. The central premise leading us to take up this topic is that our emotions influence our behaviors and decisions [27] and, consequently, our propensity to start a business [28–30]. The article fills the research gap in the broadly defined psychology of entrepreneurship [31], derived from cognitive psychology [32], which is currently one of the most dynamically developing research areas [8,19,28,29]. Unfortunately, relatively few researchers have investigated the relationship between students' emotional competencies and their entrepreneurial intentions. So far, this topic has developed in the current of Ajzen's theory [14,15], but not from the emotional competencies viewpoint. The article will enhance our understanding of students' emotional characteristics and critical competencies important in entrepreneurial inclinations. We expect to provide a new perspective on entrepreneurial education. Therefore, we set the article's aim to empirically verify the impact of emotional competence on students' entrepreneurial intentions.

The article consists of two parts: theoretical and empirical. In the theoretical part, based on a critical analysis of the literature, we present the relationship between emotional competencies and students' sustainable entrepreneurial intentions. On their basis, we derive research hypotheses. On the other hand, in the empirical part, we use logistic regression to statistically confirm the interdependence between Goleman's five types of emotional competencies [33] and students' willingness to start a business in the future. The calculations were based on a sample of 209 students of International Economic Relations at Cracow University of Economics.

2. Theoretical Background and Literature Review

Competence is usually described as a combination of three essential elements: knowledge, skills, and attitudes [34]. Similarly, Hayton and Kelley [35], based on the competence-based approach, propose a definition of competence as an aggregate of specific knowledge, skills, and personality. They point out that some researchers treat them as equivalent to such terms as ability, skills, and knowledge, thus omitting attitudes. In turn, Boyatzis [36] understands competence as either capability or ability. Others, such as MacLean and Scott [37], recall the definition proposed by the ASTD (American Society for Training and Development) that competence focuses on the skills, knowledge, abilities, and behaviors needed to succeed at work.

In the literature on the subject, we are relatively often dealing with behavioral competencies, which are defined as "a set of related but different sets of behavior organized around an underlying construct called the 'intent'" [36]. As confirmed by many researchers, these competencies significantly impact individuals' entrepreneurial intentions [9,11,38–40]. For example, Sánchez [39] lists self-efficacy (1), proactiveness (2), and risk-taking propensity (3) among its behavioral competencies. His study, based on a sample of 864 students, confirmed the hypothesis that the greater the individual's behavioral

competencies, the higher their entrepreneurial intentions are. The behavioral competence defined by the researcher indirectly derives from Ajzen's Theory of Planned Behavior [15], according to which the factors influencing an individual's entrepreneurial intentions are cognitive: entrepreneurial attitudes (1), subjective norms (2), and perceived behavioral control (According to Ajzen's Theory of Planned Behavior [15], the perceived behavioral control is based on Bandura's Self-Efficacy Theory [41]) (3). Cortellazzo, Bonesso, and Gerli [42] promote a relatively interesting division of behavioral competencies. Researchers have grouped behavioral competencies into those related to (1) awareness, (2) action, (3) social, (4) cognitive, (5) exploratory, and (6) strategic, which can be considered a source of entrepreneurial intentions.

Since relatively recently, some researchers have focused their attention on explaining the role of emotional competencies as a subgroup of behavioral competencies in shaping entrepreneurial intentions. These competencies are usually understood as interrelated sets of behaviors that individuals use to recognize and manage their own emotions and others' emotions [43]. However, it might seem to some that the definition of emotional competence may coincide with emotional intelligence. In contrast to the latter, emotional competence is a measurable skill [33], so it can be taught and learned and consequently also influence individuals' entrepreneurial intentions [29].

Individuals with developed emotional competence deal with stress much better than others [44,45], and consequently, it may result in them having higher entrepreneurial intentions. For instance, Zampetakis et al. [28] note that emotional competence influences entrepreneurial intentions indirectly through students' entrepreneurial attitudes. In turn, studies by Miao et al. [46] show that emotional competence is positively linked to individuals' entrepreneurial intentions, except that this relationship is more potent in long-term-oriented cultures.

Emotional competencies are most often divided into two groups: personal competencies, which determine the level of ability to cope with ourselves, and social competencies, which determine the level of ability to cope with others. Personal competencies include self-awareness, self-regulation, and motivation, while empathy and social skills are social competence subgroups [33].

Higher self-awareness, and thus the ability to become an object of personal attention [47], may be one of the sources of students' higher entrepreneurial intentions [43,48]. Thanks to the ability to identify their own weaknesses and advantages, draw conclusions from their experiences, or believe in their own competencies, they feel that they can take up the challenge of competitiveness in the business world. Nevertheless, van Ewijk and Al-Aomar [49] stated that the research should be deepened. Therefore, we propose the following research hypothesis:

Hypothesis 1 (H1). *The higher self-awareness is, the higher students' entrepreneurial intentions are.*

On the other hand, self-regulation refers to controlling one's own internal states, impulses, and possibilities [33]. In other words, it is the ability of individuals to anticipate desirable future events based on their past knowledge and experience and to monitor and guide their behavior in order to realize their vision [50]. The responsibility for one's own actions, the ability to act efficiently due to good self-organization of work, and being flexible and able to adapt quickly to changing conditions are essential if we are thinking about achieving business success. The feeling of full control over one's own activity is also fundamental, even in the face of dynamic changes taking place in the company's environment.

Some researchers see self-regulation as a source of entrepreneurial intentions [51], which is why we propose the following hypothesis:

Hypothesis 2 (H2). *The higher self-regulation is, the higher students' entrepreneurial intentions are.*

Many researchers believe that self-motivation is an essential (if not the most important) factor resulting in higher entrepreneurial intentions [52–55]. According to Goleman [33], it belongs to the so-called personal competence, and defines it as emotional inclinations that lead to new goals or

facilitate achievement. Personalities such as consistency in action and pursuit of a goal despite the difficulties encountered, new challenges, and additional goals to achieve, and faith in success that is stronger than fear of failure are characteristic of leaders who become critical drivers for the whole organization. The entrepreneur's own motivation will also be transferred to the other organization members and thus constitute one of the company's critical determinants.

Therefore, the following hypothesis is proposed:

Hypothesis 3 (H3). *The higher self-motivation is, the higher students' entrepreneurial intentions are.*

Empathy is usually defined as the ability to understand the views [56], feelings, needs, and concerns of others [33]. The ability to listen to others and understand their specific views, expectations, and problems, sometimes different from their own, is crucial in managing a team of employees and gaining new clients. Identifying and correctly analyzing processes in the entrepreneur's social environment is also useful in conducting business activity.

Many studies in the literature on the subject show the positive influence of empathy on entrepreneurial intentions [56–58]. Therefore, it can be assumed that:

Hypothesis 4 (H4). *The higher empathy is, the higher students' entrepreneurial intentions are.*

As Fagoulis and Phillips [59] note, social skills are not easy to define because they can be interpreted differently. First of all, they can be understood as the ability to evoke desired reactions in others [33,60]. People who are perceived positively in their own environment can easily acquire others to implement their own plans. Social skills also allow for better communication with the business environment or effective negotiation of business transactions. People with developed social skills, e.g., through active participation in informal networking processes, learn and acquire new knowledge and useful information, which they can then use in their business activities. Above all, these competencies also allow for the more accessible establishment of personal relationships that are useful in any field of business activity (e.g., acquiring investors, cooperators, lobbyists, or the favors of members of government administration).

Some researchers believe that social skills can be a source of entrepreneurial intentions [61]. Therefore, the following hypothesis is worth proposing:

Hypothesis 5 (H5). *The higher social skills are, the higher students' entrepreneurial intentions are.*

In order to verify the above hypotheses, we created the logit model. All calculations were performed in IBM® SPSS® Statistics 26.

3. Materials and Methods

3.1. Sample and Data Collection

The study included 209 students studying international economic relations at the Cracow University of Economics. The choice of course was not accidental. Similarly to Li and Wu [62], we wanted to check the interdependence among the students participating in classes whose syllabuses mainly included subjects in broadly understood (international) entrepreneurship. Based on a previously prepared questionnaire (see Appendix A), we asked 76 anonymous questions about previously defined emotional competencies and entrepreneurial intentions. Additionally, we included four questions associated with basic metrics (gender, forms of studies, city of origin, and family patterns).

The survey was conducted in the first half of October 2020 with our control and other academic teachers (coordinators) among students in the second and third years of undergraduate studies and fourth and fifth years of graduate studies. In the survey, we omitted first-year students because they did not have the opportunity to participate in any entrepreneurship course.

3.2. Research Model

In this research, we applied a binomial logistic regression model—also called the logit model. It is used to explain the dummy qualitative variable Y depending on the level of independent (exogenous) variables X_1, X_2, ... , X_k, which, in turn, can be qualitative or quantitative. Moreover, the logistic regression model is recommended when the assumption of normality distribution of variables may not be met [63]. The dependent variable is a dummy (dichotomous) variable [64]:

$$Y = \begin{cases} 1, & \text{phenomenon occurs} \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

In the logistic regression model, the critical function is known as logit and has the following form [65,66]:

$$\ln\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k \quad (2)$$

Furthermore, the logistic regression model can be written in the following form:

$$\pi = \frac{\exp\left(\beta_0 + \sum_{i=1}^{k} \beta_i x_i\right)}{1 + \exp\left(\beta_0 + \sum_{i=1}^{k} \beta_i x_i\right)} \quad (3)$$

The estimation of model parameters β_1, β_2, ... , β_k is usually performed using the maximum likelihood method. The logarithm of the likelihood function with model parameters is maximized using iterative numerical procedures [64].

The proposed research model (see Figure 1) suggests a positive relationship between the five main types of emotional competence and students' entrepreneurial intentions. It means that individuals with higher self-awareness (H1), self-regulation (H2), self-motivation (H3), empathy (H4), and higher social skills (H5) are more likely to start a business in the future.

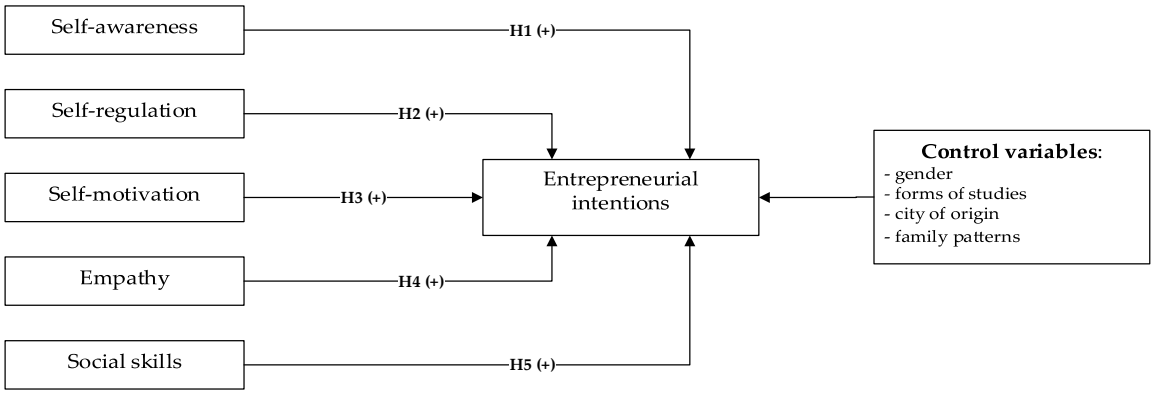

Figure 1. Proposed research model.

In the research model, we used a total of 10 variables (see Table 1), where the dependent variable represented students' entrepreneurial intentions. In contrast, among independent variables, we distinguished five emotional competencies of Goleman. Additionally, we included four control variables: gender, form of studies, city of origin, and family patterns. The research model consists of nominal (dummy) variables and ordinal variables whereby we measured, among other things, emotional competence on a 5-point Likert scale.

In the study, 209 students participated altogether. A total of 54.1% were women and 45.9% were men (see Tables 2 and 3). The vast majority of the respondents were full-time students (88.5%), and only some were part-time students (11.5%). In the study, approximately every third student came from a

city with at least 150,000 inhabitants. Moreover, most of the examined students (51.2%) confirmed that at least one parent was or still is self-employed.

Table 1. List of variables used in the analysis (N = 209).

ID	Variables	Measurement
i1	Entrepreneurial intentions	Dummy (1 = yes, 0 = no)
c1	Gender	Dummy (1 = man, 0 = woman)
c2	Form of studies	Dummy (1 = part-time, 0 = full-time)
c3	City of origin	Categorical (1 = less than 1000 inhabitants, 2 = at least 1000 but fewer than 10,000 inhabitants, 3 = at least 10,000 but fewer than 50,000 inhabitants, 4 = at least 50,000 but fewer than 150,000 inhabitants, 5 = at least 150,000 inhabitants)
c4	Family patterns	Dummy (1 = parents' self-employment background, 0 = parents' self-employment background)
d1	Self-awareness	5-point Likert scale
d2	Self-regulation	
d3	Self-Motivation	
d4	Empathy	
d5	Social skills	

Source: own elaboration based on Goleman [33].

Table 2. Students' profile.

Gender (c1)	Frequency	Percent
Male	96	45.9%
Female	113	54.1%
Form of studies (c2)		
Full-time	185	88.5%
Part-time	24	11.5%
City of origin (c3)		
less than 1000 inhabitants	24	11.5%
at least 1000 but fewer than 10,000 inhabitants	44	21.0%
at least 10,000 but fewer than 50,000 inhabitants	40	19.1%
at least 50,000, but fewer than 150,000 inhabitants	25	12.0%
at least 150,000 inhabitants	76	36.4%
Family pattern (c4) *		
Yes	107	51.2%
No	102	48.8%

* Was or is at least one parent self-employed? (Yes/No). Source: own elaboration.

Based on Table 4, it can be observed that there is no strong correlation between the independent variables used in the analysis. The highest correlation occurs between variables describing motivation and social skills (r = −0.47). In contrast, the lowest one occurs between variables representing gender and self-awareness (r = −0.01) and form of studies and self-regulation (r = −0.01).

Table 3. Summary statistic.

Category	ID	Mean	SD	Min	Max
Control variables	c1	0.46	0.50	0.00	1.00
	c2	0.89	0.32	0.00	1.00
	c3	3.41	1.45	1.00	5.00
	c4	0.51	0.50	0.00	1.00
Independent variables	d1	4.01	0.49	2.33	5.00
	d2	3.90	0.45	2.50	5.00
	d3	3.65	0.54	1.67	5.00
	d4	4.20	0.45	2.80	5.00
	d5	3.89	0.56	1.50	5.00

Source: own elaboration.

Table 4. Correlation matrix.

	c1	c2	c3	c4	d1	d2	d3	d4	d5
c1	1.00								
c2	−0.11	1.00							
c3	−0.09	−0.14	1.00						
c4	0.04	−0.10	−0.14	1.00					
d1	−0.01	−0.09	0.05	−0.02	1.00				
d2	0.21	−0.01	0.05	0.04	−0.28	1.00			
d3	0.10	−0.16	−0.06	−0.04	−0.08	−0.20	1.00		
d4	0.21	0.10	−0.11	0.02	−0.04	−0.23	0.11	1.00	
d5	−0.21	0.13	0.03	−0.08	−0.38	−0.03	−0.47	−0.44	1.00

Source: own elaboration.

3.3. Dependent Variable

In the proposed model (see Figure 1), the dependent variable was entrepreneurial intention, which was also defined as the propensity to be an entrepreneur during or after studies [67]. The question we asked the students was: Are you considering starting your own business during or soon after your studies? This variable was the dummy, i.e., it assumed values of 0 and 1. If the student answered positively, we assigned the number 1, while if the student negated, then we assigned the number 0.

3.4. Independent Variable

The study included five categories of independent variables describing emotional competence (see Table 1), which were assigned to two groups: personal competencies and social competencies. The former relates to how we manage our relationships with others [33]. The first category of emotional competence included (1) self-awareness, which distinguishes (1a) emotional awareness, (1b) accurate self-assessment, and (1c) self-confidence. The second category of variables was known as (2) self-regulation. It consists of (2a) self-control, (2b) trustworthiness, (2c) conscientiousness, (2d) adaptability, and (2e) and innovation. The third category of emotional competence, called (3) motivation, included (3a) achievement drive, (3b) commitment, (3c) initiative, and (3d) optimism. The next category of variables was (4) empathy, consisting of (4a) understanding others, (4b) developing others, (4c) service orientation, (4d) leveraging diversity, and (4e) political awareness. Finally, the last category of emotional competence, called (5) social skills, included (5a) influence, (5b) communication, (5c) conflict management, (5d) leadership, (5e) change catalyst, (5f) building bonds, (5g) collaboration and cooperation, and (5h) team capabilities.

Each of the 25 sub-independent variables (1a–5h) included between 3 and 4 questions and was evaluated using a 5-point Likert scale [68], i.e., (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree, (5) strongly agree (the questionnaire together with the questions can be found in

Appendix A). In the next step, we calculated the average for each subcategory and then the average for each of the main categories of variables (i.e., the five emotional competencies of Goleman).

3.5. Control Variable

In the study, we included several control variables that could potentially affect the results. The first control was gender (1 = male, 0 = female). Zhang et al. [69] believe that women generally have lower entrepreneurial intentions than men. Another control variable was form of study (1 = part-time, 0 = full-time), as we felt that part-time students had higher entrepreneurial intentions than full-time students. This is consistent with the research of Sandhu et al. [70]. We also controlled students' city of origin because we thought that students coming from larger cities would be more inclined toward entrepreneurship (1 = fewer than 1000 inhabitants, 2 = at least 1000 but fewer than 10,000 inhabitants, 3 = at least 10,000 but fewer than 50,000 inhabitants, 4 = at least 50,000 but fewer than 150,000 inhabitants, 5 = at least 150,000 inhabitants). The last control variable was family patterns, which should be understood as if at least one parent was/is self-employed (1= at least one parent was/is self-employed, 0 = otherwise).

4. Results and Discussion

A logistic regression model with good fit should mainly meet two criteria. First, the likelihood ratio test, estimated with the maximum probability, should be statistically significant. Second, the Hosmer–Lemeshow test should be statistically insignificant [63]. In the binomial logistic regression model, the coefficient of determination R2 is not an adequate measure of the quality of model adjustment to variables; therefore, it is not recommended to be applied [71]. Some researchers suggest using the Cox–Snell Pseudo R2 or Nagelkerke Pseudo R2 [72], which for the first model were 0.205 and 0.279, respectively. In the first logistic regression model, the likelihood test was statistically significant (chi2 = 47.964, df = 9, $p = 0.000$), which was the desired result. In addition, the Hosmer–Lemeshow test was statistically insignificant (chi2 = 11.898, df = 8, $p = 0.156$)—see Table 5.

Table 5. Logistic model verification.

Type of Test	Model	Chi-Square	df	Sig
Likelihood ratio test	Model 1	47.964	9	0.000
	Model 2	35.091	7	0.000
	Model 3	47.203	8	0.000
Hosmer–Lemeshow test	Model 1	11.898	8	0.156
	Model 2	10.466	8	0.234
	Model 3	11.807	8	0.160

Source: own elaboration.

Four control variables were included in the research model, one of which was statistically significant (see Table 6). In the study, we can note that gender is an important factor in predicting entrepreneurial intentions. The results of our research confirm that the likelihood of men having entrepreneurial intentions is 2.33 times higher than women ($p = 0.017$), which also seems to be confirmed by the research conducted by Grilo and Irigoyen [73]. In a given logistic regression model, the control variables comprised studies ($p = 0.093$) and city of origin ($p = 0.099$), but both at the level of significance $p < 0.100$. In terms of family patterns ($p = 0.886$), we could not demonstrate a correlation between someone from the immediate family running or having run their own business and students' entrepreneurial intentions.

Turning to the essential independent variables, we can see that the constructed logistic regression model confirmed the interdependence between self-awareness and students' entrepreneurial intentions ($p = 0.046$). It turns out that students with higher self-awareness are 2.8 times more likely to set up a business. This situation is similar to motivation. Motivated people are usually about six times more

likely to create a business in the future than those who are not. Therefore, we can confirm Hypotheses 1 and 3, i.e., students with higher self-awareness and motivation significantly influence higher inclination toward entrepreneurship. The logistic regression model did not confirm the statistical significance of self-regulation ($p = 0.782$), empathy ($p = 0.989$), or social skills ($p = 0.077$) as predictors of students' entrepreneurial intentions, hence hypotheses 2, 4, and 5 should be rejected.

Table 6. Binomial logistic regression model 1 (dependent variables = entrepreneurial intentions).

Variables	Coefficient	Standard Error	Wald Test	Significance	Exp (Coeff.)
Gender	0.847	0.354	5.728	0.017	2.333
Form of studies	−0.984	0.585	2.828	0.093	0.374
City of origin	0.192	0.116	2.724	0.099	1.212
Family patterns	0.047	0.331	0.020	0.886	1.048
Self-awareness	1.015	0.509	3.972	0.046	2.759
Self-regulation	0.146	0.527	0.076	0.782	1.157
Motivation	1.797	0.503	12.790	0.000	6.033
Empathy	0.007	0.519	0.000	0.989	1.007
Social skills	−0.977	0.552	3.130	0.077	0.377
Constant	−7.018	2.050	11.723	0.001	0.001

Source: own elaboration.

Next we asked ourselves which competencies within self-awareness and motivation play a key role in explaining students' entrepreneurial intentions. We built two more logistic regression models (see Tables 7 and 8). Before starting the inference, we reassessed the quality of the variables' adjustment to the newly created models. As far as the likelihood ratio test was concerned, in both cases it turned out to be statistically significant (model 2: chi2 = 35.091, df = 7, $p = 0.000$; model 3: chi2 = 47.203, df = 8, $p = 0.000$) which was desirable in this case of analysis. In turn, the Hosmer–Lemeshow test proved to be statistically insignificant (model 2: chi2 = 10.466, df = 8, $p = 0.234$; model 3: chi2 = 11.807, df = 8, $p = 0.16$), which also confirms that both models can be examined.

Table 7. Binomial logistic regression model 2 (dependent variables = entrepreneurial intentions).

Variables	Coeff.	SE	Wald	Sig	Exp (Coeff.)
Gender	0.652	0.321	4.131	0.042	1.920
Form of studies	−0.678	0.533	1.622	0.203	0.507
City of origin	0.235	0.112	4.400	0.036	1.265
Family patterns	0.046	0.322	0.020	0.887	1.047
Self–awareness					
Emotional awareness	−0.004	0.309	0.000	0.989	0.996
Accurate self-assessment	0.717	0.367	3.814	0.050	2.049
Self-confidence	0.612	0.242	6.409	0.011	1.844
Constant	−5.093	1.655	9.471	0.002	0.006

Source: own elaboration.

As for the second model of logistic regression (see Table 7), we noticed that within the framework of self-awareness, the key competencies were accurate self-assessment ($p = 0.05$) and self-confidence ($p = 0.011$). In our study, accurate self-assessment was understood as the ability to identify one's strengths and weaknesses and draw conclusions from one's own experience. Based on the second logistic regression model, we can observe that the likelihood of entrepreneurial intentions among students who can correctly self-assess is slightly more than two times higher than among those who have difficulty doing a self-assessment ($p = 0.05$). What is more, self-confidence is also essential, which increases 1.84 times the likelihood of higher willingness to start a business among the examined sample. The model did not confirmed the significance of emotional awareness for inclination toward entrepreneurship.

Table 8. Binomial logistic regression model 3 (dependent variables = entrepreneurial intentions).

Variables	Coeff.	SE	Wald	Sig	Exp (Coeff.)
Gender	0.775	0.334	5.391	0.020	2.170
Form of studies	−0.917	0.581	2.487	0.115	0.400
City of origin	0.164	0.115	2.017	0.156	1.178
Family patterns	0.041	0.327	0.016	0.900	1.042
Motivation					
Achievement drive	0.418	0.275	2.314	0.128	1.519
Commitment	0.129	0.218	0.353	0.553	1.138
Initiative	0.865	0.276	9.800	0.002	2.376
Optimism	0.307	0.279	1.213	0.271	1.359
Constant	−5.754	1.389	17.151	0.000	0.003

Source: own elaboration.

Based on the third model of logistic regression (see Table 8), it can be seen that within the framework of motivation, a critical competence is an initiative (p = 0.002), which we understood, among other things, as the ability to use every opportunity and the ability to pursue goals. It turns out that there is a chance of entrepreneurial intention in students who show initiative. It is almost 2.4 times higher than among those who do not have such a competence.

This article contributes to essential insights into the relationship between emotional competencies and Economics students' entrepreneurial intentions. The results contributed to the confirmation of the two proposed hypotheses. Emotional competence, namely self-awareness and motivation, plays a vital role in predicting students' entrepreneurial intentions.

Considering the form of studies, the city of origin, and the family patterns as control variables, they are not significant predictors of entrepreneurial intentions. The case was different for gender. The studies confirmed that men are more likely to start a business than women. This result is consistent with studies by Zhang et al., who confirmed this correlation based on the results of surveys conducted among students at 10 Chinese universities [69]. Similar conclusions were also reached by Caliendo et al., who, based on surveys among German citizens, noted that women are less likely to set up a business because of their much higher aversion to risk than men [74]. However, studies by other scientists such as Georgescu and Herman do not support the thesis that gender is essential in explaining students' entrepreneurial intentions [25,75].

As far as self-awareness is concerned, our results confirm the first research hypothesis. It turns out that self-awareness and mostly accurate self-assessment and self-confidence increase the chances of students' entrepreneurial intentions. This fact is also consistent with the research of other scientists. For example, Archana et al. surveyed students of the postgraduate program in Management Studies in India, which confirmed that self-awareness is a statistically significant predictor of entrepreneurial intentions [48]. Auzoult et al. came to a similar conclusion and, based on 216 French students, confirmed the positive relationship between self-awareness and entrepreneurial intentions [76].

The research also showed statistical significance between self-motivation and students' entrepreneurial intentions (p = 0.000). More detailed research has shown that it is mainly due to this initiative (p = 0.002), which increases the likelihood of entrepreneurial intentions in students 2.38 times more than if they had not. Similar opinions are held by Fayolle et al. [55] and Giacomin et al. [77], who see motivation as a source of entrepreneurial intentions. A pretty interesting study confirming this dependence was conducted by Solesvik, who, based on the information obtained from 321 Ukrainian students, stated that higher entrepreneurial intentions result from a properly designed entrepreneurship course, which stimulates the internal motivation of the individual [78].

5. Conclusions and Implications

In the current considerations, relatively few researchers have explored entrepreneurship's inclination from the perspective of emotional competence [79], which has still not been sufficiently

investigated. Our research confirmed two of five hypotheses. In our study, self-awareness and self-motivation proved to be factors that play a crucial role in increasing the probability of the individuals' entrepreneurial intentions examined. This fact confirms previous studies by other authors. We can formulate a thesis that the individual elements examined in these two categories are characteristic of people with leadership tendencies who are ambitious, courageous in making decisions, well organized, and maintain control and composure even in challenging situations. These attributes are characteristic of leaders who prefer to lead than be submissive. This naturally increases their desire for professional fulfilment through their own business activities, where they will be their own superiors and decide on their own actions. However, this does not mean that the influence of other factors such as self-regulation, empathy, and social skills should be rejected. As it has been mentioned, these elements' influence on entrepreneurial intentions has been demonstrated in other authors' work, so these aspects should be further researched.

This study was created to find future entrepreneurial education directions that exogenously influence entrepreneurial competencies and intentions. First, the study contributes to the development of research on entrepreneurial competencies [80–83]. Second, the scientific work intended to prove that entrepreneurial intentions result from each individual's emotional side [43], which may consequently suggest that the syllabus of entrepreneurial courses stimulates the individual's cognitive processes. Third, the study contributes to the development of Ajzen's Theory of Planned Behavior [15].

Future research should generally focus on quantitative and qualitative verification of the impact of emotional competencies on inclination toward entrepreneurship. We suggest that researchers focus more on entrepreneurial education [84] and identify methods for sufficient self-awareness and self-motivation. It is also worth exploring the relationship between entrepreneurial intentions and individual emotional competencies, taking into account active and passive entrepreneurial education forms. Future research should also include students of Economics departments and non-Economics departments (e.g., technical, medical). Undoubtedly, the research should be conducted on a more extensive research sample than in this article.

As with all empirical studies, the current one is not free of limitations. First of all, the research sample included only 209 students of International Economic Relations at the Cracow University of Economics (Poland). Therefore, further research should also include other fields of study at various universities so that potential differences between students in terms of entrepreneurial intentions and emotional competencies can be found. Second, we conducted the study on an individual level [46], so in the future, it is also worthwhile to take into account the national level and to compare different countries with each other. The rationale for such analyses stems from the fact that the entrepreneurial process is multidimensional [85]. It is essential to consider the national context of entrepreneurship concerning the perception of business conditions. In the opinion of young Poles, Poland appears to be a country with many administrative and tax barriers, which may have a negative impact on students' entrepreneurial intentions. A very frequent reason for Polish students' unwillingness to start businesses is the relatively favorable labor market situation. This situation is caused by a high supply of jobs in many multinational corporations, which is even more noticeable in Cracow. We consider that caution in formulating far-reaching conclusions from the conducted research should also result from the fact that false answers are often found in surveys. These answers may sometimes result from the respondents' subconscious willingness to present themselves as better in their opinion, or even the lack of ability to make a reliable self-assessment of themselves. Such a situation may also influence the answers provided in our study. Among the factors influencing the respondents' answers, the authors also note that the survey was conducted during the COVID-19 pandemic, which significantly reduced the possibility of conducting business activity and the profits made from it, which could also affect the size of declared entrepreneurial intentions.

The conclusions of the study should serve the decision-makers formulating the syllabuses and the teachers implementing them [86,87]. We claim that supporting the development of entrepreneurship among young people should be placed primarily on developing emotional competencies, which are vital

to increasing entrepreneurial intentions [28–30,36,43,48,88]. It should be remembered that although human development lasts throughout life, the development of emotional competencies takes place to the greatest extent in the early stages of education [89]. Therefore, it is necessary to ensure that these competencies are properly stimulated at the primary education level. The promotion of entrepreneurial attitudes does not start with teaching economics and entrepreneurship, but, among other things, with the development of emotional competencies, which have been studied in this article. The next step should be the education concerning the use of previously built competencies in running a business.

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Appendix A

Table A1. Survey questionnaire (N = 209).

No	Questions	SD	D	N	A	SA
	Self-Awareness					
1a.	I can recognize the emotions that I feel and why I feel them.	1	2	3	4	5
1a.	I am aware of the relationship between my feelings and what I think, do, and say.	1	2	3	4	5
1a.	I realize how my feelings affect my behavior.	1	2	3	4	5
1b.	I am aware of my strengths and weaknesses.	1	2	3	4	5
1b.	I can draw conclusions from my experience.	1	2	3	4	5
1b.	I can take a different viewpoint, always learn, and develop.	1	2	3	4	5
1b.	I can look at myself with humor and distance.	1	2	3	4	5
1c.	In day-to-day reality I am usually self-confident.	1	2	3	4	5
1c.	I can express unpopular views and defend in private what I think is right (even in public).	1	2	3	4	5
1c.	I can make good decisions despite pressure from others or unfavorable circumstances.	1	2	3	4	5
	Self-Regulation					
2a.	Usually, I can control negative feelings and emotions.	1	2	3	4	5
2a.	I can maintain a calm and positive attitude, even in the most challenging moments.	1	2	3	4	5
2a.	I can maintain my ability to think clearly and concentrate despite the pressure I am under.	1	2	3	4	5
2b.	I act ethically and denounce the unethical behavior of others.	1	2	3	4	5
2b.	I can admit my own mistakes.	1	2	3	4	5
2c.	I am well-organized.	1	2	3	4	5
2c.	I always perform my tasks and meet my obligations.	1	2	3	4	5
2c.	I always feel responsible for my own actions.	1	2	3	4	5

Table A1. *Cont.*

No	Questions	SD	D	N	A	SA
2d.	I can quickly adapt my reaction and tactics to changing circumstances.	1	2	3	4	5
2d.	I can cope well with a variety of requirements and changing priorities.	1	2	3	4	5
2d.	I can quickly adapt my vision of events.	1	2	3	4	5
2e.	I consider myself to be a creative.	1	2	3	4	5
2e.	I can adapt my viewpoint to changing circumstances.	1	2	3	4	5
2e.	I like to be inspired by exciting ideas from various sources.	1	2	3	4	5
	Self-Motivation					
3a.	I am consequent in my pursuit of my goals.	1	2	3	4	5
3a.	I can set challenging goals and take carefully calculated risks.	1	2	3	4	5
3a.	I can find ways to do my job better.	1	2	3	4	5
3b.	I can sacrifice myself for the group against my own goals.	1	2	3	4	5
3b.	I can find a sense of direction in pursuing what the whole group is aiming for.	1	2	3	4	5
3b.	When making a decision and making a choice I am driven by the central values of the group.	1	2	3	4	5
3c.	I can take advantage of every chance I get.	1	2	3	4	5
3c.	I strive for goals beyond what is required or expected of me.	1	2	3	4	5
3c.	I can fight the resistance of bureaucracy and sometimes bend the rules when necessary for the task.	1	2	3	4	5
3d.	In reaching my goal, I do not give in to even numerous obstacles and temporary failures.	1	2	3	4	5
3d.	Hope of success is more important to me than fear of failure.	1	2	3	4	5
3d.	Failure is more often the result of my own faults and errors than circumstances that cannot be controlled.	1	2	3	4	5
	Empathy					
4a.	I can listen to others.	1	2	3	4	5
4a.	I can understand the viewpoint of others.	1	2	3	4	5
4a.	I can feel the needs and feelings of others.	1	2	3	4	5
4b.	As a supervisor I would be able to appreciate and reward the achievements of my subordinates appropriately.	1	2	3	4	5
4b.	As a superior, I would be able to support the professional development of my subordinates actively.	1	2	3	4	5
4b.	As a supervisor, I would be able to assign tasks to my subordinates that would serve to develop their abilities.	1	2	3	4	5
4c.	I would be able to understand my customers' needs well and adapt my services or products to them.	1	2	3	4	5
4c.	I would look for ways to increase customer satisfaction and loyalty to my company.	1	2	3	4	5
4c.	I would be able to pick up a different client's viewpoint and apply it to my own actions.	1	2	3	4	5
4d.	I respect people from different communities even different from mine.	1	2	3	4	5
4d.	I can understand different worldviews than mine.	1	2	3	4	5
4d.	I can speak out against prejudice and intolerance.	1	2	3	4	5
4e.	I can identify relationships between people in my area.	1	2	3	4	5
4e.	I can detect critical networks of social networks.	1	2	3	4	5
4e.	I can understand the motives that shape the worldview of customers and competitors and influence their behavior.	1	2	3	4	5

Table A1. *Cont.*

No	Questions	SD	D	N	A	SA
	Social Skills					
5a.	I can win over others.	1	2	3	4	5
5a.	I can adapt my presentation to the viewer.	1	2	3	4	5
5a.	I can use even complex strategies to get support for a given case.	1	2	3	4	5
5b.	I can talk about difficult matters frankly.	1	2	3	4	5
5b.	I am able to seek mutual understanding and am able to share complete information with others.	1	2	3	4	5
5b.	In mutual contacts I am open-minded.	1	2	3	4	5
5c.	I can behave diplomatically and tactfully when dealing with people of difficult nature.	1	2	3	4	5
5c.	I can spot potential sources of conflict, openly present misunderstandings, and help clarify them.	1	2	3	4	5
5c.	I am a good mediator and I can propose acceptable solutions for both parties.	1	2	3	4	5
5d.	I can be a leader regardless of my position.	1	2	3	4	5
5d.	I like to set my own example.	1	2	3	4	5
5d.	I can manage others' work by giving them advice and guidance, but without removing responsibility for results.	1	2	3	4	5
5e.	I can notice the need for change and remove obstacles to it.	1	2	3	4	5
5e.	I can dispute an existing state of affairs to demonstrate the need for change.	1	2	3	4	5
5e.	I am a propagator of change, and I can win supporters for it.	1	2	3	4	5
5f.	I like to make and maintain friendship with my colleagues.	1	2	3	4	5
5f.	I can look for mutually beneficial relationships with different people.	1	2	3	4	5
5f.	I can create and maintain extensive informal networks.	1	2	3	4	5
5g.	I often try to look for opportunities to cooperate.	1	2	3	4	5
5g.	I can cooperate with others by sharing information and resources.	1	2	3	4	5
5g.	I can balance focusing on the task and taking care of the right relationship with others.	1	2	3	4	5
5h.	I can take care of the team's well-being and share the merits.	1	2	3	4	5
5h.	I can convince others to participate actively and enthusiastically in my team.	1	2	3	4	5
5h.	I can convince team members to identify themselves with the group and to show solidarity within the group.	1	2	3	4	5

(1) SD—strongly disagree, (2) D—disagree, (3) N—neither agree nor disagree, (4) A—agree, (5) SA—strongly agree. Source: based on Golemana [33].

References

1. Wach, K. Europeanisation of Entrepreneurship Education in Europe—Looking Back and Looking Forward. *Horyz. Wych.* **2014**, *13*, 11–31.
2. Stamboulis, Y.; Barlas, A. Entrepreneurship education impact on student attitudes. *Int. J. Manag. Educ.* **2014**, *12*, 365–373. [CrossRef]
3. Obino Mokaya, S.; Namusonge, M.; Sikalieh, D. The Concept of Entrepreneurship; in pursuit of a Universally Acceptable Definition. *Int. J. Arts Commer.* **2012**, *1*, 128–135.
4. Muller, P.; Mattes, A.; Klitou, D.; Lonkeu, O.-K.; Ramada, P.; Aranda Ruiz, F.; Devnani, S.; Farrenkopf, J.; Makowska, A.; Mankovska, N.; et al. SMEs Growing beyond Borders. In *Annual Report on European SMEs 2017/2018*; Publications Office of the European Union: Luxembourg, 2018; ISBN 927996822X.
5. Wach, K.; Głodowska, A. The Role of University in the Development of Entrepreneurial Intentions of Younger Generations: Selected Models. In *Fostering Entrepreneurial and Sales Competencies in Higher Education*; Pietrzykowski, M., Ed.; Bogucki Wydawnictwo Naukowe: Warszawa, Poland, 2019; pp. 47–65. ISBN 9788379862801.
6. Volkmann, C.; Wilson, K.E.; Marlotti, S.; Rabuzzi, D.; Vyakarnam, S.; Sepulveda, A. Educating the Next Wave of Entrepreneurs: Unlocking entrepreneurial capabilities to meet the global challenges of the 21st Century. In *A Report of the Global Education Initiative*; World Economic Forum: Cologny/Geneva, Switzerland, 2009.

7. Wei, X.; Liu, X.; Sha, J. How Does the Entrepreneurship Education Influence the Students' Innovation? Testing on the Multiple Mediation Model. *Front. Psychol.* **2019**, *10*, 1557. [CrossRef]
8. Wach, K.; Wojciechowski, L. Entrepreneurial Intentions of Students in Poland in the View of Ajzen's Theory of Planned Behaviour. *Entrep. Bus. Econ. Rev.* **2016**, *4*, 83–94. [CrossRef]
9. Nowiński, W.; Haddoud, M.Y.; Lančarič, D.; Egerová, D.; Czeglédi, C. The impact of entrepreneurship education, entrepreneurial self-efficacy and gender on entrepreneurial intentions of university students in the Visegrad countries. *Stud. High. Educ.* **2019**, *44*, 361–379. [CrossRef]
10. Block, J.H.; Hoogerheide, L.; Thurik, R. Education and entrepreneurial choice: An instrumental variables analysis. *Int. Small Bus. J.* **2013**, *31*, 23–33. [CrossRef]
11. Barba-Sánchez, V.; Atienza-Sahuquillo, C. Entrepreneurial intention among engineering students: The role of entrepreneurship education. *Eur. Res. Manag. Bus. Econ.* **2018**, *24*, 53–61. [CrossRef]
12. Ratten, V.; Usmanij, P. Entrepreneurship education: Time for a change in research direction? *Int. J. Manag. Educ.* **2020**, 100367. [CrossRef]
13. Hisrich, R.; Drnovsek, M. Entrepreneurship and small business research—A European perspective. *J. Small Bus. Enterp. Dev.* **2002**, *9*, 172–222. [CrossRef]
14. Ajzen, I. From Intentions to Actions: A Theory of Planned Behavior. In *Action Control: From Cognition to Behavior*; Kuhl, J., Beckmann, J., Eds.; Springer: Berlin/Heidelberg, Germany, 1985; pp. 11–39. ISBN 9783642697463.
15. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211. [CrossRef]
16. van Gelderen, M.; Brand, M.; van Praag, M.; Bodewes, W.; Poutsma, E.; van Gils, A. Explaining entrepreneurial intentions by means of the theory of planned behaviour. *Career Dev. Int.* **2008**, *13*, 538–559. [CrossRef]
17. Peng, Z.; Lu, G.; Kang, H. Entrepreneurial Intentions and Its Influencing Factors: A Survey of the University Students in Xi'an China. *Creat. Educ.* **2012**, *3*, 95–100. [CrossRef]
18. Pauceanu, A.; Alpenidze, O.; Edu, T.; Zaharia, R. What Determinants Influence Students to Start Their Own Business? Empirical Evidence from United Arab Emirates Universities. *Sustainability* **2019**, *11*, 92. [CrossRef]
19. Jena, R.K. Measuring the impact of business management Student's attitude towards entrepreneurship education on entrepreneurial intention: A case study. *Comput. Hum. Behav.* **2020**, *107*, 106275. [CrossRef]
20. Rachwał, T.; Kurek, S.; Boguś, M. Entrepreneurship Education at Secondary Level in Transition Economies. A Case of Poland. *Entrep. Bus. Econ. Rev.* **2016**, *4*, 61–81. [CrossRef]
21. Rachwał, T. Entrepreneurship Education as a Growth Stimulus for Family Firms. In *Exploring the Dynamics of Entrepreneurship*; Surdej, A., Wach, K., Eds.; Marszałek Publishing House: Toruń, Poland, 2010; pp. 139–156.
22. Marona, B.; Głuszak, M. The Ties that Bind? Real Estate Education in Europe and Regulatory Framework in Poland. *New Educ. Rev.* **2014**, *35*, 187–201.
23. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development. Available online: https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf (accessed on 24 October 2020).
24. Hajdukiewicz, A.; Pera, B. Education for Sustainable Development—The Case of Massive Open Online Courses. *Sustainability* **2020**, *12*, 8542. [CrossRef]
25. Georgescu, M.-A.; Herman, E. The Impact of the Family Background on Students' Entrepreneurial Intentions: An Empirical Analysis. *Sustainability* **2020**, *12*, 4775. [CrossRef]
26. United Nations Educational, Scientific and Cultural Organization. Education for sustainable development goals. In *Learning Objectives*; UNESCO: Paris, French, 2017; ISBN 9789231002090.
27. Cohen, J.D. The vulcanization of the human brain: A neural perspective on interactions between cognition. An emotion. *J. Econ. Perspect.* **2005**, *19*, 3–24. [CrossRef]
28. Zampetakis, L.A.; Kafetsios, K.; Bouranta, N.; Dewett, T.; Moustakis, V.S. On the relationship between emotional intelligence and entrepreneurial attitudes and intentions. *Int. J. Entrep. Behav. Res.* **2009**, *15*, 595–618. [CrossRef]
29. Padilla-Meléndez, A.; Fernández-Gámez, M.A.; Molina-Gómez, J. Feeling the risks: Effects of the development of emotional competences with outdoor training on the entrepreneurial intent of university students. *Int. Entrep. Manag. J.* **2014**, *10*, 861–884. [CrossRef]
30. FakhrEldin, H. The relationship between the emotional intelligence of entrepreneurs and the new venture creation: The role of age, gender and motive. *Arab Econ. Bus. J.* **2017**, *12*, 99–108. [CrossRef]

31. Frese, M.; Gielnik, M.M. The Psychology of Entrepreneurship. *Annu. Rev. Organ. Psychol. Organ. Behav.* **2014**, *1*, 413–438. [CrossRef]
32. Boyd, N.G.; Vozikis, G.S. The Influence of Self-Efficacy on the Development of Entrepreneurial Intentions and Actions. *Entrep. Theory Pract.* **1994**, *18*, 63–77. [CrossRef]
33. Goleman, D. *Working with Emotional Intellengence*; Bantam Books: New York, NY, USA, 1998; ISBN 0553378589.
34. Baartman, L.K.; de Bruijn, E. Integrating knowledge, skills and attitudes: Conceptualising learning processes towards vocational competence. *Educ. Res. Rev.* **2011**, *6*, 125–134. [CrossRef]
35. Hayton, J.C.; Kelley, D.J. A competency-based framework for promoting corporate entrepreneurship. *Hum. Resour. Manag.* **2006**, *45*, 407–427. [CrossRef]
36. Boyatzis, R.E. Competencies as a behavioral approach to emotional intelligence. *J. Manag. Dev.* **2009**, *28*, 749–770. [CrossRef]
37. MacLean, P.; Scott, B. Competencies for learning design: A review of the literature and a proposed framework. *Br. J. Educ. Technol.* **2011**, *42*, 557–572. [CrossRef]
38. Zhao, H.; Seibert, S.E.; Hills, G.E. The Mediating Role of Self-Efficacy in the Development of Entrepreneurial Intentions. *J. Appl. Psychol.* **2005**, *90*, 1265–1272. [CrossRef]
39. Sánchez, J.C. University training for entrepreneurial competencies: Its impact on intention of venture creation. *Int. Entrep. Manag. J.* **2011**, *7*, 239–254. [CrossRef]
40. Doanh, D.C.; Bernat, T. Entrepreneurial self-efficacy and intention among vietnamese students: A meta-analytic path analysis based on the theory of planned behavior. *Procedia Comput. Sci.* **2019**, *159*, 2447–2460. [CrossRef]
41. Bandura, A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychol. Rev.* **1977**, *84*, 191–215. [CrossRef] [PubMed]
42. Cortellazzo, L.; Bonesso, S.; Gerli, F. Entrepreneurs' behavioural competencies for internationalisation. *Int. J. Entrep. Behav. Res.* **2020**, *26*, 723–747. [CrossRef]
43. Fernández-Pérez, V.; Montes-Merino, A.; Rodríguez-Ariza, L.; Galicia, P.E.A. Emotional competencies and cognitive antecedents in shaping student's entrepreneurial intention: The moderating role of entrepreneurship education. *Int. Entrep. Manag. J.* **2019**, *15*, 281–305. [CrossRef]
44. Nikolaou, I.; Tsaousis, I. Emotional intelligence in the workplace: Exploring its effects on occupational stress and organizational commitment. *Int. J. Organ. Anal.* **2002**, *10*, 327–342. [CrossRef]
45. Davis, P.E.; Peake, W.O. The Influence of Political Skill and Emotional Intelligence on Student Entrepreneurial Intentions: An Empirical Analysis. *Small Bus. Inst. J.* **2014**, *10*, 19–34.
46. Miao, C.; Humphrey, R.H.; Qian, S.; Pollack, J.M. Emotional intelligence and entrepreneurial intentions: An exploratory meta-analysis. *Career Dev. Int.* **2018**, *23*, 497–512. [CrossRef]
47. Morin, A. Self-Awareness Part 1: Definition, Measures, Effects, Functions, and Antecedents. *Soc. Personal. Psychol. Compass* **2011**, *5*, 807–823. [CrossRef]
48. Archana, R.V.; Vasanthi Kumari, K. A Study on the Influence of Emotional Intelligence on Entrepreneurship Intention. *Int. J. Pure Appl. Math.* **2018**, *119*, 14839–14851.
49. van Ewijk, A.; Al-Aomar, R. Inspiration, self-awareness and entrepreneurial intentions: A mixed-method case study of postgraduate engineering students in the UAE. *J. Entrep. Educ.* **2016**, *19*, 103–126.
50. Pihie, Z.A.L.; Bagheri, A. Self-Efficacy and Entrepreneurial Intention: The Mediation Effect of Self-Regulation. *Vocat. Learn.* **2013**, *6*, 385–401. [CrossRef]
51. Gu, J.; Hu, L.; Wu, J.; Lado, A.A. Risk Propensity, Self-Regulation, and Entrepreneurial Intention: Empirical Evidence from China. *Curr. Psychol.* **2018**, *37*, 648–660. [CrossRef]
52. Segal, G.; Borgia, D.; Schoenfeld, J. The motivation to become an entrepreneur. *Int. J. Entrep. Behav. Res.* **2005**, *11*, 42–57. [CrossRef]
53. Raza, S.A.; Qazi, W.; Shah, N. Factors affecting the motivation and intention to become an entrepreneur among business university students. *Int. J. Knowl. Learn.* **2018**, *12*, 221–241. [CrossRef]
54. Nabi, G.; Liñán, F. Considering business start-up in recession time. *Int. J. Entrep. Behav. Res.* **2013**, *19*, 633–655. [CrossRef]
55. Fayolle, A.; Liñán, F.; Moriano, J.A. Beyond entrepreneurial intentions: Values and motivations in entrepreneurship. *Int. Entrep. Manag. J.* **2014**, *10*, 679–689. [CrossRef]

56. Younis, A.; Xiaobao, P.; Nadeem, M.A.; Kanwal, S.; Pitafi, A.H.; Qiong, G.; Yuzhen, D. Impact of positivity and empathy on social entrepreneurial intention: The moderating role of perceived social support. *J. Public Aff.* **2020**, 1–15. [CrossRef]
57. Forster, F.; Grichnik, D. Social Entrepreneurial Intention Formation of Corporate Volunteers. *J. Soc. Entrep.* **2013**, *4*, 153–181. [CrossRef]
58. Bacq, S.; Alt, E. Feeling capable and valued: A prosocial perspective on the link between empathy and social entrepreneurial intentions. *J. Bus. Ventur.* **2018**, *33*, 333–350. [CrossRef]
59. Fagoulis, I.; Phillips, N. Social Skills for Successful Career Development. *Rev. Eur. Stud.* **2011**, *3*, 85–93. [CrossRef]
60. Baron, R.A.; Markman, G.D. Beyond social capital: How social skills can enhance entrepreneurs' success. *Acad. Manag. Exec.* **2000**, *14*, 106–116. [CrossRef]
61. Ozgur, D.; Mustafa, K.; Hakan, O.A. The Influence of Personality Traits on Entrepreneurial Intention. *Int. J. Manag. Sustain.* **2017**, *6*, 33–46. [CrossRef]
62. Li, L.; Wu, D. Entrepreneurial education and students' entrepreneurial intention: Does team cooperation matter? *J. Glob. Entrep. Res.* **2019**, *9*, 1–13. [CrossRef]
63. Hair, J.; Anderson, R.E.; Tatham, R.L.; Black, W.C. *Multivariate Data Analysis with Readings*, 5th ed.; Macmillan Publishing Company: New York, NY, USA, 1998.
64. Hosmer, D.W.; Lemeshow, S.; Sturdivant, R.X. *Applied Logistic Regression*, 3rd ed.; John Wiley & Sons: Hoboken, NJ, USA, 2013; ISBN 9781118548356.
65. Sperandei, S. Understanding logistic regression analysis. *Biochem. Med.* **2014**, *24*, 12–18. [CrossRef] [PubMed]
66. McCullagh, P.; Nelder, J.A. *Generalized Linear Models*; Springer: Boston, MA, USA, 1989.
67. Turker, D.; Sonmez Selcuk, S. Which factors affect entrepreneurial intention of university students? *J. Eur. Ind. Train.* **2009**, *33*, 142–159. [CrossRef]
68. Joshi, A.; Kale, S.; Chandel, S.; Pal, D. Likert Scale: Explored and Explained. *Br. J. Appl. Sci. Technol.* **2015**, *7*, 396–403. [CrossRef]
69. Zhang, Y.; Duysters, G.; Cloodt, M. The role of entrepreneurship education as a predictor of university students' entrepreneurial intention. *Int. Entrep. Manag. J.* **2014**, *10*, 623–641. [CrossRef]
70. Sandhu, M.S.; Jain, K.K.; Yusof, M. Entrepreneurial Inclination of Students at a Private University in Malaysia. *New Engl. J. Entrep.* **2010**, *13*, 1–12. [CrossRef]
71. Blomstermo, A.; Deo Sharma, D.; Sallis, J. Choice of foreign market entry mode in service firms. *Int. Mark. Rev.* **2006**, *23*, 211–229. [CrossRef]
72. Smith, T.J.; McKenna, C.M. A comparison of logistic regression pseudo R2 indices. *Mult. Linear Regres. Viewp.* **2013**, *39*, 17–26.
73. Grilo, I.; Irigoyen, J.-M. Entrepreneurship in the EU: To wish and not to be. *Small Bus. Econ.* **2006**, *26*, 305–318. [CrossRef]
74. Caliendo, M.; Fossen, F.M.; Kritikos, A.S. Risk attitudes of nascent entrepreneurs–new evidence from an experimentally validated survey. *Small Bus. Econ.* **2009**, *32*, 153–167. [CrossRef]
75. Díaz-García, M.C.; Jiménez-Moreno, J. Entrepreneurial intention: The role of gender. *Int. Entrep. Manag. J.* **2010**, *6*, 261–283. [CrossRef]
76. Auzoult, L.; Lheureux, F.; Abdellaoui, S. Are Entrepreneurial Intentions Self-Regulated? Self-Consciousness, Core Self-Evaluations and Entrepreneurial Intentions of Higher Education Students. *Span. J. Psychol.* **2016**, *19*, E38. [CrossRef] [PubMed]
77. Giacomin, O.; Janssen, F.; Pruett, M.; Shinnar, R.S.; Llopis, F.; Toney, B. Entrepreneurial intentions, motivations and barriers: Differences among American, Asian and European students. *Int. Entrep. Manag. J.* **2011**, *7*, 219–238. [CrossRef]
78. Solesvik, M.Z. Entrepreneurial motivations and intentions: Investigating the role of education major. *Educ. Train.* **2013**, *55*, 253–271. [CrossRef]
79. Welpe, I.M.; Spörrle, M.; Grichnik, D.; Michl, T.; Audretsch, D.B. Emotions and Opportunities: The Interplay of Opportunity Evaluation, Fear, Joy, and Anger as Antecedent of Entrepreneurial Exploitation. *Entrep. Theory Pract.* **2012**, *36*, 69–96. [CrossRef]
80. Ni, H.; Ye, Y. Entrepreneurship Education Matters: Exploring Secondary Vocational School Students' Entrepreneurial Intention in China. *Asia-Pac. Educ. Res.* **2018**, *27*, 409–418. [CrossRef]

81. Arranz, N.; Ubierna, F.; Arroyabe, M.F.; Perez, C.; de Arroyabe, J.C.F. The effect of curricular and extracurricular activities on university students' entrepreneurial intention and competences. *Stud. High. Educ.* **2017**, *42*, 1979–2008. [CrossRef]
82. Mitchelmore, S.; Rowley, J. Entrepreneurial competencies: A literature review and development agenda. *Int. J. Entrep. Behav. Res.* **2010**, *16*, 92–111. [CrossRef]
83. Solesvik, M.Z. Entrepreneurial Competencies and intentions: The Role of Higher Education. *Forum Sci. Oeconomia* **2019**, *7*, 9–23.
84. Fayolle, A.; Liñán, F. The future of research on entrepreneurial intentions. *J. Bus. Res.* **2014**, *67*, 663–666. [CrossRef]
85. Shepherd, D.A.; Patzelt, H. Trailblazing in entrepreneurship. In *Creating New Paths for Understanding the Field*; Palgrave Macmillan: Berlin, Germany, 2017; ISBN 9783319487007.
86. Béchard, J.; Grégoire, D. Entrepreneurship Education Research Revisited: The case of higher education. *Acad. Manag. Learn. Educ.* **2005**, *4*, 22–43. [CrossRef]
87. Jorge-Moreno, J.; Laborda Castillo, L.; Sanz Triguero, M. The effect of business and economics education programs on students' entrepreneurial intention. *Eur. J. Train. Dev.* **2012**, *36*, 409–425. [CrossRef]
88. Tiwari, P.; Bhat, A.K.; Tikoria, J. The role of emotional intelligence and self-efficacy on social entrepreneurial attitudes and social entrepreneurial intentions. *J. Soc. Entrep.* **2017**, *8*, 165–185. [CrossRef]
89. Izedonmi, P.F.; Okafo, C. The Effect of Entrepreneurship Education on Students' Entrepreneurial Intentions. *Glob. J. Manag. Bus. Res.* **2010**, *10*, 49–60.

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Investigating the Unintended Consequences of the High School Equalization Policy on the Housing Market

Gyeongcheol Cho [1], Younyoung Choi [2,*] and Ji-Hyun Kim [3]

[1] Department of Psychology, McGill University, 2001 McGill College Avenue, Montreal, QC H3A 1G1, Canada; gyeongcheol.cho@mail.mcgill.ca
[2] Department of Adolescent Counseling, Hanyang Cyber University, Seoul 100255, Korea
[3] Department of Real Estate, Hanyang Cyber University, Seoul 100255, Korea; kimjade@hycu.ac.kr
* Correspondence: yountoto@gmail.com

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Abstract: Owing to its potentially far-reaching impact on a large population, an educational policy may lead to unintended consequences beyond the educational area. The High School Equalization Policy (HSEP), introduced into South Korea in the mid-1970s, is representative of such a policy. HSEP prohibits high school entrance exams and randomly assigns students to a high school near their residence. Despite its aim of ensuring equal opportunities in education for all students regardless of socio-economic status, a frequent criticism was that HSEP could prompt students' families to move to a region near traditional elite high schools, which, in turn, would widen the gap in house prices between different regions. Thus, we conducted an empirical study to examine the secondary influence of the HSEP on the housing market via a difference-in-differences (DD) analysis. We used house price data from the Gangwon province, as the partial introduction of HSEP into the province allowed for a quasi-experimental study on the effect of HSEP. The result revealed that, contrary to expectations, the HSEP in Gangwon had the opposite spillover effect of reducing the gap of the average house prices by 5%~9% across regions.

Keywords: educational policy evaluation; unintended consequence; high school equalization policy; housing market; difference-in-differences analysis

1. Introduction

Policymakers carefully design and implement government policies or interventions to meet their goals efficiently. Evaluating such policies mainly involves identifying "what works, for whom, and under what circumstances" and the causal mechanisms driving the outcomes within the established scope [1,2]. However, because government interventions may impact a broad population in different ways, unintended consequences may arise from the policies beyond the target population or area [3–5]. Whether these are adverse or positive spillover effects, it is meaningful to uncover, monitor, and study them for the effective implementation of such policies in the future [6,7].

Educational polices are not exempt from unintended consequences, because changes in educational policies may affect every student and their family. It may prompt them not only to adopt different educational strategies, but also to alter their expenditure patterns [8–10] and their region of residence [11,12]. Empirical studies spanning multiple countries consistently find that the local educational climate is a key factor for families choosing a residential location [13–17]. This suggests that policies influencing the educational environment of a region may also significantly affect its housing market as an unintended consequence [18–20].

The High School Equalization Policy (HSEP), which started to be implemented in South Korea in the mid-1970s, exemplifies such an intervention. This policy mainly abolishes the entrance exams of all high schools and randomly assigns students to a high school among the ones nearby their residence. It aims to alleviate the competition among students to get into a highly ranked school and to provide equal educational opportunities for all students regardless of their social economics status [21–23]. Despite concerns over potential losses in educational efficiency [24], the policy was initially implemented in 1974 in two large cities, Seoul and Busan, supplemented with follow-up measures and revisions (e.g., the adjustment of school districts), and then adopted nationwide.

Years after HSEP was introduced, an unexpected, interesting phenomenon was observed in the housing market in Seoul. House prices in Gangnam, one of the richest districts in Seoul at present, continued to soar. Critics attributed this result to HSEP, though many other factors could have affected the housing market at that time (e.g., large-scale urban development projects in Gangnam). They argued that HSEP induced households with middle-school students to move into the Gangnam district where many elite high schools would be relocated, thereby increasing the demand for the houses in the district dramatically [12]. That HSEP could inflate house prices in specific districts became a pervasive concern every time HSEP was newly introduced to a different region [25]. If such claims are true, then decision-makers in education must be cautious about introducing HSEP, as their policy for reducing disparities in education may ironically increase disparities in wealth, beyond their original scope. Considering the possibility that this sort of policy can be implemented in other countries (e.g., Japan), it is meaningful to investigate whether introducing HSEP actually affected the housing market and widened the gap of the house prices between different regions.

As the number of regions enacting HSEP has gradually increased in South Korea, we alternatively searched for a region that satisfies quasi-natural experiment conditions and provides reliable data on house prices within the region. Finally, we selected Gangwon province, where HSEP was partially introduced into some of its divisions in the early 2010s, and tested our hypothesis that HSEP influenced the housing market via a difference-in-differences (DD) analysis. To ensure the robustness of the analysis result, three different time periods were considered for the post-treatment period, including six months after, one year after, and two years after the HSEP went into effect.

2. Materials and Methods

The data used in this study came from the public database of the Ministry of Land, Infrastructure, and Transport in South Korea (the data can be downloaded from the website in [26]). It includes the actual price of a transacted apartment, the final transaction date, address, size (m^2), floor, and construction year in Gangwon province. As transactions of apartments account for more than 70% of house transactions in South Korea [27], we focused on the change of apartment prices in the study. To control for the effect of the size of an apartment on its price, we used the actual transaction price per square meter of an apartment for the individual house price.

As mentioned in Introduction, we conducted a difference-in-differences (DD) analysis for testing our hypothesis about the secondary effect of HSEP on the housing market in Gangwon province. The DD analysis is a statistical technique that is often used in social sciences to identify the effects of policies from observational data [28,29]. For the DD analysis, observations must be classified into two groups: a treatment group, where a policy is applied, and a control group, where the policy is not applied. Then, the average difference in the amount of change of an outcome variable between the two groups after the treatment is computed and statistically tested, as the average difference may represent the treatment effect under the parallel trends assumption (i.e., that changes in the outcome variable of the two groups would be parallel absent any treatment).

In our analysis, the treatment group is the group of districts in Gangwon province where HSEP was implemented, whereas the control group includes the districts that did not adopt HSEP. HSEP was implemented only for the three cities (Chuncheon, Wonju, and Gangneung), in which most of the elite

high schools within the Gangwon province were located. Figure 1 depicts the lists of districts in the two groups.

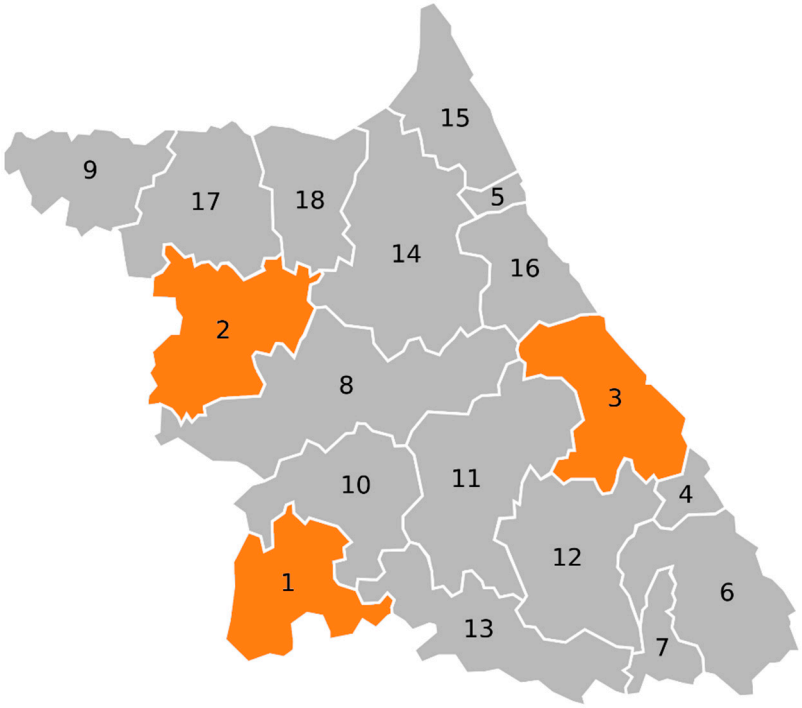

Figure 1. A map of the administrative districts in Gangwon province. Note: Each block with a number represents an administrative district (1 = Wonju, 2 = Chuncheon, 3 = Gangneung, 4 = Donghaey 5 = Sokcho, 6 = Samcheok, 7 = Taebaek, 8 = Hongcheon, 9 = Cherwony 10 = Hoengseongy 11 = Pyeongchang, 12 = Jeongseon, 13 = Yeongwol, 14 = Inje, 15 = Goseong, 16 = Yangyang, 17 = Hwacheon, and 18 = Yanggu). The three districts in the treatment group (HSEP was implemented) are orange-colored, whereas the rest in the control group (HSEP was not implemented) are in gray [30].

As the outcome variable of our study is house price, we pre-examined whether the average house prices in the two groups show the parallel trends in the year before the HSEP was legislated. Figure 2 depicts the trends of the average house prices in the two groups from the third quarter 2009 to the second quarter 2014. As the local law for implementing HSEP in Gangwon province was passed and promulgated in December 2011, we focused on the trends during the one-year period from the third quarter of 2010 to the same quarter of 2011. As shown in Figure 1, the two trends during the period were nearly parallel, indicating that the DD analysis can be applied to this data.

The DD model used in this study can be expressed as

$$\ln p_{igt} = \beta_0 + \beta_1 \text{Time}_t + \beta_2 \text{HSEP}_g + \beta_3 (\text{Time}_t \times \text{HSEP}_g) + \boldsymbol{\delta}' \mathbf{x}_{igt} + \varepsilon_{igt}, \quad (1)$$

where $\ln p_{igt}$ is the log price per square meter of the ith apartment ($i = 1, 2, \cdots, N$) in the gth group ($g = 0$ for the control group and 1 for the treatment group) at the tth time point ($t = 0$ for the pre-treatment period and 1 for the post-treatment period), β_k is the regression coefficient of the model ($k = 1$, 2, and 3), Time_t is a time dummy whose value is 0 before the treatment and 1 after the treatment, HSEP_g is a group dummy whose value is 0 for the control group and 1 for the treatment group, $\boldsymbol{\delta} = [\delta_1, \delta_2, \delta_3]$ is a 3 by 1 vector of regression coefficients for three covariates ($\mathbf{x}_{it} = [\text{Floor}_{it}, \text{Age}_{igt}, \text{Age}_{igt}{}^2]$), and ε_{igt} is the error term for $\ln p_{igt}$. The covariates are individual characteristics of apartments including a dummy (Floor_{it}) for the floor of an apartment whose value is 0 for the low floor apartment (lower than the fifth floor) and 1 for the high floor apartment (higher than the fourth floor), the age of an apartment

(Age_{igt}), and the squared age of an apartment (Age_{igt}^2). β_3 is the parameter of interest that represents the causal effect of HSEP on the house prices while controlling for the effect of the other covariates.

As the results from the DD analysis can be sensitive to the choice of time period for $Time_t$, we considered the three different time periods for the post-treatment period and built three corresponding models, while setting the pre-treatment period at the third quarter of 2011 in all conditions. We chose the first quarter of 2012 as the first post-treatment period (Model 1), to capture the immediate response from the housing market. For comparing the average house prices between the same quarter, we selected the third quarter of 2013 for the second post-treatment period (Model 2). Lastly, we chose the third quarter of 2013 (two years after the pre-treatment period) for the third post-treatment period (Model 3) because HSEP was implemented in the school in the first half of 2013.

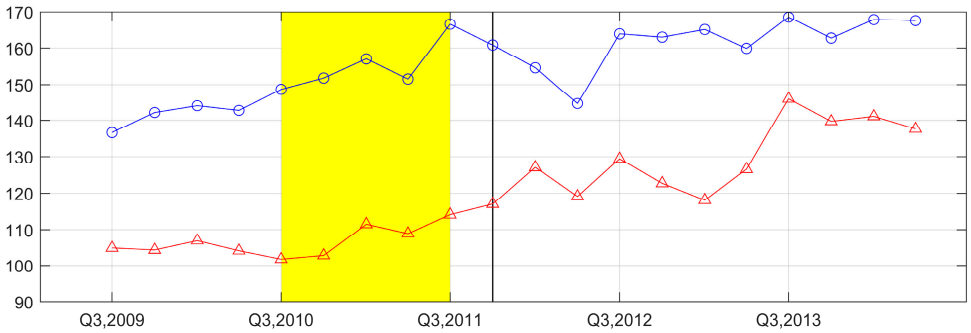

Figure 2. The average house price trends of the treatment and control groups. Note: The *X*-axis represents the time periods, whereas the *Y*-axis represents the average house price. The actual transacted price of an apartment per square meter (KRW 10,000) was used for an individual house price. The blue line marked with O denotes the average price trend of the treatment group, while the red line marked with Δ denotes that of the control group. The black vertical line shows the period when the implementation of the High School Equalization Policy (HSEP) was finally determined and announced. The parallel trends assumption was checked based mainly on the periods on the yellow background.

3. Results

3.1. Descriptive Statistics

Table 1 presents the descriptive statistics of the price per square meter of an apartment, apartment size (m^2), apartment age (years), apartment floor, and the number of observations (or transactions) in the two groups for each time period. In all the time periods, the average price per square meter of apartments in the treatment group was higher than that of the control group, but the difference between the two groups became relatively smaller in the post-treatment period (Q1, 2012; Q3, 2012; Q3, 2013), compared to that of the pre-treatment period (Q3, 2011). For instance, the difference in the average price per square meter of apartments between the two groups was KRW 524,000 in the third quarter of 2011 but became KRW 275,400 in the first quarter of 2012. The difference between these two differences from pre-treatment to post-treatment periods was KRW 248,600, implying that the gap of the average house price between the two groups may have narrowed due to the HSEP. The similar patterns were observed in the rest of the two post-treatment periods. The average size of transacted apartments in the treatment group (69 m^2~76 m^2) was a bit larger than that of the control group (60 m^2~62 m^2), whereas there were no substantial differences in their ages and floors. The total number of samples was 10,827 in the two periods for Model 1 (Q3, 2011 and Q1, 2012), 9387 in the periods for Model 2 (Q3, 2011 and Q3, 2012), and 9816 in the periods for Model 3 (Q3, 2011 and Q3, 2013).

Table 1. Descriptive statistics for the transacted apartments in the treatment and control groups for each time period.

		Treatment Group				Control Group			
		Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
2011 (3Q)	Price per size (KRW 10,000)	166.54	55.78	33.45	329.45	114.14	41.39	23.57	300.2
	Size (m^2)	75.02	29.03	19.99	244.96	60.43	20.20	15.73	166.54
	Age(year)	11.79	7.28	1.00	36.00	12.39	6.05	0.00	31.00
	Floor	7.48	4.66	1.00	25.00	6.77	4.62	1.00	24.00
	# of Samples	4138				1972			
2012 (1Q)	Price per size (KRW 10,000)	154.62	56.79	33.37	328.37	127.08	53.73	25.01	296.99
	Size (m^2)	69.26	27.56	19.99	167.73	62.12	22.95	22.84	166.54
	Age(year)	14.38	7.02	0.00	41.00	13.21	6.56	0.00	32.00
	Floor	6.98	4.49	1.00	24.00	6.94	4.44	1.00	25.00
	# of samples	3173				1544			
2012 (3Q)	Price per size (KRW 10,000)	163.89	48.49	41.83	311.80	129.43	54.68	23.57	296.66
	Size (m^2)	72.71	26.39	19.99	182.85	60.06	20.67	22.23	134.78
	Age(year)	12.54	7.02	0.00	41.00	12.91	7.89	0.00	32.00
	Floor	7.50	4.60	1.00	23.00	6.81	4.38	1.00	20.00
	# of samples	2098				1179			
2013.(3Q)	Price per size (KRW 10,000)	168.49	47.80	41.81	312.35	146.05	67.44	5.21	300.07
	Size (m^2)	72.32	25.60	19.99	167.73	61.88	22.02	22.23	166.54
	Age(year)	13.88	6.88	0.00	38.00	12.43	7.40	0.00	32.00
	Floor	7.38	4.75	1.00	23.00	7.29	4.33	1.00	21.00
	# of samples	2359				1347			

Note: The means of price per size are shaded in gray.

3.2. Difference in Differences Analysis

Table 2 reports the result from the DD analysis with the three models involving different post-treatment periods. The result indicated that all models explained more than 50% of the variance of the house price (for Model 1, $R^2 = 0.530$, $F(7, 10820) = 2035.3$, $p < 0.001$; for Model 2, $R^2 = 0.553$, $F(7, 9380) = 1934.5$, $p < 0.001$; for Model 3, $R^2 = 0.525$, $F(2, 9808) = 1803.9$, $p < 0.001$). The coefficient estimate for the interaction term (β_3; Time x HSEP), which is our main interest, was consistently negative and statistically significant in every model (for Model 1, $\beta_3 = -0.092$, $t(10820) = -7.960$, $p < 0.001$; for Model 2, $\beta_3 = -0.060$, $t(9380) = -4.906$, $p < 0.001$; for Model 3, $\beta_3 = -0.054$, $t(9809) = -4.222$, $p < 0.001$), suggesting that HSEP contributed to reducing the house price gap between the two groups of districts by 5%~9%.

The rest of the coefficient estimates were also all statistically significant at the 0.001 α level and their direction was consistent with the theoretical expectation. The coefficient estimate for Time (β_1) was 0.108 (Model 1), 0.089 (Model 2), and 0.165 (Model 3), respectively, in each model, showing that house prices in Gangwon province increased by 8%~9% per year on average. The coefficient estimates for HSEP (β_2) were between 0.33 and 0.34, implying that the average house price in the treatment group was 33%~34% higher than that of the control group at the pre-treatment period, which is in accord with the result presented in Table 1. There was an 8%~9% premium for high-floor apartments, compared to low-floor ones ($\delta_1 = 0.076$ for Model 1, 0.086 for Model 2, and 0.091 for Model 3). The age of apartments negatively affected their prices ($\delta_2 = -0.061$ for Model 1, -0.056 for Model 2, and -0.053 for Model 3), but when their age became larger than some point, it rather started to affect the price positively ($\delta_3 = 0.001$ for all models). It reflects the characteristic of the Korean housing market where the reconstruction of an apartment complex is allowed in a profitable manner if their apartments are older than the certain age (e.g., 30 years old) [31].

Table 2. Results from the difference-in-differences analysis for the three models involving different post-treatment periods.

		Model 1	**Model 2**	**Model 3**
Post-treatment period		Q1, 2012	Q3, 2012	Q3, 2013
Observation		10827	9387	9816
F-statistics		2035.3 ***	1934.5 ***	1803.9 ***
R^2		0.530	0.553	0.525
Predictors	Constant	5.205 *** (477.56)	5.153 *** (483.11)	5.152 *** (448.96)
	Time	0.108 *** (11.418)	0.089 *** (8.945)	0.165 *** (16.112)
	HSEP	0.334 *** (43.458)	0.337 *** (45.548)	0.339 *** (42.570)
	Time × HSEP	−0.092 *** (−7.960)	−0.060 *** (−4.906)	−0.054 *** (−4.222)
	Floor	0.076 *** (13.207)	0.086 *** (14.347)	0.091 *** (14.429)
	Age	−0.061 *** (−46.503)	−0.056 *** (−42.714)	−0.053 *** (−38.444)
	Age^2	0.001 *** (20.439)	0.001 *** (18.142)	0.001 *** (13.812)

Note: Coefficient estimates are on the rows of predictors. The estimates of the treatment effect are shaded in gray. *t* statistics are in parentheses. *** $p < 0.001$.

4. Discussion

In this empirical study, we found that HSEP in the Gangwon province led to a 5%~9% reduction in the house price gap between the three largest cities (Wonju, Chuncheon, and Gangneung), where HSEP was implemented, and the rest of the districts, where HSEP was not implemented. This reduction likely resulted from decreased housing demand in the three cities, as HSEP improved the relative competitiveness of general high schools, compared to traditional elite high schools that were mainly located in those cities. Specifically, several follow-up studies [32,33] reported that the previous lower-ranked general high schools in the Gangwon province were no longer socially stigmatized in the local area, and that the educational quality of these schools had substantially improved. This would have created less incentive for students to live near traditional elite schools after HSEP was implemented, thereby reducing the demand for houses in the three cities. Considering that the local educational climate is one of the key factors for households to determine their region of residence [13–17], changes in the educational environment of Gangwon caused by HSEP would reasonably have influenced housing markets in the region [34–36].

However, it is important to that the specific circumstances of Gangwon may have affected the efficacy of the policy. For instance, the HSEP that was implemented in the early 2010s in Gangwon was not introduced for the first time—but had been re-introduced by the support of over 70% of residents in the province after its abolishment in the 1980s. It is reasonable to assume that residents' favorable attitudes toward HSEP in its initial stage would have been a solid basis for establishing HSEP in the region, and that their positive expectations for HSEP would have elicited an immediate response in the housing market. However, if the HSEP in Gangwon was perceived as ineffective and failed to reduce the social divisions across high schools, the HSEP might have influenced the local housing market differently. For example, given that students are only permitted to attend the high schools near their residence, the existing preference for residing near traditional elite schools could have been exacerbated with the introduction of the HSEP, thereby increasing the house price gap across regions [37]. Therefore, it would be beneficial to conduct a further study to investigate moderating factors (e.g., residents' expectations) for the effect of HSEP on the local housing market.

5. Conclusions

This study investigated the secondary effect of high school equalization policy (HSEP) on the housing market using a difference in difference analysis. Against the expectation of critics of HSEP, our findings indicate that HSEP may alleviate the inequality in housing prices between different regions. HSEP in the Gangwon province caused the gap in average house prices between two groups of districts—one of which contains most of the traditional elite high schools in Gangwon—to decrease by 5%~9%. This implies that HSEP in the Gangwon province led to distributing economic resources though housing markets across regions as well as educational resources across social classes. Critically, these results demonstrate why decisionmakers in education should consider the effect of their policy beyond the scope of education. Specifically, it is important to take into account the secondary impact of educational policies on the housing market, as the quality of education is closely related to households' residential preferences and the relative house prices.

Nonetheless, we caution against unconditionally generalizing our finding to the HSEPs implemented in other regions, as the positive spillover effect of HSEP on the housing market we find is based on one instance of HSEP implemented in the Gangwon province at that time. As residents' positive expectations toward HSEP in its initial stage may have influenced the efficacy of HSEP in Gangwon, we recommend policymakers in education to carefully consider residents' expectations for HSEP during the initial stage of implementation.

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References

1. Bonell, C.; Fletcher, A.; Morton, M.; Lorenc, T.; Moore, L. Realist randomised controlled trials: A new approach to evaluating complex public health interventions. *Soc. Sci. Med.* **2012**, *75*, 2299–2306. [CrossRef] [PubMed]
2. Parajuly, K.; Fitzpatrick, C. Understanding the impacts of transboundary waste shipment policies: The case of plastic and electronic waste. *Sustainability* **2020**, *12*, 2412. [CrossRef]
3. Oliver, K.; Lorenc, T.; Tinkler, J.; Bonell, C. Understanding the unintended consequences of public health policies: The views of policymakers and evaluators. *BMC Public Health* **2019**, *19*, 1057. [CrossRef] [PubMed]
4. Van der Steen, M.; van Twist, M.; Fenger, M.; Le Cointre, S. Complex causality in improving underperforming schools: A complex adaptive systems approach. *Policy Polit.* **2013**, *41*, 551–567. [CrossRef]
5. Massey, D.S.; Pren, K.A. Unintended consequences of US immigration policy: Explaining the post-1965 surge from Latin America. *Popul. Dev. Rev.* **2012**, *38*, 1–29. [CrossRef]
6. Oliver, K.; Lorenc, T.; Tinkler, J. Evaluating unintended consequences: New insights into solving practical, ethical and political challenges of evaluation. *Evaluation* **2019**, *26*, 61–75. [CrossRef]
7. Hirvilammi, T. The Virtuous circle of sustainable welfare as a transformative policy idea. *Sustainability* **2020**, *12*, 391. [CrossRef]
8. Choi, J.; Cho, R.M. Evaluating the effects of governmental regulations on South Korean private cram schools. *Asia Pacific J. Educ.* **2016**, *36*, 599–621. [CrossRef]
9. Kim, S.; Lee, J.-H. Demand for education and developmental state: Private tutoring in South Korea. *Available SSRN 268284* **2001**. [CrossRef]
10. Peltzman, S. The effect of government subsidies-in-kind on private expenditures: The case of higher education. *J. Polit. Econ.* **1973**, *81*, 1–27. [CrossRef]

11. Zhang, Y.; Seo, W. Temporal effects of school features on school district housing price by introduction of school district system: Focused on Tianjin city, China. *Asia Pac. J. Multimed. Serv. Converg. Art Humanit. Sociol.* **2018**, *8*, 171–182. [CrossRef]
12. Oh, J.-Y. Relocation of Kyunggi High School in 1976 and the Birth of 'School District No. 8' in Gangnam. *Crit. Rev. Hist.* **2015**, *113*, 198–233. Available online: https://www.dbpia.co.kr/Journal/articleDetail?nodeId=NODE06566056 (accessed on 16 October 2020).
13. Downes, T.A.; Zabel, J.E. The impact of school characteristics on house prices: Chicago 1987–1991. *J. Urban Econ.* **2002**, *52*, 1–25. [CrossRef]
14. Rajapaksa, D.; Gono, M.; Wilson, C.; Managi, S.; Lee, B.; Hoang, V.-N. The demand for education: The impacts of good schools on property values in Brisbane, Australia. *Land Use Policy* **2020**, *97*, 104748. [CrossRef]
15. Glen, J.; Nellis, J. "The Price You Pay": The impact of state-funded secondary school performance on residential property values in England. *Panoeconomicus* **2010**, *57*. [CrossRef]
16. Qiu, L.; Guo, D.; Zhao, X.; Zhang, W. The value of school in urban China: A spatial quantile regression with housing transactions in Beijing. *Appl. Econ.* **2019**, *52*, 1–12. [CrossRef]
17. Bae, H.; Chung, I. Impact of school quality on house prices and estimation of parental demand for good schools in Korea. *KEDI J. Educ. Policy* **2013**, *10*, 43–61.
18. Wen, H.; Xiao, Y.; Zhang, L. School district, education quality, and housing price: Evidence from a natural experiment in Hangzhou, China. *Cities* **2017**, *66*, 72–80. [CrossRef]
19. Brunner, E.J.; Cho, S.-W.; Reback, R. Mobility, housing markets, and schools: Estimating the effects of inter-district choice programs. *J. Public Econ.* **2012**, *96*, 604–614. [CrossRef]
20. Agarwal, S.; Rengarajan, S.; Sing, T.F.; Yang, Y. School allocation rules and housing prices: A quasi-experiment with school relocation events in Singapore. *Reg. Sci. Urban Econ.* **2016**, *58*, 42–56. [CrossRef]
21. Byun, S.; Kim, K.-K.; Park, H. School choice and educational inequality in South Korea. *J. Sch. Choice* **2012**, *6*, 158–183. [CrossRef] [PubMed]
22. Park, B.K. The State, Class and Educational Policy: A Case Study of South Korea's High School Equalization Policy. Ph.D. Thesis, University of Wisconsin, Madison, WI, USA, 1988.
23. Lee, E.K. The Analysis of High School Policies in South Korea: The High School Equalization Policy, Specialty School, and Ability Grouping. Master's Thesis, State College, PA, USA, 2012.
24. Lee, J.-H. Reforming secondary echool equalization policies in Korea. *J. Econ. Financ. Educ.* **2002**, *11*, 237–269.
25. Bae, T.-S. Dissect the conspiracy of nullifying the school equalization policy. *Educ. Rev.* **2004**, *15*, 81–90.
26. Ministry of Land Infrastructure and Transport: The Open Access System for Actual Transaction Prices. Available online: http://rtdown.molit.go.kr/ (accessed on 10 June 2017).
27. Park, G.; Kim, J. *Housing Market Status in Gangwon and its Implication*; Bank of Korea: Seoul, Korea, 2016. Available online: https://www.bok.or.kr/portal/bbs/P0000800/view.do?nttId=220246&menuNo=200560&searchBbsSeCd=z23&pageIndex=1 (accessed on 16 October 2020).
28. Angrist, J.D.; Krueger, A.B. *Empirical Strategies in Labor Economics*; Ashenfelter, O.C., Card, D., Eds.; Elsevier: North Holland, The Netherlands, 1999; Volume 3, pp. 1277–1366.
29. Buckley, J.; Shang, Y. Estimating policy and program effects with observational data: The "differences-in-differences" estimator. *Pract. Assess. Res. Eval.* **2002**, *8*, 24. [CrossRef]
30. ASDFGH File:Gangwon Municipal.svg. Available online: https://commons.wikimedia.org/wiki/File:Gangwon_Municipal.svg (accessed on 11 September 2020).
31. Youn, S.-P.; Kim, J.-S. A study on the estimation of development profits by the redevelopment and reconstruction project. *Korea Real Estate Acad. Rev.* **2012**, *49*, 231–245. Available online: https://www.kci.go.kr/kciportal/ci/sereArticleSearch/ciSereArtiView.kci?sereArticleSearchBean.artiId=ART001663437 (accessed on 16 October 2020).
32. Sung, G.-S. Schools revive through the expansion of the school equalization policy. In *Educational Autonomy Revolution to Open a New Society*; Korean Educational Policy Network, Ed.; SalLimTeo: Seoul, Korea, 2014; pp. 98–118. Available online: https://www.nl.go.kr/NL/contents/search.do?isMobile=false&innerYn=false#viewKey=209779392&viewType=AH1 (accessed on 16 October 2020).
33. Sung, Y.-K.; Lee, J.-H.; Lee, G.-R. *A Feasibility Study on the Student Assignment System Adopted in the Districts where High School Equalization Policy is Implemented in Gangwon Province*; Gangwon Provincial Office of Education: Gangwon, Korea, 2017. Available online: http://keric.gwe.go.kr/boardCnts/view.do?boardID=

3027&boardSeq=6442944&lev=0&searchType=S&statusYN=W&page=1&s=keric&m=0702&opType=N (accessed on 16 October 2020).
34. Orford, S. Modelling spatial structures in local housing market dynamics: A multilevel perspective. *Urban Stud.* **2000**, *37*, 1643–1671. [CrossRef]
35. Brasington, D.; Haurin, D.R. Educational outcomes and house values: A test of the value added approach. *J. Reg. Sci.* **2006**, *46*, 245–268. [CrossRef]
36. Jud, G.D.; Watts, J.M. Schools and housing values. *Land Econ.* **1981**, *57*, 459–470. [CrossRef]
37. Lee, Y.S. School districting and the origins of residential land price inequality. *J. Hous. Econ.* **2015**, *28*, 1–17. [CrossRef]

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The Effect of Tuition Fee Constraints on Financial Management: Evidence from Korean Private Universities

Young-Hwan Lee [1], Kwon-Sik Kim [2] and Kwang-Hoon Lee [3,*]

[1] Department of Social Welfare, Won-Kwang Health Science University, Iksan 54538, Korea; apersonview@naver.com
[2] Korea Small Business Institute, Seoul 07074, Korea; kskim@kosbi.re.kr
[3] Department of Public Administration, Kangwon National University, Chuncheon 24341, Korea
* Correspondence: swiss@kangwon.ac.kr; Tel.: +82-10-5453-9125

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Abstract: This study examined the effect of tuition fee control policy on universities' financial management. Using data from 93 private universities in Korea from 2006 to 2015, we investigated the effect of tuition fees and government subsidies on labor cost, operating expenses, research expenses, and so on. Based on principal and agency theory, we used the analysis of average percentage change in expenditure and panel data analysis with the help of a Least Squares Dummy Variable (LSDV) model and polynomial regression. The results show that the increase rate of tuition fees decreased after 2011, with government subsidies increasing. The LSDV analysis indicates that universities increase labor costs, operating expenses, and student support fees, while there are no differences in research expenses, laboratory fees, and expenditures from investments and other assets. Polynomial regression reveals that, based on resources, universities behave differently in their spending. With these results, this study suggests a method to lessen information asymmetry and goal conflict, such as a performance-based research system and an incentive-based budget system in universities.

Keywords: tuition fee control policy; financial management; principal–agency model

1. Introduction

As tuition fees have increased over the years, they have become a cause for concern for students and families [1]. These concerns have led to a call for attention on government policy to address tuition fee escalation. Recently, tuition fees have become one of the most pressing issues in higher education [2]. Multiple studies have explained the driving factors of tuition fee increase, such as the reduction of state appropriations and the increase of institutional spending on services, facilities, and compensation [3]. Among these, the reduction of government appropriations has been recognized as a major contributing factor of tuition fee increase [4,5].

In South Korea (hereafter Korea), the situation is different from in other countries. University tuition fees have increased by more than the inflation rate from 2000 to 2010. Similar to other countries, the fee increase has led to parents and students being concerned and becoming the targets of political and social controversy. Finally, in 2011, the Higher Education Act of Korea was amended to restrict the increase rate of tuition fees to be below a certain level. Since 2011, a few universities reduced their tuition fees by about 5–10%. While the government began controlling the increase of tuition fees, it also increased its financial support to universities through government subsidies using formula funding, which has since been reinforced. As Kim and Ko [2] indicate, tuition control policy is most

effective when it is linked with financial aid and provides incentives to limit tuition fee increase; Korean universities tend to follow tuition control policy in order to receive government financial aid.

However, as the expectations placed on universities are on the rise [6], the demands for financial expenditure have also increased. This coupling of tuition fee control and the increased demands presents a significant challenge to higher education institutions in Korea. This challenge is particularly problematic for Korean universities, for which tuition fees form the vast majority of institutional operating budgets, and which have limited the options to create other revenues. In particular, the decline of school-age populations has become a serious burden to universities, whose finances significantly depend on tuition fees. Although universities are making an effort to diversify their sources of financing, in reality, it is not easy for universities to create new sources of revenue. In this situation, it is desirable for universities to set their financial priority on student performance, which is important for formula funding to receive government financial support and for reserved students. As part of their efforts to attract reserved students, universities have to allot their expenditure on student services and education. However, under such financial constraints, this can lead to cuts in spending on student education. This approach is frequently undertaken in the name of cost reduction by decreasing course and program offerings and by reducing library and student services [7]. It has been argued that cuts in these areas negatively impact the quality of education and the university's reputation, and impair the core mission of research, teaching, and service [8]. It is necessary to empirically analyze the impact of tuition fee control policy on internal financial management. Thus far, numerous studies have investigated the factors of tuition fee increase [4,9], the impact of tuition control policy [2], and the effect of tuition fees on university attendance [10]. However, there is limited knowledge about the effects of tuition fee policy on university financial management.

This study examines the characteristics of income and expenditure in university finances with respect to tuition fee control policy. Specifically, this study explores which expenditures have been reduced and which are being maintained or have increased, and how the characteristics of financial management in universities have changed after tuition fee control. In analyzing these issues, this study uses the principal–agency theory, which is an appropriate framework for analyzing the relationship between government and universities [11]. Using this theory, this study examines whether there are opportunistic behaviors or moral hazard from the agent.

To enhance a university's competitiveness, provide high-quality education, and increase financial sustainability [12,13], it is necessary to efficiently and stably manage the university's finances. Financial management in universities, as a key area of university management, can be defined as a series of economic activities by universities in order to secure, distribute, spend, and evaluate finances necessary for producing and supplying higher education services to fulfill educational purposes. This study investigates the link between tuition fee control and the financial management of universities. By analyzing the impact of tuition fee control policy on the university's financial management, the study shows how universities respond strategically to fiscal constraints. In doing so, it will enhance our understanding of financial management in universities as well as universities' behavioral characteristics. In addition, it is expected to provide a new perspective on the universities' strategic behaviors.

The rest of this study is organized as follows: Section two reviews prior literature about tuition fee policy and its effect on universities. Section three discusses Korean tuition fee policy and the theoretical framework. Section four describes the data. The estimation method is presented in the fifth section, while the sixth section presents the results and identifies the main policy implications. The final section provides the conclusions.

2. Literature Review

As tuition price increase has accelerated beyond inflation and family incomes, tuition policy has become a pressing policy issue in higher education [2]. College prices and costs have become a major political issue at the national level [14]. Along with policy concerns about tuition, the academic community has made various efforts to address this issue. Focusing on tuition setting is a complex

and ambiguous process, and numerous studies have explored the factors that influence the level of tuition fees. For example, Mumper [3] investigated the driving factors of tuition fee increase, such as reduced state appropriation and increased institutional spending on services, facilities, and compensation. Haptman [4] explained tuition fee increases as being caused by consumer prices, the use of expanded and improved services, and so on. While these studies focused on the factors of tuition fee increase, other studies examined the effects of state policies on tuition fee control, such as curbs, caps, and freezes [15], as well as financial aid and incentives [16]. For example, Kim and Ko [2] analyzed the impacts of state control polices on college tuition fee increase using data from 50 states and 540 public four-year universities and colleges. Using hierarchical multiple regression analysis, they examined the effects of state policy on tuition change and concluded that linking tuition to financial aid and providing incentives to limit the tuition fee increase are effective in controlling tuition fees. Interestingly, this study provides the evidence that the state's tuition cap policy can adversely affect tuition.

Several studies investigated the effects of tuition fees on university attendance [10,17], enrollment [18], intentions of degree [19], and quality [20]. Dearden et al. [10] studied participation rates with respect to the level of tuition fees in the UK. Using fixed effects regression, they found that fees have a significant adverse effect on university participation. Yoo [21] reported that introducing the half-price tuition policy in Korea is against the benefit principle and creates the contradiction of high school graduates supporting college graduates. He stated that this regulation causes side effects, such as increased youth unemployment due to academic inflation, delays in the restructuring of insolvent colleges, an increase in repeaters due to excess demand for college education, and an increase in private education expenses. Görgen et al. [18] investigated the effect of the introduction of tuition fees on university student enrollment behavior. In order to identify potentially relevant factors and control in a short time frame, this study used the Lasso technique and used spatial cross-effects in a fixed effects panel model for the enrollment analysis. Using this methodology, this study presented significant negative effects of tuition fees, inducing an up to 4.5% percentage point reduction in enrollment rates. Bahrs and Siedler [19] analyzed the effect of tuition fees on the intention to acquire a university degree. Using data from Youth Questionnaire of the German Socio-Economic Panel, they analyzed the different effects of the introduction and elimination of university tuition fees in Germany with difference-in-difference settings. The result showed that tuition fees have a negative effect on the intention of 17-year-olds to acquire a higher educational degree. Gawellek et al. [20] examined the impact of the introduction of modest tuition fees on perceived instructional quality. To analyze the effect of tuition fees on instructional evaluation ratings, they adopted the difference-in-difference method and found that the instruction of fees in a publicly financed system has a significantly positive impact on faculty evaluation.

If these studies focused on the effects of tuition fee policy, others investigated financial management in universities under fiscal constraints. Government pressure and control of tuition fees combined with decreased government funding have led universities into an unprecedented situation [22]. Responding to this situation, universities have been motivated to seek alternative revenues from research funding [23], donations, and financial investment [24]. In addition to these efforts, universities have modified their budget systems from incremental budget systems to decentralized budget models. A number of universities have adopted responsibility center management (RCM), which devolves both budget responsibility and decision-making authority in ways that motivate lower-level actors to meet larger organizational goals [7]. Using RCM, universities aim to increase the responsibilities of organizational subunits by devolving ownership of revenues and costs to encourage revenue generation and cost effectiveness, as well as enhance transparency about budget allocation and financial flexibility [25]. Accordingly, numerous studies have examined the implementation challenges of RCM [7,26], its benefits and drawbacks [27,28], and its effect on revenue and student satisfaction [25,29]. For example, Ozan et al. [29] analyzed the effect of RCM adoption on tuition revenue at four public universities, namely Iowa State University, Kent State University, the University of Cincinnati, and the

University of Florida. Using the synthetic control method approach, they concluded that RCM positively affected tuition revenue at all universities except the University of Florida.

Previous studies have provided valuable insights to universities by analyzing the tuition control policy, its effects, and universities' financial management under fiscal constraints. However, to the best of our knowledge, no empirical research has established a causal link between tuition control policy and university financial management. This study aims to analyze the effect of tuition control policy on university financial management using the principal–agent model. Until now, multiple studies have analyzed the relationship between government and university by applying the principal–agent model [30–32]. For example, Liefner [30] analyzed the form of resource allocation and performance in universities using the principle–agent theory. He attempted to explain who the principal and agent are in higher education from a theoretical perspective, and recognized that the assumptions concerning goal conflicts and information asymmetries are especially relevant in the higher education context. Gornitzka et al. [32] introduced the principal–agent theory between state and higher education and analyzed the sphere of contract arrangements between state and higher education institutions. Using concepts such as moral hazard and information asymmetry, they analyzed the contract arrangements in Finland, Sweden, and Denmark. The major concepts of principal–agent theory can help in understanding the relationship between government and universities, including university administration. This theory also provides a better understanding of the problems and implications for university management.

3. Theoretical Background

3.1. University Accounting System in Korea

To analyze the effect of tuition fee and government financial support on university financial management, it is necessary to understand accounting systems in Korean private universities. There are external rules governing the operation of university finance. "Special Rules on the Finance and Accounting for Private Universities" are the accounting standards currently applied to private universities. According to this regulation, universities have to produce financial statements, such as balance sheets, statements of revenues and expenses, and statements of fund flow (Figure 1). In making financial statements, the principle of double-entry book-keeping, principle of continuity, and principle of clarity are applied.

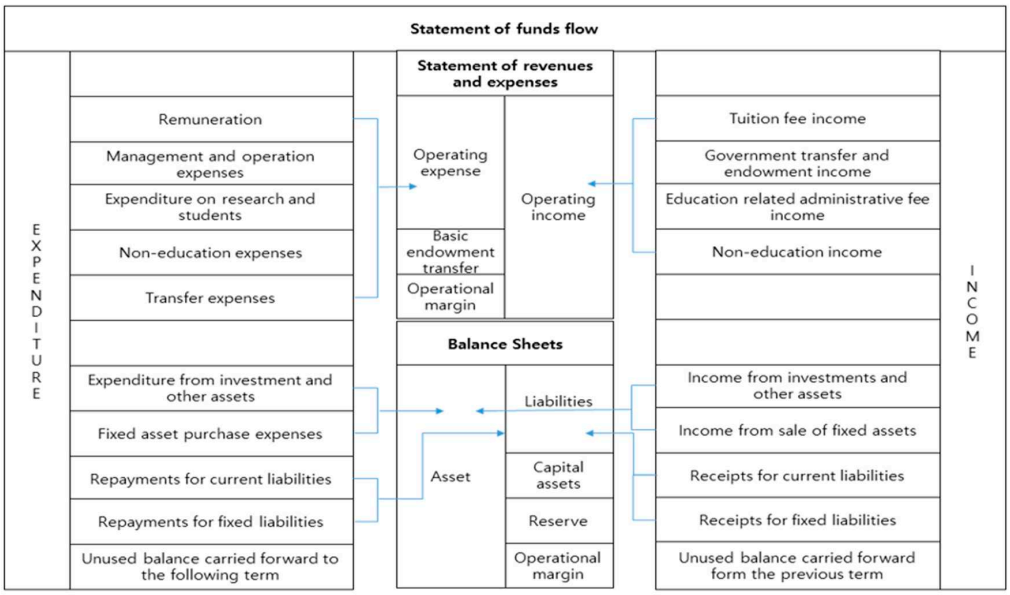

Figure 1. The structure of financial statements of private universities in Korea.

3.2. Korean University Tuition Policy, Government Subsidy Mechanism

In Korea, the fundamental philosophy and policy direction of university tuition fees have been affected by the government's university education policy in 2003. At the time, the Korean government liberalized the tuition fees of all national universities. Accordingly, university tuition fee increase rates were remarkably high in the early 2000s.

Beginning in 2009, the government began controlling the increase of university tuition fees, and thus, the rates of increase have been slowing down. One of the biggest complaints of education consumers regarding university tuition fee policy is that the portion of tuition fees takes up too much of a university's finances and that there is an unequal financial burden between the university's founders and beneficiaries. Moreover, due to the lack of persuasive tuition fee appropriation methods, the grounds for appropriation are vague, and education consumers have many complaints about the unclear appropriation and operation process due to supplier-led tuition fee policy management [33].

Finally, considering the effect on prices, the government put a ceiling on tuition fee increases and revised the Higher Education Act. According to the Higher Education Act: "No school shall set the rate of increase in tuition fees at a level exceeding 1.5 times the average consumer price inflation for the three preceding years". Furthermore, the Ministry of Education has implemented a tuition fee control policy through state scholarships and a financial support project. To receive a state scholarship, it is necessary to freeze tuition fees at the least. Students can receive more state scholarships only if universities make constant efforts to reduce tuition fees or increase scholarships [34].

In addition, the government uses financial support as a tool for university control. Around 2010, the government increased the amount of financial support to universities and changed the way to distribute financial support. "Formula funding" and "block grant" schemes were implemented, and the rate of tuition increase rate was used as the key indicator in the selection process for support recipients. In this situation, universities may not be able to raise tuition fees and may be requested to lower their tuition fees. Combined with tuition fee control, universities face an unprecedented situation—a decline in school-age population. Due to the dramatic decline of the school-age population, the school-age population saw an 11.3% decrease in 2018 compared to 2013, and the increase rate of student numbers in private universities is lower than in public universities (Figure 2).

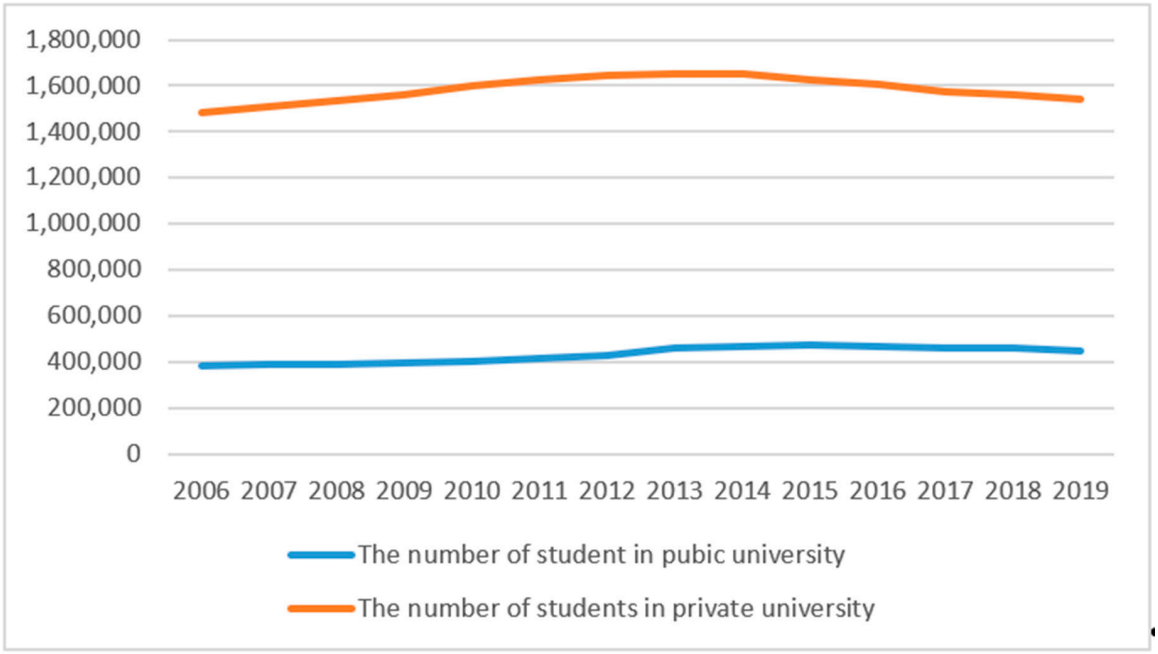

Figure 2. The number of students in private and public universities in Korea. Source: Korean Education statistic service, https://kess.kedi.re.kr/eng/index.

These trends will be a burden to universities because most of a university's income depends on tuition fees. This decrease will translate into a financial burden to universities. Attaining government projects has thus emerged as a major goal for universities to secure; government subsides have become a major factor for the survival and sustainability of universities.

The financial structure of Korean universities is highly dependent on tuition fee income, while the ratio of government income has been increasing in recent years. In 2006, the tuition fee income from all private universities was 11,042,157 million KRW, which accounted for 68.8% of all income. In 2006, transfer and endowment income was 1,696,934 million KRW, which was 10.6%. However, in 2015, tuition fee income was 13,657,620 million KRW (56.9%), while transfer and endowment income was 5,712,058 million KRW (23.8%). The ratio of transfer and endowment income seems to have increased due to the increase of government subsidies (Table 1).

Table 1. Annual income of private universities (Unit: million KRW).

Category	2006	2007	2008	2009	2010
Tuition fee income	11,042,157	11,740,739	12,670,596	13,160,818	13,735,532
Government transfer and endowment income	1,696,934	1,872,182	2,001,802	2,531,757	2,619,801
Education-related administrative fee income	423,100	479,569	536,024	625,224	718,247
Non-education income	637,659	756,620	832,873	878,081	806,131
Income from investments and other assets	773,985	993,405	744,290	895,250	980,278
Income from sale of fixed assets	94,701	89,610	41,390	28,896	36,678
Receipts for current liabilities	2057	2090	3043	644	2644
Receipts for fixed liabilities	102,857	98,865	186,425	150,581	203,458
Unused balance carried forward from the previous term	1,256,314	1,241,322	1,450,637	1,744,106	1,864,169
Category	**2011**	**2012**	**2013**	**2014**	**2015**
Tuition fee income	13,724,007	13,781,492	13,725,653	13,395,827	13,657,620
Transfer and endowment income	2,704,543	3,994,669	4,686,934	5,168,779	5,712,058
Education-related administrative fee income	766,296	924,573	990,304	1,004,594	1,079,303
Non-education income	803,171	739,496	578,832	547,841	425,648
Income from investments and other assets	1,629,779	1,230,731	1,082,146	1,348,758	1,404,353
Income from sale of fixed assets	25,073	65,699	59,364	156,265	155,745
Receipts for current liabilities	635,149	345,378	2865	1466	1538
Receipts for fixed liabilities	239,273	137,209	220,868	180,160	169,693
Unused balance carried forward from the previous term	1,852,146	2,144,458	1,950,733	1,448,032	1,335,294

Source: Private School Financial Data System.

Regarding expenditure, in 2006, remuneration was 6,078,237 million KRW, which accounted for 37.9% of all expenditures, and management and operating expenses were 1,683,451 million KRW, which was 10.5%. Expenditure on research and students was 2,846,651 million KRW (17.7%) in 2006. However, in 2015, remuneration was 9,299,141 million KRW (38.8%), management and operating expense was 2,532,611 million KRW (10.5%), and expenditure on research and students was 7,527,429 million KRW (31.4%). This rapid increase in expenditure on research and students may have been due to the increase in state scholarships (Table 2).

Table 2. Annual expenditures of private universities (Unit: million KRW).

Category	2006	2007	2008	2009	2010
Remuneration	6,078,237	6,326,260	6,818,692	7,273,686	7,735,373
Management and operating expenses	1,683,451	1,830,510	1,998,206	2,131,326	2,304,174
Expenditure on research and students	2,846,651	3,141,699	3,476,399	4,017,846	4,270,347
Non-education expenses	147,816	152,705	169,697	205,459	176,330
Transfer expenses	23,793	17,436	14,682	31,671	29,612
Expenditure from investments and other assets	1,464,843	1,755,249	1,770,188	1,895,335	1,761,906
Fixed asset purchase expenses	2,345,657	2,465,258	2,458,940	2,483,390	2,603,733
Repayments for current liabilities	11,512	10,968	14,302	12,282	17,301
Repayments for fixed liabilities	101,982	133,637	118,034	114,185	112,007
Unused balance carried forward to the following term	1,325,820	1,440,680	1,627,939	1,850,177	1,974,108
Category	**2011**	**2012**	**2013**	**2014**	**2015**
Remuneration	7,966,689	8,590,134	8,895,711	8,865,079	9,299,141
Management and operating expenses	2,420,198	2,536,298	2,531,540	2,477,145	2,532,611
Expenditure for research and students	4,570,886	5,851,675	6,607,738	7,039,274	7,527,429
Non-education expenses	160,657	125,146	111,182	100,329	93,943
Transfer expenses	16,061	4413	5188	6001	6485
Expenditure from investments and other assets	1,884,229	1,294,934	1,224,080	1,354,988	1,417,681
Fixed asset purchase expenses	2,568,536	2,528,381	2,208,582	2,097,255	1,799,602
Repayments for current liabilities	8244	8570	10,091	14,829	23,231
Repayments for fixed liabilities	168,805	150,449	142,292	227,812	144,819
Unused balance carried forward to the following term	1,997,045	1,950,127	1,562,814	1,272,696	1,119,711

Source: Private School Financial Data System.

3.3. Conceptual Framework

This study aims to examine the characteristics of financial management in universities with regard to constraints on tuition fees and increase of government subsidies using the agency theory, which originates from studies by Ross [35] and Jensen and Meckling [36]. Traditionally, the principal–agent relationship is regarded as a contractual relationship [36]. In a comprehensive sense, the agency problem is caused when a certain agent depends on the action of another person in a principal–agent relationship [37]. The principal–agent relationship is a general phenomenon and "a pervasive fact of economic life" [38]. Jensen and Meckling [36] indicated that the principal–agent relationship exists in all organizations and cooperative activities, such as corporate management, universities, conferences, and government agencies.

In the relationship between state and university, states are considered to be the principal because the governments delegate the state's educational goals to universities [39]. Universities were formed and funded by the government to fulfill the need of society to create, preserve, and transmit knowledge. The agent problem arises when (a) the principal and the agent have conflicting goals and/or (b) there is information asymmetry between them. Universities perform diverse functions, and the organizational goals of universities are complicated, ambiguous, and dynamic. Moreover, universities with multiple groups that have different interests [40] reinforce goal conflict within universities. Information asymmetry arises when the principal lacks information about the agent's work. Universities use diverse and complicated mechanisms in their production [41], and use intensive technology that requires various skills. Universities have the characteristics of joint production, in which various outputs are produced at once [42]. Due to these characteristics, the process through which professors produce and provide knowledge is difficult to monitor and control [30]. These factors lead to information asymmetry.

Goal conflict and information asymmetry activate the possibility of agent problems, such as adverse selection and moral hazard. These problems can be illustrated using the model of revenue theory of cost [43] and the utility-maximizing models [44]. For example, the revenue theory of cost model assumes that universities raise as much money as they can and then spend it all.

In the context of the government–university relationship, the principal–agent theory could provide a useful and applicable framework for analyzing the effects of tuition fee policy on university financial management. Agency problems that may occur in the relationship between government and university or management staff and students in universities include shirking, budget maximization, and cross-subsidization [10]. Shirking is classified into passive shirking, in which the school does not achieve the objective pursued by the government and students, and aggressive shirking, in which the school acts contrary to the objective desired by the government and students [45]. Some examples include professors doing personal consulting rather than focusing on education and research for students, or the university excessively using the budget on publicity and events rather than investing in education and research. There are many accounts related to shirking in the expenditure accounts of universities in Korea. First, operating expenses include welfare benefits, training costs for faculty and staff, general service costs, business operating expenses, publicity costs, meeting costs, event costs, missionary work costs, and other operating expenses, which are costs related to the management of the university rather than costs invested to meet the purposes desired by the government and students, and thus, excessive spending on these items can be regarded as a form of shirking. Expenditure from investments and other assets is also an account to increase the financial income activities of universities rather than investment in education and research. The pursuit of a greater budget involves the act of making efforts to constantly increase the budget and to spend it. This can be determined by the variation of unused balance carried forward to the following term. In cross-subsidization, the budget that must be used for students' education is, in fact, used for the university's management or operations. This includes spending the budget that must be invested in education and research on constructing or buying a new school building, implementing a computer system to reduce the workload of administrative staff, or increasing labor costs [22]. Accordingly, the analysis in this study will be conducted by setting the following research question and hypotheses. Research Question: What are the characteristics of university financial management with regard to tuition control policy? Do universities act with moral hazard in their financial management? To analyze this research question, this study constructs the following hypotheses.

Hypothesis 1. *Universities will display shirking behavior despite tuition fee constraints.*

Hypothesis 2. *Universities will display budget maximization behavior despite tuition fee constraints.*

Hypothesis 3. *Universities will display cross-subsidization behavior despite tuition fee constraints.*

4. Research Design

4.1. Data

This study analyzed private universities in Korea because private universities account for 80% of higher education in Korea, and are under relatively tighter constraints on financial management than national universities. The period of analysis is from 2006 to 2015, because the regulations on tuition fee increase rates in the Higher Education Act were amended in September 2011, and there is a difference in tuition fee increase rates before and after 2011. Although the number of universities slightly varied by year, there were around 93 universities.

This study analyzed the characteristics of financial management in universities based on the account of university expenditure. Information on the account of university expenditure was obtained from the financial statements of universities. The financial statement of a university includes balance sheets, statements of revenues and expenses, and statements of funds flow. This study analyzed the financial characteristics using the statements of funds flow because this statement presents a university's fund income and spending for a certain period. Data regarding the funds flow were collected from the Private School Financial Data System.

In analyzing the effect of tuition fee control, this study uses tuition fees and government subsidies as the explanatory variables because the government started controlling tuition fees with the increase of financial support to universities. As the dependent variables, this study uses expenditure from investments and other assets, fixed asset purchase expenses, and labor costs, among others. Through these variables, we can explore the characteristics of universities' financial management under the tuition fee control policy. For example, operating expenses include welfare benefits, training costs for faculty and staff, general service costs, business operating expenses, publicity costs, meeting costs, event costs, missionary work costs, and other operating expenses related to the management of the university, rather than the costs invested to meet the purposes desired by students; therefore, excessive spending on these items can be regarded as a form of moral hazard. In addition, expenditure from investments and other assets also results in increasing the financial income activities of universities rather than investment in education and research. The pursuit of a greater budget involves making efforts to constantly increase the budget and expenditure. This can be determined by the variation of unused balance carried forward to the following term. Table 3 provides a list of the control variables, independent variables, and dependent variables used in this study.

Table 3. Variables and contents of analysis.

Category	Variable	Note
Control variables	Fiscal year: 2006–2015 Size: Fewer than 5000 students = 1, 5000 to fewer than 10,000 students = 2, 10,000 students and more = 3 Finance size: Fewer than 10 billion KRW = 1, 10 billion KRW to fewer than 50 billion KRW = 2, 50 billion to 100 billion KRW = 3, 100 billion KRW to 200 billion KRW = 4, 200 billion KRW and more = 5 University establishment year	
Independent variables	Tuition fee Government subsidies	
Dependent variables	Operating expenses	shirking
	Expenditure from investments and other assets	shirking
	Fixed asset purchase expenses	shirking
	Unused balance carried forward to the following term	budget maximization
	Labor costs	cross-subsidization
	Research expenses	cross-subsidization
	Laboratory fees	cross-subsidization
	Student support fees	cross-subsidization

The mean value of tuition fees is 93,513,167 KRW (one US dollar is equivalent to 1180 Korean won) and the mean value of government subsidies is 9,853,121 KRW. Among the expenditures, labor costs make up the largest portion (see Table 4).

Table 4. Descriptive statistics. (Unit: 1000 KWR).

	Mean	Min.	Max.
Tuition fees	93,513,167	7,366,817	383,330,038
Government subsidies	9,853,121	1	66,359,084
Labor costs	60,953,790	4,532,384	482,828,806
Operating expenses	16,242,164	1,443,113	123,557,121
Research expenses	4,221,199	1	79,950,857
Laboratory fees	1,801,100	56,887	9,283,436
Student support fees	2,658,183	5029	22,782,981
Expenditure from investments and other assets	12,704,207	1	180,521,886
Fixed asset purchase expenses	17,184,608	220,055	142,486,789
Unused balance carried forward to the following term	8,764,900	1	120,581,735

4.2. Method of Analysis

To analyze the effects of tuition fee control policy on university financial operation, this study used panel data. Before using the panel data regression model, this study tests the stationarity of the data. The results of the LLC (Levin, Lin and Chu [46]) panel unit root test and Fisher stationary test indicate that all variables satisfy data stationarity at the level of trans-log variables (see Table 5).

Table 5. Results of unit root test.

	Variable	LLC	Fisher
Label variables	Tuition fees	−5.0838 ***	4.5162 ***
	Government subsidies	5.5706	7.8925 ***
	Labor costs	−1.4675 *	0.2549 ***
	Operating expenses	−4.0846 ***	1.7872 **
	Research expenses	−10.3454 ***	3.9814 ***
	Laboratory fees	−5.2519 ***	6.2017
	Student support fees	−2.5769 **	2.5867 **
	Expenditure from investments and other assets	−23.0822 ***	6.4828 ***
	Fixed asset purchase expenses	−9.0398 ***	9.3314 ***
	Unused balance carried forward to the following term	−8.3428 ***	2.9690 **
Log-trans variables	Tuition fee	−5.8952 ***	8.9989 ***
	Government subsidies	−26.1368 ***	14.2754 ***
	Labor costs	−3.6059 ***	3.4120 ***
	Operating expenses	−9.0974 ***	1.8012 **
	Research expenses	−5.3402 ***	2.0106 ***
	Laboratory fees	−6.4330 ***	8.4936 ***
	Student support fees	−5.2303 ***	1.3841 **
	Expenditure from investments and other assets	−12.3069 ***	10.6963 ***
	Fixed asset purchase expenses	−9.8209 ***	8.6506 ***
	Unused balance carried forward to the following term	−16.2357 ***	7.5542 **

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

As the stationary test results indicate, we use logged variables in model specification. Because logged variables minimize the influence of outliers, they are appropriate when the distribution of a variable is skewed. Using logged specification, the pooled Ordinary Least Square (POLS) model can be considered. This model can be presented in the following form:

$$lny_{it} = \alpha + \beta_i lnx_{it} + \varepsilon_{it}, \qquad i = 1, \ldots, n;\ t = 1, \ldots, t$$

where y_{it} = university expenditure vectors, α = constant, and x_{it} = tuition and government fund.

In the pooled OLS model, it is presumed as $\varepsilon_{it} = \delta_i + e_{it}$. However, as the data used in this research are panel data, we can consider the panel data regression model. To use the panel data regression model, it is necessary to consider whether δ_i is 0 for all panel entities. This can be done using the Breush Pagan Lagrangran (BPL) Multiplier test. The BPL test shows that panel data analysis is suitable in all variables. Therefore, we decided to use the panel data model, which can be written as follows:

$$lny_{it} = \alpha + \beta lnx_{it} + u_i + e_{it} \qquad i = 1, \ldots, n;\ t = 1, \ldots, t$$

where y_{it} = university expenditure vectors, α = constant, and x_{it} = tuition and government fund.

To use the panel data regression model, the Hausman test was conducted to select either the fixed or random effects model. The Hausman test results (Table 6) show that laboratory and fixed asset variable models are more suitable than the random effects model. Except for the two dependent variables, all models indicate that the fixed effect is suitable.

Table 6. Results of the Hausman test.

Labor Costs	Operating Expenses	Research Expenses	Laboratory Fees	Student Support Fees	Expenditure from Investments and Other Assets	Fixed Asset Purchase Expenses	Unused Balance Carried Forward to the Following Term
0.5	0.18	0.28	5.18 *	4.16	0.72	6.37 *	1.27

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

For research consistency, this research uses the fixed effect model. To analyze the effects of individual characteristics, the time characteristic effect is used as a dummy variable. The model can be presented as follows:

$$lny_{it} = \alpha + u_i + \beta lnx_{it} + e_{it}\ i = 1, \ldots, n;\ t = 1, \ldots, t \tag{1}$$

where y_{it} = university expenditure vectors, α = constant, x_{it} = tuition and government fund, and u_i = year dummy from 2006 to 2015.

To investigate the response and behavior of universities to tuition, we estimate the marginal effects of tuition fees and government subsidies. Using polynomial regression, the marginal effects of tuition fees and government subsidies can be presented as follows:

$$lny_{it} = \alpha + \beta_1 ln\pi_{it} + \beta_2 ln\pi_{it}^2 + \gamma_1 ln\varphi_{it} + \gamma_2 ln\varphi_{it}^2 + \delta lnx_{it} + u_i + \varepsilon_{it}, \tag{2}$$

where y_{it} = university expenditure vectors, α = constant, β_1 = tuition fees, β_2 = tuition fee square, γ_1 = government subsidies, and γ_2 = government subside square.

5. Results

As a preliminary analysis, this study first examines the rate of change in variables. Tuition fees increased by 2.54% on average compared to 2007, but government subsidies increased by 38.65%. The percentage of government subsidies is higher than that of any other variables. This implies that the government provides a monetary incentive to minimize tuition fee increases. Student support fees showed a relatively significant increase compared to other variables, and a decrease after 2012.

The average rate of research expenses and fixed asset purchase expenses was negative. Labor costs increased by 0.711% on average, but the rate decreased from 2011 onward. The same pattern was observed in research expenses, fixed asset purchase expenses (Table 7).

Table 7. Change rate of variables (Unit: Percentage).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Tuition fee	9.092	7.794	1.304	3.883	3.386	−2.284	−0.135	0.890	−0.995	2.548
Government subsidies	8.570	36.428	100.466	19.575	7.403	107.680	39.059	20.077	8.675	38.659
Labor costs	6.505	8.107	4.458	6.322	5.941	4.715	3.357	2.310	2.461	4.908
Operating expenses	11.252	9.158	3.802	7.533	6.180	1.036	0.628	2.441	−0.980	4561
Research expenses	14.125	−5.551	1.927	1.509	2.516	−1.755	−3.494	−6.026	−4.796	−0.172
Laboratory fees	4.033	6.036	8.768	6.212	8.435	−3.512	0.278	−1.520	−3.624	2.790
Student support fees	13.043	13.765	19.309	15.078	12.918	11.496	−0.341	−0.655	1.671	9.587
Expenditure from investments and other assets	30.744	−4.078	5.594	−4.745	11.735	−32.190	−2.244	5.537	−2.232	0.902
Fixed asset purchase expenses	8.164	−4.974	−5.409	9.149	0.230	−5.029	−9.313	−4.372	−9640	−2.355
Unused balance carried forward to the following term	9.675	18.619	11.833	7.212	10.941	−7.980	−22.097	−13.076	−8.729	0.711

To analyze the effects of tuition fees on financial management, a fixed model was conducted first. The control variables show different values according to each model. For example, universities with large-scale finances would spend more money on labor, operation, and laboratory costs along with student support fees, whereas there was no difference in research costs, expenditure from investments, and other assets. Relating to the year of establishment, if universities were recently established, they tend to spend less money on labor costs, research costs, laboratory fees, and expenditure from investments and other assets. It is plausible to assume that older universities invest more money on labor and research costs as well as laboratory fees than recently established universities.

Turning to the present study's core focus, the impact of tuition fees turned out to be significant at a level of 0.001 for all dependent variables, except unused balance carried forward to the following term. This result indicates that tuition increase is positively and significantly associated with university financial expenditure. However, the government subsidies variable shows different behaviors, as it is only significant for variables such as labor costs, operating expenses, laboratory fees, and student support fees (Table 8).

We estimated the effect of tuition fee control policy in universities by including a Least Squares Dummy Variable (LSDV) model. We found that universities increased labor costs, operating expenses, and student support fees even after 2011. However, other models, such as research expenses, laboratory fees, and expenditure from investments and other assets, did not show significant differences from 2006. This finding indicates that universities would be more likely to increase their labor costs, operating expenses, and student support fees rather than increasing their research expenses, laboratory fees, and expenditure from investments and other assets. This implies that universities show the tendency to not invest their expenditure in long-term development. With such results, it is logical to assume that spending cuts as a method of financial constraint are a popular strategy [7], but decreases in expenditure are undertaken differently in terms of items.

In addition to the LSDV model, we can test whether the relationship between tuition fees and each expenditure is nonlinear by examining the squared tuition fee variable (Table 9). Holding all other variables constant, if tuition fee proves to be positive and tuition fee square proves to be negative, the average expenditure will first increase as tuition fee increases, but at a diminishing rate.

Table 8. Results of the fixed model.

	Labor Costs	**Operating Expenses**	**Research Expenses**	**Laboratory Fees**	**Student Support Fees**	**Expenditure from Investments and Other Assets**	**Fixed Asset Purchase Expenses**	**Unused Balance Carried forward to the Following Term**
Variables	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)
2007	−0.01476 (0.02828)	0.02942 (0.03829)	−0.29437 (0.21530)	−0.03216 (0.05692)	0.07339 (0.08135)	0.19713 (0.27129)	−0.0895 (0.10077)	0.06827 (0.33895)
2008	−0.00123 (0.02891)	0.05373 (0.03914)	−0.37764 (0.22010)	−0.04957 (0.05819)	0.08899 (0.08316)	0.26373 (0.27734)	−0.03832 (0.10302)	0.32757 (0.34651)
2009	0.02181 (0.03016)	0.06809 (0.04084)	−0.19920 (0.22962)	−0.00080 (0.06070)	0.17710 (0.08676)	0.22303 (0.28933)	−0.05294 (0.10747)	0.78988 * (0.36149)
2010	0.04474 (0.03096)	0.10817 * (0.04192)	−0.34752 (0.23570)	0.02670 (0.06231)	0.25682 * (0.08905)	0.45069 (0.29699)	−0.06073 (0.11032)	1.04254 ** (0.37107)
2011	0.08719 ** (0.03137)	0.16186 *** (0.04247)	−0.13834 (0.23882)	0.09393 (0.06314)	0.33886 *** (0.09023)	0.29161 (0.30092)	−0.06897 (0.11178)	1.18069 ** (0.37598)
2012	0.14862 *** (0.03314)	0.17923 *** (0.04487)	−0.23124 (0.25233)	0.03539 (0.06671)	0.34256 *** (0.09534)	0.01490 (0.31794)	−0.10851 (0.11810)	1.10039 ** (0.39724)
2013	0.17934 *** (0.03404)	0.16132 *** (0.04609)	−0.36277 (0.25916)	0.02197 (0.06851)	0.31807 ** (0.09792)	−0.22887 (0.32655)	−0.29921 * (0.12130)	0.74546 * (0.40800)
2014	0.19776 *** (0.03460)	0.16181 *** (0.04685)	−0.33982 (0.26341)	0.01604 (0.06964)	0.29624 ** (0.09953)	−0.19081 (0.33191)	−0.37022 ** (0.12329)	0.57306 (0.41470)
2015	0.22787 *** (0.03478)	0.15175 *** (0.04709)	−0.40713 (0.26478)	0.00869 (0.07000)	0.30619 ** (0.10004)	0.19899 (0.33363)	−0.55517 *** (0.12393)	0.40590 (0.41684)
Size 2	0.00568 (0.03377)	−0.16353 *** (0.04573)	1.07321 *** (0.25712)	−0.39731 *** (0.06797)	0.12522 (0.09715)	0.02251 (0.32399)	−0.30039 * (0.12035)	0.49460 (0.40480)
Size 3	0.20578 *** (0.04993)	−0.19757 ** (0.06761)	0.84919 * (0.38016)	−0.46930 *** (0.10050)	0.16738 (0.14364)	−0.57829 (0.47902)	−0.24054 (0.17794)	1.27007 * (0.59850)
Finance size 2	−0.08645 (0.07106)	−0.04505 (0.09622)	−1.26558 * (0.54104)	−0.12601 (0.14303)	0.25969 (0.20442)	−1.34524 * (0.68173)	−0.89541 *** (0.25324)	−3.43467 *** (0.85177)
Finance size 3	0.11619 * (0.06669)	0.24477 ** (0.09031)	−0.50636 (0.50778)	0.48793 *** (0.13424)	0.54865 ** (0.19186)	−0.34339 (0.63983)	−0.08124 (0.23767)	−1.35397 * (0.79941)
Finance size 4	0.56976 *** (0.07855)	0.37265 *** (0.10636)	−0.14532 (0.59806)	0.64218 *** (0.15811)	0.60163 ** (0.22597)	0.52592 (0.75359)	−0.06373 (0.27993)	−2.31693 * (0.94155)
Finance size 5	0.62062 *** (0.07778)	0.82258 *** (0.10531)	−0.41478 (0.59218)	0.51976 *** (0.15655)	0.83239 *** (0.22374)	0.47565 (0.74617)	0.63097 * (0.27717)	0.31588 (0.93228)
Year	−0.00084 * (0.00042)	0.00003 (0.00057)	−0.0065 * (0.00322)	−0.00450 *** (0.00085)	0.00235 *(0.00122)	−0.01328 *** (0.00406)	−0.00436** (0.00151)	−0.0033 (0.00507)
tuition fee	0.71858 *** (0.02958)	0.739 *** (0.04006)	1.31021 *** (0.22523)	0.91076 *** (0.05954)	0.72633 *** (0.08510)	1.57892 *** (0.28380)	0.65774 *** (0.10542)	−0.32858 (0.35459)
government subsidies	0.01338 *** (0.00506)	0.02026 *** (0.00685)	0.01060 (0.03851)	0.02347 * (0.01018)	0.07606 *** (0.01455)	−0.07408 (0.04852)	0.00344 (0.01802)	−0.02347 (0.06062)

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The results of polynomial regression for labor costs indicate that tuition fee proves negative, whereas tuition fee square proves positive. This implies that labor costs will increase as the tuition fees increase, but at an increasing rate. We found similar results in the operating expenses and student support fee models. However, the negative tuition fee squared coefficient in research expenses, expenditure from investments and other assets, and unused balance carried forward to the following term models indicate that the effect of tuition fees diminishes as tuition fees increase. Government subsidies provide different results compared to tuition fees. It is important to note that the research cost, expenditure from investments and other assets, and unused balance carried forward to the following term models show different signs between tuition fees and government subsidies.

Table 9. Results of the polynomial regression model.

	Labor Costs	Operating Expenses	Research Expenses	Laboratory Fees	Student Support Fees	Expenditure from Investments and Other Assets	Fixed Asset Purchase Expenses	Unused Balance Carried Forward to the Following Term
	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)
Size 2	0.10932 ** (−0.03547)	−0.0755 (−0.04949)	0.90783 ** (−0.28127)	−0.36045 *** (−0.07475)	0.35643 ** (−0.10414)	−0.33384 (−0.35398)	−0.31036 ** (−0.1323)	−0.18047 (−0.44232)
Size 3	0.28677 *** (−0.04893)	−0.12888 * (−0.06826)	0.74141 * (−0.38799)	−0.44008 *** (−0.10311)	0.34773 ** (−0.14366)	−0.82654 * (−0.4883)	−0.24356 (−0.1825)	0.76844 (−0.61015)
Finance size 2	−0.02854 (−0.06824)	0.00312 (−0.09521)	−1.11739 ** (−0.54119)	−0.10065 (−0.14382)	0.38524 * (−0.20038)	−1.20538 * (−0.6811)	−0.84749 ** (−0.25456)	−3.52164 *** (−0.85106)
Finance size 3	0.15811 ** (−0.06394)	0.28038 ** (−0.08922)	−0.57538 (−0.50708)	0.50281 ** (−0.13475)	0.6422 ** (−0.18776)	−0.49051 (−0.63818)	−0.08574 (−0.23852)	−1.62956 ** (−0.79744)
Finance size 4	0.55514 *** (−0.07513)	0.35987 ** (−0.10482)	−0.03909 (−0.59578)	0.63863 *** (−0.15833)	0.56775 ** (−0.2206)	0.69299 (−0.74981)	−0.0439 (−0.28024)	−2.12168 ** (−0.93692)
Finance size 5	0.52856 *** (−0.07529)	0.7445 *** (−0.10504)	−0.29402 (−0.59706)	0.4865 ** (−0.15866)	0.62742 ** (−0.22107)	0.75534 (−0.75142)	0.63401 ** (−0.28083)	0.88397 (−0.93893)
Year	−0.00055 (−0.00041)	0.00029 (−0.00058)	−0.00848 ** (−0.00328)	−0.00442 *** (−0.00087)	0.00305 ** (−0.00121)	−0.01638 *** (−0.00413)	−0.00472 ** (−0.00154)	−0.00705 (−0.00516)
tuition fee	−2.79458 *** (−0.6576)	−2.26815 ** (−0.91749)	12.46893 ** (−5.21486)	−0.2286 (−1.38582)	−7.1948 ** (−1.93091)	21.48103 ** (−6.56308)	2.23008 (−2.45289)	29.25179 ** (−8.20085)
tuition fee square	0.09578 *** (−0.01818)	0.08202 ** (−0.02537)	−0.31302 ** (−0.1442)	0.03089 (−0.03832)	0.21609 *** (−0.05339)	−0.55498 ** (−0.18149)	−0.04482 (−0.06783)	−0.81707 ** (−0.22678)
government subsidies	−0.07617 *** (−0.01381)	−0.05399 ** (−0.01927)	−0.2761 ** (−0.10951)	−0.01689 (−0.0291)	−0.11722 ** (−0.04055)	−0.37141 ** (−0.13782)	−0.08345 (−0.05151)	0.04165 (−0.17221)
government subsidies square	0.00556 *** (−0.00082)	0.00461 *** (−0.00115)	0.01864 ** (−0.00654)	0.00252 (−0.00174)	0.01198 *** (−0.00242)	0.01965 ** (−0.00823)	0.00558 (−0.00307)	−0.00302 (−0.01028)

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6. Discussion

Tuition fee increase has become an important issue in Korea since the early 2000s. Along with public concerns about tuition fees, the government made efforts to address these problems with the amendment of the Higher Education Act. Using data from the financial statements of private universities, this study aimed to provide important insight into higher education policies while examining the impact of the tuition fee policy on university financial management. This study briefly examines the average tuition increase in percentage change by year. The findings revealed that government tuition fee policies have been effective in controlling tuition fees after 2011. While the tuition fee increase rate slowed down after 2011, government subsidies showed a critical increase rate. The tuition fee control policy has major implications for universities in Korea because tuition is the largest source of revenue for most universities, comprising 65% of their total revenue. With this background, this study analyzed the effects of tuition fee control on university expenditures, such as labor costs, operating expenses, research expenses, laboratory fees, and student support fees. The effect of tuition fee control was examined using the LSDV model. The results indicate that universities increase their spending in some items, such as labor costs, operating expenses, and student support fees, while there is no difference in research expenses, laboratory fees, and expenditure from investments and other assets. Based on the principal–agency theory, the findings regarding labor costs and operating expenses are intuitive, but those pertaining to student support fee increases are not. These results can be explained by considering government subsidies. As mentioned above, the Korean government has increased their subsidies to enhance university capability in a competitive situation. Most government subsidies include student capability enhancement projects, and these subsidies flow into universities through the university matching the fund. In addition, government subsidies increased through scholarships for students, and thus expenditure on students also increased. In this context, it is plausible to understand that the increase in student support fees after 2011 arose from government subsidies. However, there is no significant increase in research expenses, laboratory costs, and expenditure from investments and other assets. In the case of fixed asset purchase expenses, we found that expenditure decreased after 2011. These results prove the existence of a moral hazard in university expenditure under financial constraints. The labor costs of faculty and staff are essential for education and research,

and increasing these costs does not necessarily mean that education and research were neglected. It is natural for universities to use selective reinvestment because comprehensive coverage is considered unviable for universities in a financial constraint situation. These differences may result from the differences in universities' priorities and organizations' purposes. However, it is important to note the universities' behaviors and responses. When universities face financial constraints, it is said that some initiatives, such as decreasing the number of full-time faculty members, decreased course and program offerings, and reduced library and student services are undertaken in the name of cost reduction [7]. However, this study provides different results, namely that universities seek other methods to avoid financial constraints. The results indicate that universities cut their spending in specific areas; however, in certain areas, universities tended to pursue benefits such as labor and operating costs.

These findings added to our understanding about universities' characteristics. One perspective on universities' characteristics considers the university as an academic community that shares the same values and norms and makes consensual decisions [47]. Universities are operated as per the norms and values of learning that are shared among not only the professors, but also other members of the university [48]. Another perspective views universities as complex organizations with an official hierarchy and a series of regulations. In these perspectives, all universities have official communication channels and bureaucratic stages of authority [49]. However, universities have multiple members in their organizational structures, such as the president, chairman, board of directors, professors, students, and staff, and have complicated decision-making and execution processes that reflect their education and research capabilities. In addition, as Liefner [30] notes, there are numerous principals and agents in higher education institutions. Furthermore, we find that professors themselves have different goals because they increase their labor cost while decreasing research expenditure. This study provides the evidence that members of a university have different goals and preferences [45], and there may be conflicts in their preferences and priorities.

In addition to the LSDV model, the polynomial regression model provides the result that universities behave differently according to resources, whether they are tuition fees or government subsidies. The labor costs, operating expenses, and student support fees show an increase as the tuition fees increase with an increasing rate for both tuition fees and government subsidies. Research expenses and expenditures from investments and other assets increase as tuition fees increase with a diminishing rate. In contrast, research expenses and expenditure from investments and other assets increase as government subsidies increase with an increasing rate. It is important to note that these results are relevant to principal–agency theory. There is the relationship between the government as principal and the university as agent [50]. Principal–agency theory can be used to understand motivations and the impact of competing demands on the decision-making of universities [51]. Applying the principal and agent model, this study provides the evidence that universities have different organizational interests according to resources. In a situation where the introduction of tuition fee control policy could be seen as a threat to universities [2], this study reveals the pattern that universities raise as much money as they can and spend all the money from government subsidies: The so-called revenue theory of cost [43]. However, with tuition fees, universities show different patterns in specific expenditures, such as research expenses and expenditure from investments and other assets. This result provides the evidence that the attempt to integrate the perspective of principal and agency theory into the sphere of financial management between government and university is successful [51]. It is important to note some of the key perceptions and insights that principal and agency theory could offer for university financial management.

In this context, it is necessary to adapt the performance-based research funding system. In Korea, the government employs a performance-based system in the area of university education, while there is no systematic performance-based system for university research [52]. The performance-based funding system reduces the risk of adverse selection and moral hazard problems. This system makes universities more autonomous and increases productivity along with more strategic university management [53].

At the university level, it is necessary to rethink universities' planning and management practices from a general fund approach and centralized, incremental budgeting to an incentive-based budget system or Responsibility Center Management [25]. Until now, most Korean universities have used centralized and incremental budgeting. Given that goal conflicts and information asymmetries are relevant in the university context, it is necessary to improve decision-making through better information and an incentive mechanism. An incentive-based budget system provides better information for the unit level to increase planning capacity [54]. In addition, an incentive-based system devolves budget responsibility to academic units to create the incentive for academic units to generate revenues and decrease costs [29].

7. Conclusions

The rapid growth of higher education tuition fees has led to greater interest in higher education policy and scholarship. The Korean government amended the Higher Education Act to strengthen control over tuition fee increase and set a limit on the increase, and it has also been implementing policies to control tuition fee increase through various financial projects. In this situation, this study investigated the effect of the tuition fee control policy and examined the characteristics of financial management in universities under tuition fee constraints.

An analysis was conducted on the income and expenditure structure of university finance. The results showed that the increase rate of tuition fees decreased after 2011, but that on government subsidies increased significantly. Government policy to increase subsidies tends to be suppressing tuition increase. In addition, this study further examined the characteristics of financial management in universities using the principal–agent model. This study examined the effects of tuition fees and government subsidies on dependent variables such as labor cost, operating expenses, and so on. Using an LSDV model, this study investigated the effects of tuition fees on individual models. The LSDV results indicate that universities increase labor costs, operating expenses, and student support fees. Relating to student support fee increase, this study explains that this increases through government subsidies and scholarships. In the case of research expenses, laboratory fees, and expenditure from investment and other assets, we found no difference from 2006. Using polynomial regression, this study found that universities tend to behave differently according to source, whether it is from government or tuition. Applying the principal and agent theory, this study suggested the necessity of a performance-based research system in research at government levels and an incentive-based budget system in universities.

Despite such significance, this study has some limitations. While it analyzed the characteristics of financial management under tuition fee constraints, it failed to examine the changes in financial structure that may have been caused by tuition fee constraints. It is necessary to examine how financial structures, such as financial stability, growth, and soundness, have changed due to tuition fee constraints. Furthermore, while this study examined the characteristics of financial management under tuition fee constraints, it did not review financial expenditure related to university performance. It is thus necessary to review whether the increase or decrease of expenditure relates to university performance.

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References

1. Boehner, J.A.; McKeon, H.P. The College Cost Crisis: A Congressional Analysis of College Costs and Implications for America's Higher Education System. 2003. Available online: http://www2.bgsu.edu/downloads/finance/file17013.pdf (accessed on 20 April 2020).
2. Kim, M.M.; Ko, J. The impacts of state control policies on college tuition increase. *Educ. Policy* **2015**, *29*, 815–838. [CrossRef]
3. Mumper, M. State efforts to keep public colleges affordability in the face of fiscal stress. In *The Finance of Higher Education: Theory, Research, Policy & Practice*; Paulsen, M.B., Smart, J.C., Eds.; Agathon Press: New York, NY, USA, 2001; pp. 321–354.
4. Haptman, A.M. *The College Tuition Spiral: An Examination of Why Charges Are Increasing*; Macmillan and the American Council on Education and The College Board: New York, NY, USA, 1990.
5. Okunade, A.A. What factors influence state appropriations for public higher education in the United States? *J. Educ. Financ.* **2004**, *30*, 123–138.
6. Fisher, D.; Rubenson, K.; Jones, G.; Shanahan, T. The political economy of post-secondary education: A comparison of British Columbia, Ontario and Québec. *High. Educ.* **2009**, *57*, 549–566. [CrossRef]
7. Deering, D.; Sa, C.M. Financial management of Canadian universities: Adaptive strategies to fiscal constraints. *Tert. Educ. Manag.* **2014**, *20*, 207–224. [CrossRef]
8. Gumport, P. Academic restructuring: Organizational change and institutional imperatives. *Higher Educ.* **2000**, *39*, 67–91. [CrossRef]
9. Paulsen, M.B. The economics of human capital and investment in higher education. In *The Finance of Higher Education: Theory, Research, Policy and Practice*; Paulsen, M.B., Smart, J.C., Eds.; Agathon Press: New York, NY, USA, 2001; pp. 55–94.
10. Dearden, L.; Fitzsimons, E.; Wyness, G. *The Impact of Tuition Fees and Support on University Participation in the UK*; Centre for the Economics of Education: London, UK, 2011; p. 126.
11. Kivistö, J.A. *Agency Theory as a Framework for the Government-University Relationship*; Higher Education Group/Tampere University Press: Tampere, Finland, 2007.
12. Caruana, J.; Brusca, I.; Caperchione, E.; Cohen, S.; Manes Rossi, F. (Eds.) *Financial Sustainability of Public Sector Entities: The Relevance of Accounting Frameworks*; Palgrave Macmillan: London, UK, 2019.
13. Di Carlo, F.; Modugno, G.; Agasisti, T.; Catalano, G. Changing the Accounting System to Foster Universities' Financial Sustainability: First Evidence from Italy. *Sustainability* **2019**, *11*, 6151. [CrossRef]
14. Kane, T.J.; Orszag, P.R. *Funding Restrictions at Public Universities: Effects and Policy Implications*; Working Paper; Brookings Institution: Washington, DC, USA, September 2003.
15. Burgess, B. Evaluating the polices that lead to substantial tuition variation at public land-grant universities. *Plan. High. Educ.* **2011**, *39*, 25–33.
16. Boatman, A.; L'Orange, H. *State Tuition, Fees, and Financial Assistance Policies for Public Colleges and Universities*; 2005–06; State Higher Education Executive Officers: Denver, CO, USA, 2006.
17. Crowford, C.; Dearden, L. *The Impact of the 2006–2007 HE Finance Reforms on HE Participation*; BIS Research Paper, no.13; Department for Business, Innovation and Skills: London, UK, 2010.
18. Görgen, K.; Schienle, M. Evaluating Effects of Tuition Fees: Lasso for the Case of Germany. 2019. Available online: https://arxiv.org/pdf/1909.08299.pdf (accessed on 15 December 2019).
19. Bahrs, M.; Siedler, T. *University Tuition Fees and High School Students' Educational Intentions*; Discussion Paper Series, No. 12053; IZA Institute of Labor Economics: Bonn, Germany, 2018.
20. Gawellek, B.; Süssmuth, B.; Singh, D. Tuition fees and instructional quality. *Econ. Bull.* **2016**, *36*, 84–91.
21. Yoo, J.S. *Influence of Half-Tuition Policy and Political Economy*; Korea Economic Research Institute: Seoul, Korea, 2014.
22. McLendon, M.K.; Hearn, J.C.; Mokher, C.G. Partisans, professionals, and power: The role of political factors in state higher education funding. *J. High. Educ.* **2009**, *80*, 686–713. [CrossRef]
23. Leslie, L.L.; Rhoades, G. Rising administrative costs: Seeking explanations. *J. High. Educ.* **1995**, *66*, 187–212. [CrossRef]
24. Cheslock, J.J.; Gianneschi, M. Replacing state appropriations with alternative revenue sources: The case of voluntary support. *J. High. Educ.* **2008**, *79*, 208–229. [CrossRef]

25. Hearn, J.C.; Lewis, D.R.; Kallsen, L.; Holdsworth, J.A.; Jones, L.M. "Incentives for managed growth": A case study of incentives-based planning and budgeting in a large public research university. *J. High. Educ.* **2006**, *77*, 286–316.
26. Gros Louis, K.R.R.; Thompson, M. Responsibility center budgeting and management at Indiana University. In *Incentive-Based Budgeting Systems in Public Universities*; Priest, D.M., Becker, W.E., Hossler, D., John, E.P.S., Eds.; E. Elgar: Cheltenham, UK; Northhampton, MA, USA, 2002; pp. 93–108.
27. Adams, E.M. Rationality in the Academy Why Responsibility Center Budgeting Is a Wrong Step down the Wrong Road. *Chang. Mag. High. Learn.* **1997**, *29*, 58–61. [CrossRef]
28. Murray, B. Can academic values mesh with fiscal responsibility? Business-like budgeting clashes with team spirit, some psychologists say. *Monit. Psychol.* **2000**, *31*, 1–5.
29. Jaquette, O.; Kramer, D.A.; Curs, B.R. Growing the Pie? The Effect of Responsibility Center Management on Tuition Revenue. *J. High. Educ.* **2018**, *89*, 637–676. [CrossRef]
30. Liefner, I. Funding, resource allocation and performance in higher education system. *High. Educ.* **2003**, *46*, 469–489. [CrossRef]
31. Tandberg, D.A.; Fowles, J.T.; McLendon, M.K. The governor and the state higher education executive officer: How the relationship shapes state financial support for higher education. *J. High. Educ.* **2017**, *88*, 110–134. [CrossRef]
32. Gornitzka, Å.; Stensaker, B.; Smeby, J.-C.; de Boer, H. Contract arrangements in the Nordic countries. Solving the efficiency/effectiveness dilemma? *High. Educ. Eur.* **2004**, *29*, 87–101. [CrossRef]
33. Jeong, J.H.; Ban, S.J. Study on the reform of a tuition setting method in higher education. *J. Educ. Adm.* **1999**, *17*, 283–326. (In Korean)
34. Lee, J.M.; Lee, S.D. An analysis on issues and logics on New National Student Aid Program. *J. Educ. Adm.* **2012**, *30*, 79–104.
35. Ross, S.A. The economic theory of agency: The principal's problem. *Am. Econ. Rev.* **1973**, *63*, 134–139.
36. Jensen, M.C.; Meckling, W.H. Theory of the firm: Managerial behavior, agency costs and ownership structure. *J. Financ. Econ.* **1976**, *3*, 305–360. [CrossRef]
37. Pratt, J.W.; Zeckhauser, R.J. *Principals and Agents: The Structure of Business*; Harvard University Press: Cambridge, MA, USA, 1985.
38. Arrow, K. The economics of agency. In *Principals and Agents: The Structure of Business*; Pratt, J., Zeckhauser, R., Eds.; Harvard University Press: Cambridge, MA, USA, 1985; pp. 37–51.
39. Lowry, R. Governmental structure, trustee selection, and public university prices and spending. *Am. J. Political Sci.* **2001**, *45*, 845–861. [CrossRef]
40. Baldridge, J.V. *Power and Conflict in the University: Research in the Sociology of Complex Organizations*; Wiley: New York, NY, USA, 1971.
41. Enders, J.; Fulton, O. *Higher Education in a Globalising World: International Trends and Mutual Observations a Festschrift in Honour of Ulrich Teichler*; Springer Netherlands: Dordrecht, The Netherlands, 2002.
42. Winston, G.C. Subsidies, hierarchy and peers: The awkward economics of higher education. *J. Econ. Perspect.* **1999**, *13*, 13–36. [CrossRef]
43. Bowen, H.R. *The costs of Higher Education: How much Do Colleges and Universities Spend per Student and How Much Should They Spend*; Jossey-Bass: San Francisco, CA, USA, 1980.
44. Garvin, D.A. *The Economics of University Behavior*; Academic Press: New York, NY, USA, 1980.
45. Salancik, G.; Pfeffer, J. The bases and use of power in organizational decision making. *Adm. Sci. Q.* **1974**, *19*, 453–473. [CrossRef]
46. Levin, A.; Lin, C.F.; Chu, J. Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties. *J. Econometrics.* **2002**, *98*, 1–24. [CrossRef]
47. Millett, J.D. *Academic Community: An Essay on Organization*; McGraw-Hill: New York, NY, USA, 1962.
48. Clark, B.R. The organizational saga in higher education. *Adm. Sci. Q.* **1972**, *17*, 178–184. [CrossRef]
49. Stroup, H. *Bureaucracy in Higher Education*; The Free Press: New York, NY, USA, 1966.
50. Ahmad, A.R.; Farley, A.; Naidoo, M. Analysis of government-university relationship from the perspective of agency theory. *J. Educ. Pract.* **2012**, *3*, 12–22.
51. Lane, J.E.; Kivisto, J.A. Interest, information and incentives in higher education: Principal-agent theory and is potential application to the study of higher education governance. In *Higher Education: Handbook of Theory and Research*; Springer International Publishing: Cham, Switzerland, 2008.

52. Lee, Y.H.; Kim, H.K. Financial support and university performance in Korea universities: A panel data approach. *Sustainability* **2019**, *11*, 5871. [CrossRef]
53. Hicks, D. Performance-based university research funding systems. *Res. Policy* **2016**, *41*, 251–261. [CrossRef]
54. Curry, J.R.; Laws, A.L.; Strauss, J.C. *Responsibility Center Management: A Guide to Balancing Academic Entrepreneurship with Fiscal Responsibility*; National Association of College and University Business Officers: Washington, DC, USA, 2013.

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Interpreting the Sustainable Development of Human Capital and the Sheepskin Effects in Returns to Higher Education: Empirical Evidence from Pakistan

Zhimin Liu [1], Aftab Ahmed Memon [1,*], Woubshet Negussie [2] and Haile Ketema [2]

[1] College of Public Administration, Nanjing Agricultural University, Nanjing 210095, China; liuzhimin@njau.edu.cn
[2] College of Land Management, Nanjing Agricultural University, Nanjing 210095, China; wube14@yahoo.com (W.N.); haileketema2005@yahoo.com (H.K.)
* Correspondence: aftabahmed32@gmail.com

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Abstract: According to poststructuralists, workers with higher level of education and possession of potential experience are supposed to have higher wages. Yet, there are plausible questions that arise as to what levels of education or work history are needed for the enhancement of wage discrimination. Additionally, the outcomes arising from rehashing years of schooling are worth considering. We used a several methods, employing the administrative Household Integrated Economic Survey (HIES) data from Pakistan without ignoring environmental effects. Our estimated results support the conventional assumptions of linearity of log-wage. First, we found substantial returns for postgraduate diploma holders in both public and private sectors, even after controlling the individual's heterogeneity. Second, we did notice a significant divergence in return to low-level education (LLE) and job history. Third, rehashing years of education may create suspiciousness regarding the lack of competence. Our results suggest that continuous investment in human capital toward postgraduate diploma may result in higher premiums.

Keywords: higher education; human capital investment; rate of returns; screening and sheepskin effects

1. Introduction

The economic theory emphasizes that individuals who possess higher education diplomas are likely to earn more. While it is not solely education that makes them productive, it does identify them as being productive with accreditation, which is called the sheepskin effect (diploma). A huge and growing literature base has cited a positive relationship between education and its outcomes; for example, scholars [1–6] reported the compensation from human capital investment in schooling, which is insufficient for theoretical contribution. However, there are more debates and unresoved research issues that need more explanation on how the level of education may affect wage. Without necessarily invoking a theoretical standpoint, it is an unquestionable empirical fact that high-level educated (HLE) workers are generally paid more compared to their low-level educated (LLE) cohorts. Similarly, the individual's marginal productivity tends to differ by occupation in earnings in the labor market. However, employers rely on proxies of accumulated diplomas, as it is difficult to observe the productive capacity of employees by screening their behavior or attitude.

A theoretical framework reflects an internal connection between these theories, providing the most likely mechanism for employers, called sheepskin (diploma or certificate) effects. For example, the level of education has an impact on outcomes with an institutional setting, considering evidence of existing sheepskin effects. The Norweigan tourism industry [7] reported the net profit value for

accumulated schooling years with exceptional returns. Another Spanish study [8] implicates that secondary education diploma holders enjoy higher premiums in the private sector, while the tertiary diploma holders enjoy higher premiums in the public sector.

According to the human capital theory, the accumulation of schooling can reflect the ability of a workforce by conveying knowledge and skills in the labor market [9,10]. The human capital theory explains the nature of the causal relationship between schooling and throughput by providing theoretical justifications for the earnings which are linearly related to specific mechanism of schooling levels. Moreover, education enhances the worker's productivity through the amplification of their inherent capacity and installation of applicable expertness [3]. The leading empirical suppliance of the human capital theory is executed by demonstrating that earnings vary linearly with schooling years and labor market work experience [11].

The prospective study seeks to explore wage discrimination in terms of how the nonlinearity of academic qualification and acquired experience create variation in the market. We differentiated schooling achievements in two dimensions: years of education and earnings relation, that is, earnings experience, as a quadratic function where the square of experience is related to employment history (as experience is the concave function). On the other hand, [12,13] reported the individuals' outcome differences based on their obtained schooling diplomas. In doing so, they showed that the acknowledgment of diplomas (sheepskin effects) is related to earnings by controlling the years of education. Most scholars have underestimated this relationship, such as the frequent measurement related with acquired and rehashed years of education. It is also worth considering the pure human capital function, in which the logarithm of earning is regressed on constant education, job history in the labor market and other control conditions [14].

It is challenging for an employer to make a direct hypothesis for high or low productivity of an employee by considering their innate ability and cognitive skills. However, entry to the market for an employee requires a productivity signal, which is exactly how sheepskin (diploma) works as a signaling device. In places unlike France, where schooling years are frequently repeated (more than 50% of students retake a year in some discipline), individuals who repeat schooling years are probably considered as owning less intellectual capital. Such measurements are worthless in countries where individuals get priority for repeating years of schooling instead of obtaining specified diploma years. In Figure 1, a description of wage distribution for all designed levels of diplomas is given, where the slope of wage increases step by step with each level of schooling. Kindergarten can formulate a greater capacity for cumulative ability in the preliminary years of schooling.

Previous pieces of evidence in the literature, that considered sheepskin effects [15,16] reported a great upsurge in returns related to schooling years, such as at twelve years (higher secondary) and sixteen years (graduation). The deficiency of extant studies is that the data did not categorize the graduate and dropout students; also, they have ignored the regional effects. However, first, we identified the dominance of sheepskin effects, primarily from log earning deviations between the diploma completers and incompleters by the attainment of dissimilar years of schooling. Second, we identified the outcomes of rehashing schooling years. Third, we identified the different outcomes of work history along with schooling by using multidimensional data measurement over time. Moreover, we believe that all regions are not parallel, which is a significant limitation.

The next section presents the interpretation of sheepskin effects; Section 3: human capital investment toward wage distribution; Section 4: data description; Section 5: results; Section 6: discussion: Section 7: conclusion: and Section 8: policy recommendation.

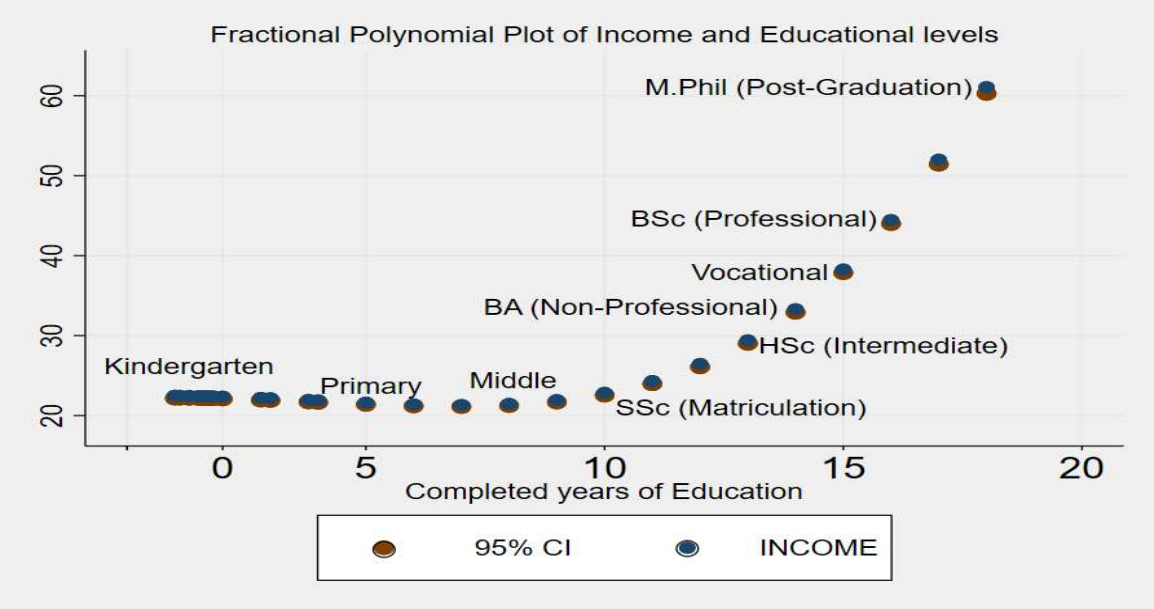

Figure 1. Average earnings for each level of education. Source: Pakistan Bureau of Statistics 2011 sample from public sector employees; author's calculation.

2. Interpreting Convexity of Sheepskin Effects

Very few studies have addressed the existence of sheepskin effects in Pakistan. Partial evidence [17] suggested that higher premiums are related to a completed primary diploma as compared to an incomplete primary diploma. However, this evidence only supports the existing primary diploma at the restricted dataset for the assessment of a private rate of returns. Moreover, the above evidence declares paucity of study, which constitutes an inappropriate dataset of an individual's education.

The circumstances for non-developed countries are not exceptionally different from the conditions of Pakistan, when it comes to unambiguous breakdowns of the effects of diploma. In general, very few studies have been conducted on the issue in non-developed countries. A Malaysian study [18] reported that university dropouts are able to get higher rate of returns than post-secondary diploma holders because dropouts invest more years in schooling and consequently earning rates become higher for them. Nevertheless, it is acknowledged that university dropouts accumulate more cognitive skills and knowledge due to more investment in human capital compared to secondary schooling. However, it might be an incompatible implication that they can earn higher rate of returns compared to their university cohorts. Another Philippine study revealed that sheepskin returns are substantially significant for only tertiary diploma holders [19].

The signaling hypothesis interprets that schooling is not only a tool that can enhance the workforce's productivity, but it also serves as an existing tool for the employer to sort out employability. However, it is difficult to comprehend directly in the labor market that a signal had taken place. The findings regarding sheepskin or diploma effects on the cornerstone of worker's earnings are endorsements that signaling occurs.

Several scholars have determined the workforce's (log) earnings by inspecting the role of sheepskin effects. For the most part, these analyses provided backup for the perception of sheepskin effects. The simplified punctuated spline function allows the stipulation of the altered rate of return to contrasting years of schooling and dissimilar returns to diploma years. These three studies [15,16,20] are primarily applicable to our research.

Many revisions have not observed the tenacity of sheepskin effects in statistical discriminations because they have endeavored to assess whether sheepskins occur in the countries. For example, Denny and Harmon [21] determined the sheepskin effects for two continents' five nations, which are

the U.S, Canada, Ireland, Great Britain, and Sweden. [1] Established a suggestion that the impact of sheepskin in the Canadian labor market is associated with the attainment of course credit hours after controlling educational inputs.

It is noticed that sheepskin effects are in a harmonious format with the notion of signaling, and these are also compatible with the explanation of the human capital theory. In the Midwestern United States, an Ohio state's scholar [22] found substantial returns for college diploma holders, who were considered as more proficient learners compared to those who did not complete college. Another study [23] estimated a female's primary education has a sole impact on fertility and survival of children and moderated effects of quality educational returns from the investment on human capital. The human capital hypothesis [24] observed the different outcomes between the early entrants and late entrants, who were holding diplomas that comprised year-wise courses in a peculiar area. Henceforth, there is no doubt that productive skills are needed for the sustainable development of a firm, which is a key determinant of a country's internationalization competitiveness in the rapidly growing world economy [6].

3. Human Capital Investment toward Wage Distribution

Capital investments are made based on the objectives of the firms, such as shares or infrastructure for the enhancement of production. Figure 2 presents the graphical explanation of human capital inputs in education toward the future outcomes. The investment on human capital is made on the preferences of intellectual capital including present vs. future outcomes. For example, few jobs require no more than 12 years of schooling whereas some jobs require more than 12 years of schooling. Similarly, more investment on schooling tends to result in endogenous growth in the distribution of income.

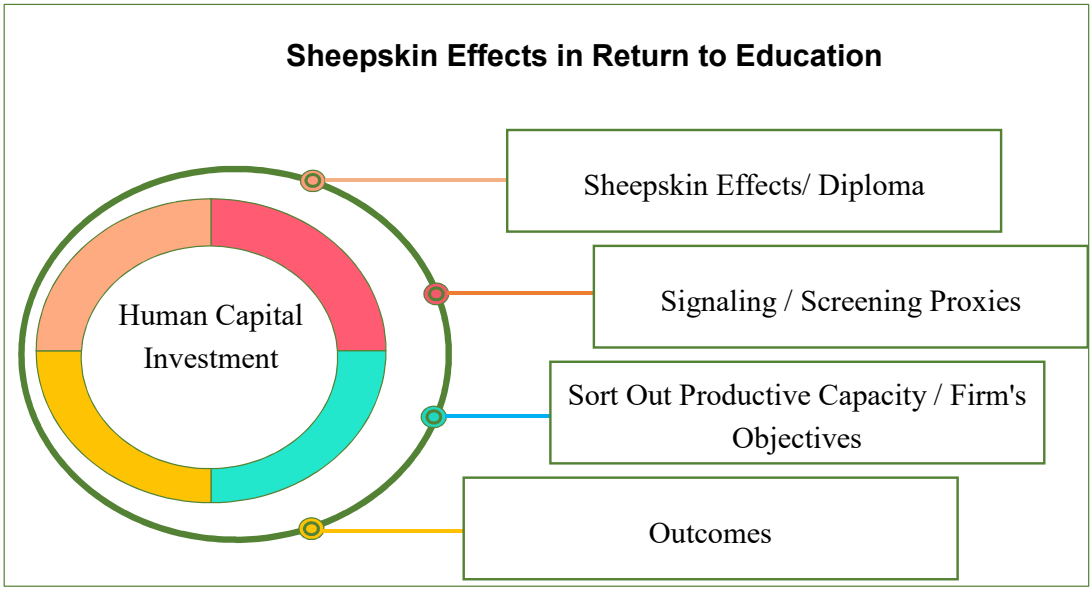

Figure 2. Capital investment toward the outcomes. Author-designed schematic diagram.

In the current era, there is massive economic competition among the labor markets, including a strict way of hiring employees. Employers rely on the proxies (diploma) to sort out the productive capability or mental agility on behalf of the firm. However, the firm is the only place where human capital can be effectively appreciated and the returns on human capital are higher [25].

4. Data Description

4.1. Data Collection

To assess the effectiveness of sheepskin, we have used Pakistan's annual administrative dataset, named Household Integrated Economic Survey (HIES). Every year, the Pakistan Bureau of Statistics (PBS) conducts the HIES survey in all provinces, comprising matters on education, health, income, and expenditures, which can assist in the estimation of all-encompassing studies or an individual's wage equilibrium in Pakistan. The survey is an appropriate dataset for the characteristic of sheepskin effects. This study focuses on three years of data: 2004/05, 2007/08, and 2010/11 on 31 populated cantons. This is consistent with our aim to manage the fluctuations in the curve of personal average returns to the different levels of diplomas. This modification can be seen over the next five years, as a result of skill development programs all over the world.

The latest HIES is also convenient for providing valuable information for the assessment of efficiency related to investment in human capital (education). Impressive features were considered for the sample selection performed from 2004/05 to 2010/11. First of all, the individual's selection criteria were restricted at the age between 15 and 64. Second, those individuals who did not attend school or who had no formal education were excluded. Third, also excluded were those who were working while studying or who were self-employed (to be consistent with preceding literature), those currently enrolled in schools, migrant workers, or those whose qualifications were not recognized by Pakistan's Ministry of Education (MoE). Fourth, workers who worked without salary, pensioners, unpaid family, and housewives were also excluded. The self-employed or employed were excluded because there was a problem in the measurement of their incomes. The selection standard of individuals consisting of education, occupation, and average wages are shown in Table 1.

Table 1. Descriptive statistics (enrolment)

	Male		**Female**	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Log Wage (Pkr)	1.5323	0.8784	1.5130	0.5894
Income	26,773.82	13,320.33	24,423.55	21,340.71
S	4.4643	2.1358	4.1287	2.0744
AGE	31.6619	1.8466	31.2508	1.0178
EXP	12.8847	7.9891	12.7657	5.1641
Director Manager	0.1427	0.3498	0.0955	0.2940
Professional	0.0576	0.2331	0.1578	0.3647
Associated Teachers	0.0987	0.2984	0.0913	0.2882
Agriculture and Fisheries	0.0949	0.2932	0.1179	0.3226
Supervisors	0.0010	0.0331	0.0253	0.4350
Finance	0.0241	0.1535	0.0234	0.4167
Plant and machine operator	0.1163	0.3207	0.0789	0.2697
Clerks	0.2403	0.4274	0.1909	0.3914
Elementary	0.2261	0.4184	0.1300	0.3340
Public	0.6427	0.4793	0.5747	0.4945
Private	0.3572	0.4793	0.4252	0.4945

Data Source: Household Integrated Economic Survey (HIES), conducted every year by the Pakistan Bureau of Statistics, figures are based on a stochastic subsample; Log Wage in Pakistani rupee (Pkr).

4.2. Sheepskins Estimation Methodology

We have followed a conventional approach to estimate the sheepskin effects by inducing a distinctive and detailed look at the educational curricula of workers. We have employed the binary method (0 and 1) for the actual years spent in school and the degree achieved within the educational milestone [26,27].

The sheepskin effects are often defined as an excessively large rate of return to schooling, followed by the accomplishment of a certain year's program that entails a diploma. The description ascends in large parts from the nonexistence of data that represents information on both actual years of education and years of an obtained degree. Hence, the scholar's approximation mostly depends on the proxies of logarithm wage (Mincer's equation), to measure the sheepskin effects as follows:

$$\begin{aligned} \log W_i = \alpha + \beta_1 S_i + \beta_2 Exp_i + \beta_3 {Exp_i}^2 + \beta_4 D6_i + \beta_5 D10_i + \beta_6 D12_i + \beta_7 D14_i \\ + \beta_8 D15_i + \beta_9 D16_i + \beta_{10} D18_i + \in \end{aligned} \quad (1)$$

In our estimation, the dependent variable (DV) is the natural logarithm $\log W_i$ of earnings, i is the index, and independent variables (IV) is the fixed or actual diploma years. $S_i : \beta$ is the coefficient of obtained diploma, where each diploma has been created as a proxy of dichotomous variable to evaluate the log wage distribution. The number of years of experience Exp_i and the quadratic function of labor market Exp_i^2 are applied to hold the concavity of earning experience profiles. For consistency with the previous standard formulation in the literature, it is assumed that children begin school at six years of age, and they immediately join the labor market after completion of S years. To control the individual's possible heterogeneity effects, certain classifications may be inherent in the ability that may cause biases in educational effectiveness. This is specified by using the spline function in Equation (2). By inspecting whether the sheepskin's returns decline with rehashing years, the above variant of Equation (1) is used, to estimate the interaction terms among the proxy variables of schooling with $Exp_{i.}$ Similarly, Equation (2) analyses the rehashing years' outcome in the following equation:

$$\begin{aligned} \log W_i = \alpha + \beta_1 S_i + \beta_2 Exp_i + \beta_3 {Exp_i}^2 + \beta_4 [(S_i - 6) * D6_i] \\ + \beta_5 [(S_i - 10) * D10_i] + \beta_6 [(S_i - 12) * D12_i] + \beta_7 D_6 + \beta_8 D_{10} \\ + \beta_9 D_{12} + \beta_{10} D_{14} + \beta_{11} D_{15} + \beta_{12} D_{16} + \beta_{13} D_{18} + \in \end{aligned} \quad (2)$$

The spline $(S_i - 6) * D6_i$, $(S_i - 10) * D10_i$ and $(S_i - 12) * D12_i$ is applied to capture the variation in the slope of S levels. The variable $\in$ is the error term.

To investigate whether or not the sheepskin effects decline with experience, the following variant of Equation (2) is used, whereby the interaction terms between the dummy variables for completion $D10_i$, $D12_i$, and $D16_i$ are interacted with Exp_i in Equation (3) as follows:

$$\begin{aligned} \log W_i = \alpha + \beta_1 S_i + \beta_2 Exp_i + \beta_3 Expi^2 + \beta_4 D6_i + \beta_5 [(S_i - 6) * D6_i] + \beta_6 D10_i \\ + \beta_7 [(S_i - 10) * D10_i] + \beta_8 D12_i + \beta_9 [(S_i - 12) * D12_i] \\ + \beta_{10} D14_i + \beta_{11} D15_i + \beta_{12} D16_i + \beta_{13} D18_i + \beta_{14} \left(D10_i * Exp_i\right) \\ + \beta_{15} \left(D12_i * Exp_i\right) + \beta_{16} \left(D16_i * Exp_i\right) + \in \end{aligned} \quad (3)$$

In addition to proceeds, sheepskin's examination may support the diplomas with interaction of experience. The results are estimated separately for male and female employees in both public and private sectors, which are known as the p-test [28,29]. Under the strong screening hypothesis, employers will pay higher wages to post-graduate diploma holders compared to the low dimensional diploma holders.

5. Results

This study aims to examine the exceptional effects of schooling years and the marginal differences between HLE and LLE. First, we underlined the contributed results of the sheepskin effects using natural log model [30] and human capital theories [31].

Table 2 presents the estimated results of Mincer Model Equation (1). First, we found that only a single year of investment on schooling (S_i) can tend 2.4% premium. Second, all diplomas have outcomes either positive or negative, as $D6_i$ diploma did not make a significant variation in remunerations (at 95% confidence level in all samples), it seems, by the time, LLE has dropped it's

worth. The propensity from the ancestral to the modern profession (using LLE as a reference) is not sufficient to adapt to the 21st-century competitive environment. Third, our results were supportive of more investment on schooling after higher secondary diploma ($D12_i$); those individuals who have obtained a tertiary diploma or higher are able to get charge out for higher premiums. Table 2 shows that earnings are consistently increasing with extra years of schooling, with $D15_i$ = 33%, $D16_i$ = 38%, and $D18_i$ = 55% respectively.

Table 2. Estimated coefficient of ($\log W_i$) Equation (1).

Variables	Mincer Model		
	Equation (1a)	**Equation (1b)**	**Equation (1c)**
α	0.9280 (0.090) ***	1.1226 (0.041) **	1.1675 (0.046) ***
S	0.024 (0.005) ***	0.026 (0.002) **	0.027 (0.002) ***
Exp	0.050 (0.007) **	0.049 (0.003) **	0.049 (0.004) ***
Exp^2	−0.001 (0.0002) ***	−0.001 (0.0001) ***	−0.0014 (0.0001) ***
D6	−0.779 (0.083) **	−0.938 (0.038) **	−0.974 (0.043) *
D10	−0.06 (0.069)	0.0005 (0.032) *	0.002 (0.036)
D12	0.257 (0.063)	0.254 (0.029) **	0.241 (0.032)
D14	0.313 (0.033) **	0.294 (0.015) **	0.290 (0.017) *
D15	0.337 (0.029) ***	0.328 (0.013) *	0.325 (0.015) ***
D16	0.387 (0.033) **	0.377 (0.015) **	0.374 (0.017) ***
D18	0.558 (0.029) ***	0.556 (0.013) **	0.556 (0.015) ***
R-squared	0.3890	0.3589	0.3524
No. Obs.	3026	15,257	12,231

Note: Estimated coefficients are significantly different from zero at * at 10% level; ** at 5% level and *** at 1% level. Standard Errors are reported in the parenthesis.

Hence, after tertiary education (TE), a little bit more investment in the accumulation of post-graduation diplomas can uncover higher premiums. Our results are in contrast with a previous study [32] that found significant effects of elementary, secondary, and tertiary diploma. Two other related studies on Pakistan [33,34] implicated that higher returns to schooling can be determined until graduation level, but they have not discussed the post-graduate diploma and the impact of repeated years of schooling.

Table 3 presents the estimated spline function results from the stochastic sample of PBS. The result contains corresponding specifications for all recorded earning relationships, identified as a piece-wise linear. Several worthwhile observations have been found in the estimated results in Table 3. First, by incorporating the F-test statistics flexibility, the spline function significantly fits all of the specifications over the prototypical Mincer's model. Second, the outcomes for rehashing years ($S_i - 10$) *$D10_i$ and ($S_i - 12$) *$D12_i$ are proportionately less effective than an investment on $D16_i$ or $D18_i$ diplomas, which might be beneficial for higher wage discrimination.

Table 3. Estimated coefficient of ($\log W_i$) Equation (2).

Variable	Spline Function		
	Equation (2a)	**Equation (2b)**	**Equation (2c)**
α	0.987 (0.087) ***	1.203 (0.040) **	1.254 (0.045) ***
S	0.114 (0.004) ***	0.127 (0.001) **	0.130 (0.001) ***
Exp	0.050679 (0.007) ***	0.049 (0.003)	0.048 (0.004) **
Exp^2	−0.001438 (0.0002) ***	−0.001 (0.0001) ***	−0.001 (0.0002) **
D6	−0.637 (0.085) **	−0.800 (0.038) ***	−0.837 (0.043) ***
(S-6) *D6	0.083 (0.016) **	0.085 (0.007) ***	0.085 (0.008) **
D10	0.1642 (0.217) *	0.170 (0.098)	0.171 (0.111)
(S-10) *D10	0.080 (0.033) ***	0.091 (0.015) ***	0.094 (0.017) **
D12	−0.721 (0.274) *	−0.826 (0.124) ***	−0.853 (0.138) **
(S-12) *D12	−0.148 (0.030) ***	−0.159 (0.014) **	−0.162 (0.015) **
D14	0.318 (0.033) **	0.299 (0.015) **	0.295 (0.017) ***
D15	0.344 (0.028) ***	0.334 (0.013) ***	0.332 (0.015) ***
D16	0.398 (0.033) *	0.390 (0.015) **	0.388 (0.017) **
D18	0.553 (0.029) ***	0.549 (0.013) ***	0.549 (0.015) ***
R-squared	0.3962	0.3664	0.3600
F-test	164.801 ***	734.7497 ***	572.755 ***
No. of Obs.	3026	15,257	12,231

Note: Estimated coefficients are significantly different from zero at * at 10% level; ** at 5% level and *** at 1% level. Standard Errors are reported in the parenthesis.

Although the predictions about having longer work history may often be associated with higher premiums, these effects are not necessarily true for workers who have completed only secondary and higher secondary education. Taking experience into account, the Equation (3) estimated results as shown in Table 4 indicate positive and significant estimated coefficients for D16*Exp. It shows that diploma holders are enjoying higher premiums with interaction of job history even with a negative effect for secondary (D10*Exp) and post-secondary (D12*Exp). Therefore, our results partially confirm the hypothesis in a cross-wise sub-sample of both public and private sectors. Our results suggest that individuals with the same length of experience but with less education are not able to get premiums like those with D15, D16, and D18 who are enjoying higher premiums. Moreover, the estimated results are similar to an Italian study, which [35] found higher outcomes for only intermediate education in the public sector by using a p-test.

Table 4. Estimated coefficient of ($\log W_i$) Equation (3).

	Public Sector		**Private Sector**	
	Male	**Female**	**Male**	**Female**
α	1.63079 (0.1541) ***	1.5072 (0.2507) ***	1.6104 (0.2061) ***	1.6424 (0.3060) ***
S	0.1669 (0.0173) ***	0.1574 (0.0138) ***	0.1741 (0.0235) ***	0.1547 (0.0164) ***
Exp	0.0282 (0.0121) ***	0.0520 (0.0153) ***	0.0270 (0.0162) ***	0.0354 (0.0178) ***
Exp^2	−0.0004 (0.0003) **	−0.0014 (0.0004) ***	−0.0003 (0.00051) ***	−0.0009 (0.0005) ***
D6	−0.5018 (0.1252) ***	−0.6613 (0.1348) ***	−0.4295 (0.1692) ***	−0.7122 (0.1669) ***
(S-6) *6	−0.1358 (0.0536) **	−0.0454 (0.0523) *	−0.1183 (0.0723) *	−0.0233 (0.0576)
D10	0.2138 (0.1276) **	0.0915 (0.1147) *	0.1929 (0.1705) **	0.1500 (0.1385) **
(S-10) *10	−0.1580 (0.0576) ***	−0.0884 (0.0445) **	−0.1664 (0.0817) **	−0.0841 (0.0527) *
D12	0.2350 (0.0835) ***	0.1548 (0.0797) ***	0.2030 (0.1123) ***	0.1890 (0.0953) ***
(S-12) *12	0.2318 (0.0427) ***	0.1195 (0.0390) ***	0.2299 (0.0597) ***	0.1042 (0.0447) ***
D14	0.2980 (0.0557) ***	0.2027 (0.0775) ***	0.2974 (0.0753) ***	0.2165 (0.0921) ***
D15	0.3127 (0.0434) ***	0.2473 (0.0522) ***	0.3041 (0.0588) ***	0.2359 (0.0612) ***
D16	0.3550 (0.0554) ***	0.2930 (0.0685) ***	0.3350 (0.0737) ***	0.2695 (0.0797) ***
D18	0.4680 (0.0467) ***	0.3792 (0.0541) ***	0.4879 (0.0632) ***	0.3988 (0.0641) ***
D10*Exp	−0.0059 (0.0138)	−0.0204 (0.0224) **	−0.0127 (0.0186)	−0.0200 (0.0242) **
D12*Exp	−0.0313 (0.0190) **	−0.0247 (0.0244) **	−0.0403 (0.0255) ***	−0.0163 (0.0282) *
D16*Exp	0.0356 (0.0180) ***	0.0269 (0.0311) ***	0.0348 (0.0239) **	0.0285 (0.0339) ***
R-Squared	0.4629	0.4240	0.4662	0.4171
F-Statistics	61.74 ***	32.34 ***	34.77 ***	22.00 ***
No. of Obs	1163	720	654	509

Note: Estimated coefficients are significantly different from zero at * at 10% level; ** at 5% level and *** at 1% level. Standard Errors are reported in the parenthesis.

Table 5 suggests that earnings are constant at every level of education. The DVs have flexible impact on every place, and we have used panel data time series around 31 cantons. The Hausman test compared the estimated coefficients from the fixed effect model, $\hat{\beta}\ FE$, to those from a random effects model, $\hat{\beta}\ RE$. Under the present specifications and according to our assumption, the individuals' diplomas are adequately modeled, which is resoundingly rejected by a random effects model. Table 5 results are beached on the rest of our model specifications, and random effects might be an appropriate for some alternative models of wages.

Table 5. Labor market outcomes related with diplomas.

All Variables	(b) Fixed-Effects	(B) Random-Effects	Hausman Test
	Coef. (Std. Err.)	Coef. (Std. Err.)	Difference (b)-(B) (Std. Err.)
α	3.616 (0.383) ***	3.161 (0.344) ***	
age	−0.0111 (0.005) **	−0.010 (0.004) **	−0.0008 (0.0028)
Exp	0.410 (0.255) *	0.407 (0.209) *	0.0035 (0.1463)
Exp^2	−0.00005 (0.0005) ***	−0.0002 (0.0005) ***	0.0001 (0.0001) **
D6	−3.137 (0.437) ***	−2.668 (0.391) ***	−0.4689 (0.1944) ***
D10	−1.902 (0.597) ***	−1.423 (0.563) **	−0.4787 (0.1982)
D12	0.566 (0.201) ***	0.247 (0.175)	0.3192 (0.0973)
D14	−0.173 (0.261)	0.322 (0.221)	−0.4960 (0.1403) **
D15	1.146 (0.197) ***	0.927 (0.180) ***	0.2186 (0.0786) **
D16	2.081 (0.588) ***	1.499 (0.541) ***	0.5822 (0.2284) ***
D18	1.367 (0.281) ***	1.729 (0.244) ***	−0.3614 (0.1393) ***
R^2			
Within	0.9423	0.9355	
Between	0.4537	0.6063	
Overall	0.8240	0.8609	

Note: Estimated coefficients are significantly different from zero at * at 10% level; ** at 5% level and *** at 1% level. Standard Errors are reported in the parenthesis.

Although our primary focus is on the advancement over TE outcomes, we have sorted out the data to explain more on the association between graduation and post-graduation returns. Figure 3 shows log earning gaps between BS and MS degrees. We have separated the individual's BS or MS degree accomplishment in order to interpret the earning differences by their employment. Those who procure BS and do not procure MS likely, reflects a causal impact of MS in a flexible way without imposing restrictive forms on the higher rate of return function.

The selected pattern reveals several outcomes in Figure 3. In a horizontal line, the first quarter indicates that both degrees have comprising earnings. The second quarter does not line up perfectly with gains. Though at the initial three quarters both degrees have fewer gains, after the fourth quarter, substantial increments have been observed in MS diploma. This suggests that additional years (MS) are able to overtake BS shortly after completion of a post-graduate diploma.

From the above perspective, it is observed that statistical comparison of wage shows a symmetrical productive approach for graduate BS ($D16_i$) and postgraduate MS ($D18_i$) diplomas. Under the contextual interpretation, the educational consequences on wage are exclusively emerging on the influence of productivity, not from any screening capacity. Unfortunately, the enrollment in the post-graduation diploma is very low (Table A2 and Figure A1 in Appendix A).

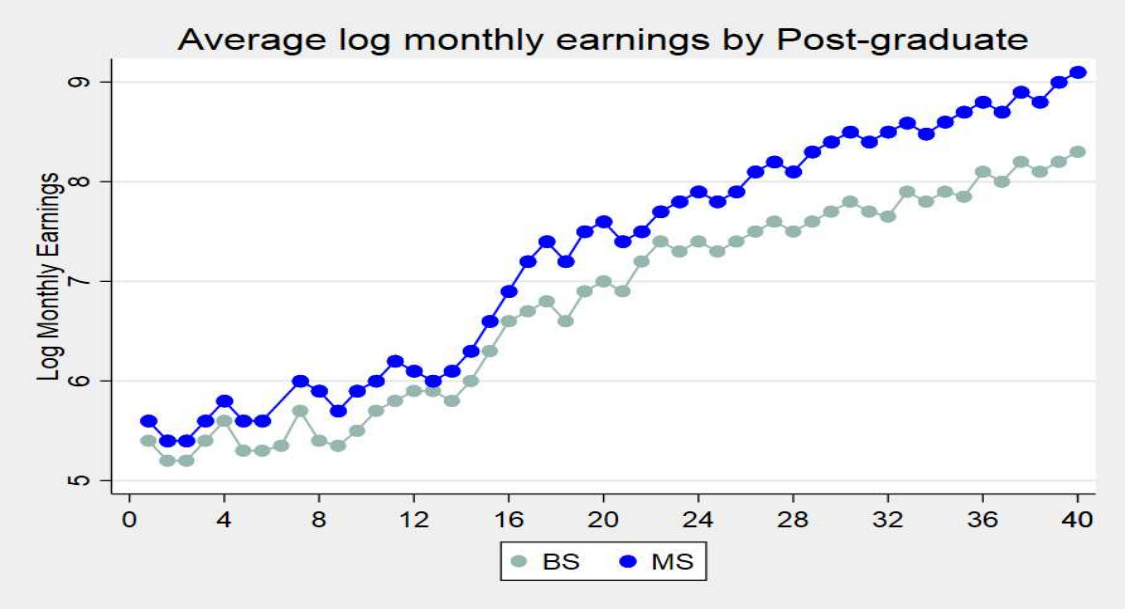

Figure 3. This figure depicts the monthly log earnings of public sector employees with 16 years (BS(honors)) education and 18 years (MS(honors)) education from the sample period.

6. Discussion

The investigations on the characteristics of market supply/demand factors have enabled economists to explore that those individuals who accumulate LLE or HLE will contribute significantly towards a nation's endurance. College or higher education enrollment is considered imperative in developed or non-developed countries [36], especially when the government is responsible for managing all sustainable resources for public support, for example, in enhancing mobility or investment on education and its co-occurrence for the community welfare net.

Although in the literature, the association between education and wage-aspirations is well-established, yet it's unclear what aspects of education drive this association [37–39]. However, we have found that individuals who possess postgraduate diploma are able to hold standard jobs with high return, because more investment on schooling makes them capable and more productive.

The education seems to be an individual's productive investment, which brings drastic change in the detected wage returns by type of qualification (sheepskin effects). Especially, the academic conference or baccalaureate diploma seems to be fascinated more substantial incentives on the labor market. Employers rely on the proxies to screen out the hypothesis of sheepskin effect and as a signaling model against human capital by looking at the external effects of education, for example, individuals' behavior or attitude. The central difference between the models is not only how employers are rewarding the individual at educational level, but also the primary difference that occurs at the societal level. While the human capital theory suggests that the external effects remain absent, most signaling models and sheepskin effects predict that private returns are higher than social returns.

Notwithstanding, a number of students have obtained qualifications from high to low level, and all the educational benefits for men and women have remained unchanged from 2004/2005 to 2010/2011, the only exception being the withdrawal of returns from LLE. First, our estimated results indicated that the signaling model fit better than the human capital model does. The strong sheepskin effects at additional dimension of schooling (postgraduate) were discovered. The additional investment on higher-degree can have value as a signal, whereas LLE has almost negative impact on wages. Second, the years spent on education even rehashed years on explicit dimensions have a small effect on wages by using Mincer equation and spline function. This could clarify the non-appeared effects of longer years of education. For example, students who obtain rehashing years might be understood as

possessing low-ability or low-motivational power or low-catching power compared to their cohorts. This goes directly against the human capital model, which expresses that consistently spending more years in education can enhance someone's productivity. If less-able students spend more years in education than strictly necessary, then everyone will observe an overall decline in the private rate of return and decline in validity. Third, by giving the same length of experience, we found that experience did not make any change at the possession of LLE.

As, I have no control over unobserved heterogeneity, I have used preventative comments at its place. It means the heterogeneity is observed by the employer during the employee selection process. A scholar [40] argued that other attributes should not be included to capture the productivity differences except the effects of education. However, only the employer can screen out the tentative signaling model against the human capital model, because he/she has already settled the imaginary sketch of productivity. Hence, other scholars and I determined to examine the sheepskin effects and their impact on wage discrimination.

Consequently, our results are in contrast with a Netherland study [41], which reported significant returns on schooling years. In this paper we have utilized a distinctive procedure as used by Van der Meer (2011) to estimate wage equation. Van der Meer did not take into account the outcome effects for repeated years of education or the outcomes' relationship with experience, even no one has focused on regional effects as we did in the current study. However, this fact is not the cause of different results since we have estimated spline function, results (Table 3) and interaction of schooling with experience in (Table 4). Although there is no age for learning and education cannot be presumed, but the sustainable development of human capital relies on more investment toward a baccalaureate diploma.

7. Conclusions

There is a strong belief that general education is responsible for the sustainable development of skills and learning, that learning is called human capital. Individuals are more likely to be highly paid, with the presence of human capital and baccalaureate diploma (sheepskins). The individuals studying at the public or private institutions, it grants them baccalaureate diplomas after the completion of degree years.

However, current study showed an exceptional rate of returns to education and the cumulative convexity in the income function will be greater over time. We had observed the number of possible explanations in the patterns. First, the postgraduate diploma had substantial returns compared to rest of diplomas, because the ability or divisibility of human capital formation makes a difference in the organizational objectives or in the productivity. Second, there was a negative impact on rehashing diploma years as repetition may create doubt on the individual's ability or motivation. Third, for school-to-work transition program, the firm seeks perspective productive elements from the employee. Hardly, very few candidates may fit on those elements, all because of lack of investment on human capital or education. There should be a systematic supporting ground to polish the skills of candidates, by the arrangement of sustainable developmental internship programs for inclusion in the curricula.

8. Policy Recommendation

The higher education systems in the non-developed countries are surviving under pressure and fluctuating conditions. By comparing the progress of sustainable development of education, it has been statistically noticed from the standard—through the supply and demand mismatch, that there is sparse information flow in the labor market. In this complex environment, government should review their applied policies.

The college or university sectors need to improve the quality of standards of education, and update the syllabus, as the latest technologies exist in the transitive labor market. Moreover, the government should retain an optimum interest in the complex range of objectives for higher education by funding and strategically planning to overcome poverty. To promote the national objectives, there is a need

to stimulate an appropriate improvement in the quality of higher education. Let the nation be assured that resources are employed in higher education and will ensure equity access and equality in the opportunity.

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Appendix A

Table A1. Description of variables with definitions.

Variables	Variable's Description
Y	Natural log of the income (Pak rupees)
S	Accumulated schooling
AGE	Age in years
EXP	No. years' experience
D6	Primary (s ≥ 5)
D10	Secondary (s ≥ 10)
D12	Higher secondary (s ≥ 12)
D14	B.A (s ≥ 14)
D15	Vocational/Polytechnical (s ≥ 15)
D16	BSc (honors) (s ≥ 16)
D18	MSc/MPhil (s ≥ 18)
Director Manager	Employment status
Professional	
Associated Teachers	
Agriculture and Fisheries	
Supervisors	
Finance	
Plant and machine operator	
Clerks	
Elementary	

Table A2. Density of educational attainment and dropouts.

Variables	Mean	Standard Error	Kurtosis	Skewness	Confidence Level (95.0%)
Incomplete Primary	0.1107023	0.00413537	13.1309219	3.88957257	0.008105996
Complete Primary	0.2867304	0.00797572	5.57123356	2.75142192	0.01563368
Incomplete Secondary	0.4938271	0.01189846	3.24266102	2.28957000	0.02332287
Complete Secondary	0.6573460	0.01527782	2.75933134	2.18148577	0.029946943
Completed Higher	1.1076772	0.02104994	0.64390550	1.62597670	0.041261215

Source: The Pakistan Bureau of Pakistan (PBS); author's calculation.

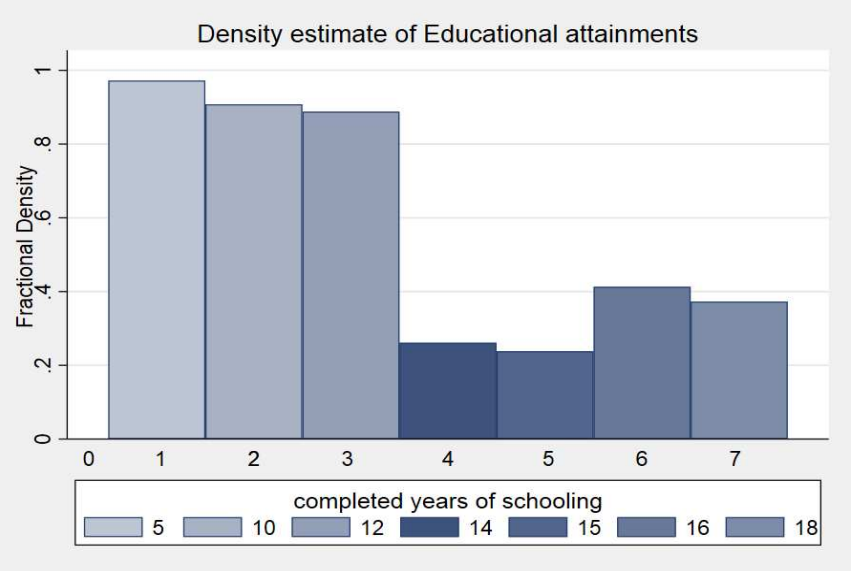

Figure A1. Estimated mean of actual years of degree attainment according to MOE system. Source: Pakistan Bureau of Statistics 2011; author's calculation.

Table A3. Robust regression.

Independent Variables	Coefficient (Standard Errors)	
	Model 1a	**Model 1b**
Intercept	0.655 (0.269) ***	1.348 (0.138) ***
Age	0.0044 (0.002)	−0.001 (0.001) **
S	0.115 (0.0163) ***	0.050 (0.008) ***
Exp	0.107 (0.005) ***	0.027 (0.002) **
Exp^2	0.0114 (0.000025) **	0.0007 (0.0000078) *
Primary	−0.858 (0.352) **	−0.478 (0.133) ***
SSc	0.538 (0.212) **	0.434 (0.132) **
HSc	0.887 (0.161) ***	0.851 (0.122) ***
Vocational	1.92 (0.079) ***	2.034 (0.046) ***
Associate degree	1.269 (0.302) ***	1.991 (0.055) **
Graduate	2.455 (0.100) ***	2.492 (0.055) ***
Postgraduate	1.647 (0.098) ***	2.822 (0.047) **
Marital status	0.029 (0.093) *	−0.0107 (0.047)
Gender	0.982 (0.072) **	0.371 (0.038) *
F-Test	560.92	1734.4
N	3514	12,104

Standard errors are in parentheses. * significant differences at the 1% level; ** significant differences at the 5% level; *** significant differences at the 10% level.

References

1. Ferrer, A.M.; Riddell, W.C. The role of credentials in the Canadian labour market. *Can. J. Econ. Rev. Can. Écon.* **2002**, *35*, 879–905. [CrossRef]
2. Mora, J.J. Sheepskin effects and screening in Colombia. *Colombian Econ. J.* **2003**, *1*, 95–108.
3. Bauer, T.K.; Dross, P.J.; Haisken-DeNew, J.P. Sheepskin effects in Japan. *Int. J. Manpower* **2005**, *26*, 320–335. [CrossRef]
4. Teixeira, P.N. Great expectations, mixed results and resilient beliefs: The troubles of empirical research in economic controversies. *J. Econ. Methodol.* **2007**, *14*, 291–309. [CrossRef]
5. Peet, E.D.; Fink, G.; Fawzi, W. Returns to education in developing countries: Evidence from the living standards and measurement study surveys. *Econ. Educ. Rev.* **2015**, *49*, 69–90. [CrossRef]
6. Memon, A.A.; Liu, Z.J.S. Assessment of Sustainable Development of the Performance of Higher Education Credentials in the Transitive Labor Market. *Sustainability* **2019**, *11*, 2628. [CrossRef]
7. Thrane, C. Education and earnings in the tourism industry–the role of sheepskin effects. *Tour. Econ.* **2010**, *16*, 549–563. [CrossRef]
8. Alba-Ramirez, A.; San Segundo, M.J. The returns to education in Spain. *Econ. Educ. Rev.* **1995**, *14*, 155–166. [CrossRef]
9. Becker, G.S. Investment in human capital: A theoretical analysis. *J. Polit. Econ.* **1962**, *70*, 9–49. [CrossRef]
10. Schultz, T.W. Investment in Human Capital The Role of Education. *Econ. Dev. Cult. Chang.* **1971**, *23*, 553–559. [CrossRef]
11. Mincer, J.; Polachek, S. Family investments in human capital: Earnings of women. *J. Polit. Econ.* **1974**, *82*, S76–S108. [CrossRef]
12. Flores-Lagunes, A.; Light, A. Interpreting degree effects in the returns to education. *J. Hum. Resour.* **2010**, *45*, 439–467. [CrossRef]
13. Lemieux, T. Increasing residual wage inequality: Composition effects, noisy data, or rising demand for skill? *Am. Econ. Rev.* **2006**, *96*, 461–498. [CrossRef]
14. Card, D. The causal effect of education on earnings. In *Handbook of Labor Economics*; Elsevier: Amsterdam, The Netherlands, 1999; Volume 3, pp. 1801–1863.
15. Hungerford, T.; Solon, G. Sheepskin effects in the returns to education. *Rev. Econ. Stat.* **1987**, *69*, 175–177. [CrossRef]
16. Belman, D.; Heywood, J.S. Sheepskin effects in the returns to education: An examination of women and minorities. *Rev. Econ. Stat.* **1991**, *73*, 720–724. [CrossRef]
17. Hamdani, K.A. Education and the income differential: An estimation for Rawalpindi city. *Pak. Dev. Rev.* **1977**, *16*, 144–164. [CrossRef]
18. Yunus, N.M. Sheepskin effects in the returns to higher education: New evidence for Malaysia. *Asian Acad. Manag. J.* **2017**, *22*, 151. [CrossRef]
19. Olfindo, R. Diploma as signal? Estimating sheepskin effects in the Philippines. *Int. J. Educ. Dev.* **2018**, *60*, 113–119. [CrossRef]
20. Crespo, A.; Reis, M.C. Sheepskin effects and the relationship between earnings and education: Analyzing the evolution over time in Brazil. *Rev. Brasil. Econ.* **2015**, *69*, 209–231. [CrossRef]
21. Denny, K.J.; Harmon, C.P. Testing for sheepskin effects in earnings equations: Evidence for five countries. *Appl. Econ. Lett.* **2001**, *8*, 635–637. [CrossRef]
22. Ost, B.; Pan, W.; Webber, D. The returns to college persistence for marginal students: Regression discontinuity evidence from university dismissal policies. *J. Labor Econ.* **2018**, *36*, 779–805. [CrossRef]
23. Kaffenberger, M.; Pritchett, L.; Sandefur, J. Estimating the Impact of Women's Education on Fertility, Child Mortality, and Empowerment When Schooling Ain't Learning. Available online: https://www.gov.uk/dfid-research-outputs/estimating-the-impact-of-women-s-education-on-fertility-child-mortality-and-empowerment-when-schooling-ain-t-learning#abstract (accessed on 10 November 2019).
24. Lang, K.; Kropp, D. Human capital versus sorting: The effects of compulsory attendance laws. *Q. J. Econ.* **1986**, *101*, 609–624. [CrossRef]
25. Dustmann, C.; Fadlon, I.; Weiss, Y. Return migration, human capital accumulation and the brain drain. *J. Dev. Econ.* **2011**, *95*, 58–67. [CrossRef]

26. Trostel, P.A. Nonlinearity in the return to education. *J. Appl. Econ.* **2005**, *8*, 191–202. [CrossRef]
27. Heckman, J.J.; Lochner, L.J.; Todd, P.E. *Fifty Years of Mincer Earnings Regressions, No. w9732*; IZA Discussion Paper Series; National Bureau Of Economic Research: Cambridge, MA, USA, 2003.
28. Psacharopoulos, G.; Teixeira, P. Rates of Return to Education: Conceptual and Methodological Issues. In *Encyclopedia of International Higher Education Systems and Institutions*; Springer: Dordrecht, Germany, 2019; pp. 1–8.
29. Patrinos, H.A. Estimating the return to schooling using the Mincer equation. *IZA World Labor* **2016**. [CrossRef]
30. Mincer, J. *Schooling, Experience, and Earnings*; National Bureau Of Economic Research: Cambridge, MA, USA, 1974.
31. Becker, G.S. Human capital revisited. In *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*, 3rd ed.; The University of Chicago Press: Chicago, IL, USA, 2009; pp. 15–28.
32. Schady, N. *Convexity and Sheepskin Effects in the Human Capital Earnings Function: Recent Evidence for Filipino Men*; The World Bank: Washington, DC, USA, 2001. [CrossRef]
33. Shabbir, T. Sheepskin effects in the returns to education in a developing country. *Pak. Dev. Rev.* **1991**, *30*, 1–19. [CrossRef]
34. Aslam, M. Education gender gaps in Pakistan: Is the labor market to blame? *Econ. Dev. Cult. Chang.* **2009**, *57*, 747–784. [CrossRef]
35. Brown, S.; Sessions, J.G. Education and employment status: A test of the strong screening hypothesis in Italy. *Econ. Educ. Rev.* **1999**, *18*, 397–404. [CrossRef]
36. Pagani, L.S.; Brière, F.N.; Janosz, M.J.I. Fluid reasoning skills at the high school transition predict subsequent dropout. *Intelligence* **2017**, *62*, 48–53. [CrossRef]
37. Liu, V.Y.; Belfield, C.R.; Trimble, M.J. The medium-term labor market returns to community college awards: Evidence from North Carolina. *Econ. Educ. Rev.* **2015**, *44*, 42–55. [CrossRef]
38. Limam, I.; Hafaiedh, A.B. Education, Earnings and Returns to Schooling in Tunisia. *Econ. Res. Forum Working Papers* **2017**. Available online: https://erf.org.eg/publications/education-earnings-and-returns-to-schooling-in-tunisia/ (accessed on 10 November 2019).
39. Mateos-Romero, L.; del Mar Salinas-Jiménez, M. Labor Mismatches: Effects on Wages and on Job Satisfaction in 17 OECD Countries. *Soc. Indic. Res.* **2018**, *140*, 369–391. [CrossRef]
40. Weiss, A. Human capital vs. signalling explanations of wages. *J. Econ. Perspect.* **1995**, *9*, 133–154. [CrossRef]
41. Van der Meer, P.H. Mobility. Educational credentials and external effects: A test for the Netherlands. *Res. Soc. Stratif. Mobility* **2011**, *29*, 107–118. [CrossRef]

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The Trivariate Causality among Education, Health, and Economic Growth in Zimbabwe

Michael Takudzwa Pasara [1,*], Tapiwa Kelvin Mutambirwa [2] and Nolutho Diko [3]

[1] Economic and Management Sciences, Walter Sisulu University, Butterworth 4960, South Africa
[2] UNICEF Malawi, P.O. Box 30375, Lilongwe, Malawi; kmutambirwa@unicef.org
[3] Faculty of Education, Walter Sisulu University, Butterworth 4960, South Africa; ndiko@wsu.ac.za
* Correspondence: michaelpasara@gmail.com

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Abstract: This study investigated the causality among education, health, and economic growth in Zimbabwe. Causality effects are a thinly explored area in literature, with most studies focusing on bidirectional relationships. Granger causality tests were employed in a Vector autoregressive (VAR) model. Results showed that education Granger causes health improvements, with health improvements in turn fairly associating to Granger cause economic growth in Zimbabwe. Thus, the effect of education on economic growth is not direct, but works through improved health, pointing to the conclusion that health is a transmission mechanism through which education drives economic growth. No feedback effect was established from health to education and from economic growth to education and health. Thus, results suggest the need for a holistic policy approach which integrates education and health policies in a bid to drive economic growth, since education has no effect on economic growth in its own domain, but through health.

Keywords: trivariate causality; education; health; economic growth; Zimbabwe

1. Introduction

Endogenous growth theories are acknowledged for incorporating education, health, and human capital in economic growth analysis, although they do not account for the possible causal interlinks among these human capital components and economic growth. Empirical literature has made remarkable advances by incorporating the associated causal links between education, health, and economic growth, by using advanced causality techniques. Studies that have attempted to examine the causal relationships have mostly looked at bidirectional relationships: education–growth [1–8]; health–growth [9–12]; or education–health [13–15]. These studies produced mixed results, with some observing bidirectional relationships unidirectional from either way and in some cases, no causal links. Less attention, however, has been devoted to the trivariate causality subject for education, health, and economic growth. Empirical studies on the trivariate causality subject are recent and the area has not been vastly explored. The spirit behind the trivariate causality subject is that education and health possibly causally interact in influencing economic growth. As such, it is imperative to model their causal interaction with economic growth in a joint model.

Education is believed to be a health driver, because educated people are more health conscious and likely to invest more resources on healthcare services [16–18]. Then again, there is a feedback effect expected from health to education—improved health outcomes are believed to enhance schooling outcomes [13]. Therefore, an educated and healthy population is more productive and, in turn, expected to contribute more to national output and consequently economic growth, which is, in turn, expected to have a feedback effect on education and health, because improved economic performance implies improved capacity to invest in education, research, and development [5,19,20]. It is therefore

reasonable to argue that there are interrelationships between education, health, and economic growth, whereby education is highly associated with health improvements, which, in turn, should fairly associate with driving economic growth, with feedback effects expected to run from either angle. However, as argued earlier, few studies have modeled this interaction in a joint model.

Despite the nation boasting a highly educated population, the Zimbabwean economy has a paradox in that there is a relatively poor health population and low economic growth, which does not accord well with expectations of economic theory. Thus, the focus of this study is to establish whether there is a joint causal interaction between education, health, and economic growth in Zimbabwe, as this will have both empirical and policy significance.

This study is not only interested in correlations but also in causality issues, following the conceptualization that economic growth also has a feedback effect on education and health outcomes. As such, this study uses causality techniques in a multivariate time series framework, where education, health, and economic growth are considered simultaneously in a joint model. Following Poças [20]), the interaction between the concerned variables under study are explained by a mechanism which is anchored on the cumulative causation characteristic, with increased returns to scale stemming from human health as a contributor to human capital.

Justification of the Study

The trivariate causality among education, health, and economic growth is a recent and thinly-explored area in the empirical literature, with no country-specific study available specifically in Africa. In particular, the subject has only been examined in Africa by [21] in a panel study, which included Zimbabwe. However, the panel methodological technique used did not quite satisfactorily address the causality subject, as it only produced panel effects/correlations. Such effects are flawed with partiality, because variables might be correlated but not causally linked, as argued by [22]. In light of this methodological shortcoming, this study uses a vector autoregressive (VAR)/vector error correction model (VECM) methodology which has been successfully applied in accounting for causality issues in the empirical literature. For a Zimbabwean focus, [23] did a study on health and growth, while [5] examined the bidirectional causality between education and economic growth. This leaves the trivariate subject an unexplored area, as no standalone study has investigated the joint causality among education, health, and economic growth for Zimbabwe.

2. Overview of the Zimbabwean Economy, Health, and Education Sector

Statistics show that Zimbabwe has been highly characterized by subdued economic performance since the late 1990s. As of 2014, the average growth rate of the Zimbabwean economy stood at 3.17%. Health-wise, life expectancy stood at 55.68 years (which ranks 202 of 220 countries), while in Japan life expectancy averages 84 years. More precisely, a Japanese person is expected to live for 84 years, with 92% of that life in decent health, whereas a baby born in Zimbabwe expects to live for a mere 55 years, with more than five years (about 11%) spent in ill health [24,25]. In addition, infant mortality rate in Zimbabwe, as of 2014, stood at 72.3 deaths per 1000 population, which is more than double the global infant mortality rate, averaging 32 deaths per 1000 population [24]. On the contrary, on the education frontier, the nation ranks top in Africa, boasting a high literacy rate, averaging 98% [26]. Indeed, Zimbabweans are known worldwide for their educational and skills competency.

Since 1980, the economic performance of Zimbabwe has produced mixed outcomes, as depicted in Figure 1. Poor policy lapses and adverse weather conditions significantly influenced the agro-based economy, as agricultural output was inconsistent [27]. In general, economic growth fluctuations were mainly caused by government controls, droughts, and the provision of basic amenities whilst sacrificing increased production capacity, resulting in foreign currency shortages [27]. Inconsistent policies included the International Monetary Fund (IMF)-backed Economic Structural Adjustment Program (ESAP, 1991–1995) which was abandoned by the government in favor of the Zimbabwe Program for Economic and Social Transformation (ZIMPREST). Consequently, there was an economic

crisis in 1997, despite the economy having attained an all-time peak of 9.2% the year earlier. The period 2000–2008 was characterized by hyperinflation, which broke records of modern-day economies and a lowest GDP of −17.56% in 2008 [24,25]. Factors which contributed included poor governance, an unstructured land reform program leading to sharp declines in support from international financial institutions, low investment, capital flight, and the Global Financial Crisis. The adoption of the multicurrency regime in 2009, led to a marked recovery in economic growth. The growth rate sharply rose from −17.7% in 2008 to 5.9% in 2009, which further rose to 11.9% in 2011, before subsiding from 2012 onwards.

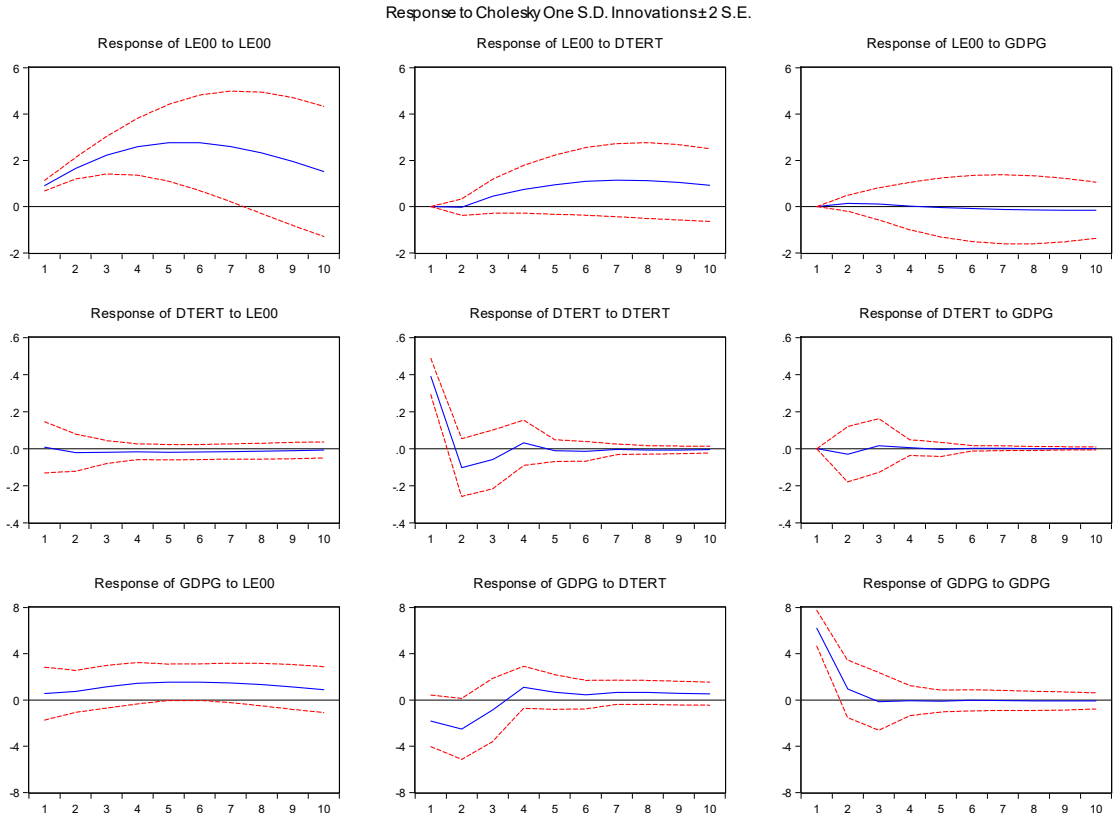

Figure 1. Impulse response function (IRF) analysis. Source: Extracted from E-Views 7.

In terms of education, the government, attempted to redress the imbalances of the colonial regime by improving access to education through the "Growth with Equity" principle and "Education for All" policy. However, the economy was heavily affected by a massive brain drain of teachers and other professionals at the beginning of the 21st century, a trend which subsided after dollarization in 2009 (UNICEF, 2015). Zimbabwe is ranked first on the continent, with the literacy rate at 98% as of 2014 [26].

The commendable results in the education sector in Zimbabwe cannot be said about investment in the health sector [28]. The data from the Zimbabwe Demographic and Health Survey 2005/2006 (ZDHS), [29], Maternal and Perinatal Mortality Study, and other studies reflect that easily preventable and treatable conditions are killing the majority of Zimbabweans. These include malaria, acute respiratory infections, diarrhea, injuries, malnutrition, HIV and AIDS, tuberculosis (TB), pregnancy-related and perinatal complications, hypertension, and mental health disorders, among others. Given the poor health outcomes experienced in the nation, one is prompted to pose a question as to whether the huge investments in health have not been beneficial, as with education investments. Perhaps, the uncertainty and complexity in the health sector, such as the recent cholera and Ebola threats, have disrupted any developmental programs in place. What is worrisome is that the failure of the nation to deal with curable diseases, such as malaria, typhoid, and cholera, is coupled with high cases of tuberculosis. The HIV/AIDS pandemic accounted for about 50% of the disease burden in the

nation by 2009. Life expectancy dropped from an average of 60 years to reach 47.8 years in 1997, which worsened to 44.9 years by the end of the decade. By 2009, the life expectancy for women was only 34 years [28]. Infant mortality similarly worsened. In general, as the economy down spiraled in the early 1990s, so did the health indicators. However, the government managed to decrease the HIV prevalence from around 30% in the 1990s to 14.3% (1.4 million) in 2014, mainly due to the 3% AIDS levy on taxable income which was introduced in 2000. When the economy showed positive growth between 2009 and 2012, relations between the Zimbabwean government and the international donor community also improved, with reengagement and partnership between the two resuscitated [28].

3. Literature Review

The original exogenous growth model by Solow and Swan frameworks offered a useful starting point for analyzing economic growth but omitted the role of human capital [30,31]. Solow's work was later augmented to include education human capital by Mankiw, Romer, and Weil (MRW) [32]. However, the human capital introduced by MRW [32] was narrowly defined as education, yet health also forms part of human capital. Generally, endogenous growth theories introduced the role of human capital and education in the process of economic growth, notably [33,34], and later on emphasized in the human capital-augmented Solow model of MRW [32]. They argued that economies which have a faster growth rate in education will have faster rates of transition, leading to higher incomes. They extended a simple Solow model by imputing human capital as a separate variable into the Cobb–Douglas production function in a labor-augmenting in a Harrod-neutral framework with technological progress. The improved model, commonly referred to as the capital-augmented Solow model, is given by:

$$y_t = k_t^{\alpha} e_t^{\beta}, \tag{1}$$

where $y_t = \frac{Y_t}{A_t L_t}$, $k_t = \frac{K_t}{A_t L_t}$, and $e_t = \frac{E_t}{A_t L_t}$, Y_t is output, K_t is capital, E_t represents stock of human capital (education), A_t represents technology level, and L_t is "raw" labor. α and β are output elasticities. A reasonable assumption by MRW (1992) is that $\alpha + \beta < 1$, which implies constant returns to scale (CRTS), although they are diminishing returns to reproducible factors. Introducing logs and differentiating Equation (1) with respect to time yields a growth equation of the form:

$$\dot{y}_t = \theta + \alpha \dot{k}_t + \beta \dot{e}_t, \tag{2}$$

where $\dot{y}_t$ represents the growth rate of the economy, $\dot{k}_t$ and $\dot{e}_t$ are growth rates in the stock of physical and education human capital, respectively, and θ is some residual constant. However, the MRW extension only incorporated education human capital but did not include the health component. Ram later showed that while education does very well in the MRW framework, as they reported, health (captured by life expectancy) better explains economic growth, if included in the growth regression [35]. Incorporating health human capital in Equation (1) yields the following intensive form production function:

$$y_t = k_t^{\alpha} e_t^{\beta} h_t^{\varphi}, \tag{3}$$

where y_t, k_t, and e_t are as previously defined, $\alpha + \beta + \varphi < 1$, and $h_t = \frac{H_t}{A_t L_t}$, with H_t representing health human capital. As such, the variant of the MRW growth equation that should be estimated becomes:

$$\dot{y}_t = \theta + \alpha \dot{k}_t + \beta \dot{e}_t + \varphi \dot{h}_t, \tag{4}$$

where $\dot{y}_t$, $\dot{k}_t$, and $\dot{e}_t$ are as defined before, while $\dot{h}_t$ represent the growth rate in the health human capital stock. In this regard, most empirical literature on the human capital–growth nexus follows the MRW (1992) regression approach.

However, emphasis should be on the fact that the human capital-augmented Solow model by MRW (1992) omitted the possible feedback effect of economic growth on education and health human

capital [33,34,36]. Abstracting from MRW's view that education human capital enters the production function as a separate input, endogenous growth theories earlier on had considered education as a process that changes the production technology itself. In addition, education facilitates the adoption of foreign technology [36–43].

Nelson and Phelps [36] argued that higher human capital levels accelerate technological diffusion, thereby enabling countries lagging behind to 'catch up'. However, their model identified technology as exogenous and human capital plays the role of narrowing that gap. Romer [43] extended the concept and highlighted that not only will economies adopt new technologies, but they will also create new ones through observation and research and development [33]. The implication is that the rate of technological process and growth is a function of human capital stock and not necessarily its accumulation.

Differing from the human capital–growth conceptualization by [33,34] argued that human capital should be viewed as cumulative with positive externalities and as the engine of long-run economic growth. The accumulation of human capital increases physical capital and labor productivity. The premise of Lucas' thinking is that educated people are more efficient, an argument complemented by Poças [20], who demonstrated that education enhances productivity through the stimulation of physical investment, investment in technology, and improved competencies [44]. Lucas [34] considered human capital as entering the production function in a labor-augmenting way. Lucas proposed the following production technology:

$$Y_t = AK_t^{\beta}(u_t h_t L_t)^{1-\beta} h_{a,t}^{\gamma}, \tag{5}$$

where Y_t, A, K_t, and L_t represent output, technology, capital, and labor; while u_t is the proportion of time devoted to work, h represents the level of skill (human capital), h_a is the average human capital in the economy, and A is the level of technology, which is a constant. Although the Lucas model made a major breakthrough by incorporating human capital in the growth process, it, similar to exogenous models, did not account for the possibility of a feedback effect from economic growth to human capital. However, empirical evidence has conceptualized the idea that economic growth also has the effect of improving human capital accumulation.

Endogenous growth theories consider health and education separately in explaining economic growth, with not much emphasis on the education–health interaction. Following [37–39], education and health are likely to interact in affecting economic growth and, as such, it appears imperative to consider their interconnection and effect on economic growth within a joint model. Such a development had earlier on been strongly advocated for [40]. This paper considers both education and health human capital jointly in explaining economic growth. Apart from narrowly focusing on either education or health in analyzing economic growth, the endogenous growth theories, together with [32], omitted the possibility of a feedback effect of economic growth on education and health. In this vein, some empirical studies have shown that economic growth indeed has a feedback effect on human capital development (see, for instance, [1–3,7–10,38,41,42]). The idea is that economic growth is associated with improvements in per capita incomes, which implies improvements in standards of living for the population, thus, individuals should be able to invest more in education and health services.

Generally, education human capital affects economic growth through four main channels. First, and in the sense of [34], education enhances productivity. The second channel relates to labor market participation. Thus, human capital investment increases the chances of finding a job in the labor market. Thirdly is the argument that a more skilled workforce utilizes domestic and foreign investment more effectively, which will have multiplier effects on the growth of the economy. The fourth link works through the income effect of human capital, which promotes better product variety and innovation, as demonstrated by Romer's [43] endogenous growth model.

On the other hand, health affects the growth of the economy through four main channels: productive efficiency, labor supply, education, and capital formation. First, health, like education, conditions the productivity and efficiency of individuals, as healthier workers have more energy and are more creative [40,41,45]. Second, and important in this study, it has been documented that health

affects economic growth via its effect on education [13,39]. This rests on the notion that improved health in the early phases of life has an indirect contribution to future productivity through increased education and skill acquisition. Health improvements raise the incentive to acquire education, lower absenteeism, and increase cognitive functioning. Third, health has a link with capital formation. In this vein, health affects both the ability and impetus to save [9,11–13,41]. Fourth, though theoretically ambiguous, health has an impact on labor supply. On one end there is the substitution effect, which states that improvements in health are associated with wage increments and hence the inducements to increase labor supply. On the other end is the income effect, as being healthy allows for higher lifetime earnings [1,3,5,7,41].

If these theoretical propositions are true, then there seems to be an apparent paradox in Zimbabwe in that the nation has experienced subdued economic performance over the years, coupled with poor population health in the face of a highly educated population. This seemingly existing paradox prompts a question as to whether there is no causal relationship existing among education, health, and economic growth in Zimbabwe. In addition, there is a documented stylized fact that developing countries are associated with low income growth rates, poor population health, and low educational levels. However, the Zimbabwean situation does not accord well with such findings in that there is low health–low growth, despite the nation being highly endowed with an educated workforce.

Empirically, some studies have attempted to investigate the trivariate causality subject. Firstly, some have used government expenditure on health and education as proxies for education and health human capital [20,46–49]. However, such proxies may not satisfactorily reflect education and health human capital in a country like Zimbabwe, where there are a lot of inefficiencies associated with the use of public funds. Against this backdrop, this study uses tertiary enrolment rates and life expectancy as education and health proxies, respectively. Second, other studies have used panel techniques in analyzing the trivariate interrelationships [21,39,50]. Zimbabwe was included in one such panel study by Eggoh et al. [21]. Nonetheless, it is well known that two variables may be highly correlated but not automatically causally linked [22].

4. Methodology

The literature reviewed in this study indicated that no specific theory addressed the possible joint interaction associated with causal links among the three variables under consideration. Thus, this study employed the vector autoregressive (VAR) model because of its ability to capture endogeneity among all variables. It should be noted that the VAR framework is empirically informed and has no theoretical framework [5]. However, inferences drawn from employing a VAR framework may be sensitive to model specification. Thus, pre-estimation tests to assess the properties of the time series data were conducted. These included unit root tests and Granger Causality tests.

Generally, a variable is integrated of order k, if it becomes stationary after differencing k times. With the purpose of identifying any trend(s) in the data, stationarity is vital in avoiding spurious regressions. Spurious regressions arise in time series regressions, where one often obtains a very high R^2 (in excess of 0.9) even though there is no meaningful relationship [22]. The most common unit root tests are the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) test. Given that these tests provide the same results, this study used the conventional ADF test for stationarity testing.

Granger causality is a statistical concept of causality that is based on prediction, which is used to test whether one variable is useful in forecasting another variable. Granger causality rests on two assumptions. First, the future cannot cause the past—the past causes the present or the future. Second, a cause contains unique information about an effect not available elsewhere. Put differently, the information relevant to the prediction of the respective variables is solely contained in the time series data on these variables [22]. The test was offered by Granger and Sims and was motivated by the observation that the existence of a relationship between variables does not prove causality or the direction of influence (correlation does not imply causality) [51–54]. This study focused on establishing the nature of causality among economic growth, education, and health.

The mathematical formulation of the Granger causality test is based on linear regression modeling of stochastic processes [52]. A time series X_t Granger causes time series Y_t if past values of X_t provide statistically significant information about the future values of series Y_t. Given:

$$Y_t = \varphi + \delta t + \alpha_1 Y_{t-1} + \ldots + \alpha_p Y_{t-p} + \beta_1 X_{t-1} + \ldots + \beta_q X_{t-q} + \varepsilon_t, \quad (6)$$

time series X_t Granger causes time series Y_t if any or all of $\beta_1, \ldots\ldots, \beta_q$ are statistically significant. The proper way to do Granger causality testing is to test the hypothesis: $\beta_1 = \beta_2 = \ldots = \beta_q = 0$. Time series X_t Granger causes time series Y_t if the hypothesis is rejected. The joint testing is done using the F-statistic, where a probability value less than 10% or an absolute F-statistic of at least two confirms the existence of causality claim. In the trivariate regression, joint causality was suggested when the sets of education, health, and economic growth coefficients were statistically significantly different from zero.

The paper employed the vector autoregressive (VAR) model, given that the thrust of the study was on causality issues. Although VAR models do not have sound theoretical frameworks, Zivengwa [5] argued that they can be used to test interdependent relationships between variables. Unit root and Granger causality tests were outlined before the model specification, as specified by Gujarati [22]. The augmented Dickey–Fuller (ADF) tests were used in this paper for stationarity tests. The optimal lag, k, length in the VAR model was determined by the Akaike information criterion (AIC) in order to minimize the possibility of multicollinearity due to too many lagged degrees of freedom, whilst too few lags might also lead to specification errors [22]. The estimated VAR model consisted of three variables, education, health, and economic growth, and was applied to the data set in the form of a trivariate model. Subsequently, a parsimonious trivariate VAR model of the following form was formulated:

$$EG_t = \gamma_1 + \sum_{i=1}^{k} \alpha_{1i} EG_{t-i} + \sum_{i=1}^{k} \beta_{1i} Educ_{t-i} + \sum_{i=1}^{k} \theta_{1i} Heal_{t-i} + \mu_{1t}, \quad (7)$$

$$Educ_t = \gamma_2 + \sum_{i=1}^{k} \alpha_{2i} EG_{t-i} + \sum_{i=1}^{k} \beta_{2i} Educ_{t-i} + \sum_{i=1}^{k} \theta_{2i} Heal_{t-i} + \mu_{2t}, \quad (8)$$

$$Heal_t = \gamma_3 + \sum_{i=1}^{k} \alpha_{3i} EG_{t-i} + \sum_{i=1}^{k} \beta_{3i} Educ_{t-i} + \sum_{i=1}^{k} \theta_{3i} Heal_{t-i} + \mu_{3t}. \quad (9)$$

In the specified equations, EG_t is economic growth, $Educ_t$ is education, and $Heal_t$ is health, while α, β, and θ are the related coefficients and the μs are white noise disturbances, known as shocks in VAR language. The γs are constants known as drifts, whereas $i = 1 \ldots..k$ is the number of lags, with k being the optimal lag length.

If all the three variables were integrated of the same order, say one, and there was cointegration, then a vector error correction mechanism (VECM) was constructed, in which case all the variables entered the trivariate regression in their first differenced form. On the other hand, an unrestricted VAR framework was employed if the variables were integrated of different orders, because similar order of integration nullifies cointegration and consequently the use of VECM [5] Cointegration means that even though individuals are nonstationary, a linear combination of two or more series is stationary; that is, there is a long run or equilibrium relationship between two variables. A cointegration test was performed using the Johansen cointegration test [37].

The study also provided variance decomposition (VDC) analysis, which informed us of the relative importance of each random shock by showing forecast error variance for each endogenous variable. Moreover, the paper analyzed the impulse response function (IRF) which traced out the response of current and future values of a variable to a one-unit increase in the current value of one of the VAR errors [55]. The IRF assumes that the associated error returns to zero in subsequent phases. IRF shows the dynamic effects of a shock to both other variables and itself.

Explanation of Variables

The paper employed the rate of growth of real GDP to measure economic growth (EG_t). Real GDP measures the health of the economy and the variable is used extensively in economic literature [50]. However, similar to most measures of economic growth, real GDP growth omits inequalities in income distribution, which is an issue of concern in developing nations like Zimbabwe. Although literacy is mostly used as an education indicator in most empirical literature, this paper employed tertiary enrolment due to data availability.

This study acknowledged that literacy level as proxied by either primary or secondary enrolment is mostly employed in the majority of empirical literature [56–60]. However, this study employed tertiary enrolment because, in line with [5,19,39], it inferred that tertiary enrolment contributes directly to skilled human capital and is closely related to the quality of education in Zimbabwe. In other words, tertiary enrolment was deemed a better proxy for education in the case of Zimbabwe since it captures both quantity and quality of education. According to the 2014 World Bank survey, the literacy rate for Zimbabwe was 88.7%. However, literacy rate could not be employed for time series analysis because it is in surveys (1982, 1992, 2011, and 2014). On the other hand, UNESCO (2019) statistics indicate that the secondary enrolment level for Zimbabwe is around 1,953,352, whilst that of tertiary enrolment is 1,354,863, indicating that 70% of the secondary-enrolled students transition into tertiary level. This is because Zimbabwe is a very small economy with more than 10 universities and an even greater number of diploma-level institutions. Moreover, the secondary going age for Zimbabweans is 13 to 18 years, whilst the tertiary going age is 19 to 23 years. Since the legal age of majority is 18 years, the authors employed the rationale that decisions concerning health matters are made beyond 18. With the exception of [44] and [50], it is worth noting that studies on the trivariate subject have mostly used the share of public education and health expenditures to GDP as proxies for education and health human capital. However, in developing countries, there are some inherent inefficiency, corruption, bureaucratic, and governance issues associated with the use of public funds, which jeopardize the achievement of their intended objectives, thereby compromising the expected value-for-money, productivity, and growth effects. Inefficiencies in the utilization of public funds in developing countries, like Zimbabwe, possibly lessen the expected growth-stimulating effect of investment in human capital. Against this backdrop, this study used tertiary enrolment as a proxy for education and life expectancy as a health indicator in establishing whether there is a triangular causality among education, health, and economic growth in Zimbabwe.

Life expectancy at birth (LEB) as a measure of health ($Heal_t$) was employed ahead of other aggregate health indicators like mortality rates. LEB quantifies the expected years an infant is to live if the conditions are to remain *ceteris paribus* throughout the life cycle of the child. LEB is an internationally-recognized indicator (used in measuring the Human Development Index (HDI)) as a basic indicator of health and social development. It also indicates the general mortality level, as it summarizes mortality patterns across all ages. Data were sourced from the World Bank Development Indicators [24], and Zimbabwe Statistics [26] spanning from 1980 to 2014 were employed due to the availability of consistent data.

5. Results

Descriptive statistics indicated, using 35 observations, that average life expectancy is 53.22 years, the average tertiary enrolment rate is 1.64%, while the economy grew by an estimated 1.86%. The coefficients of skewness were negative for health (LE00) (−0.2718) and economic growth (GDPG) (−0.7073) and positive for education (TERT) (0.7702), indicating that LE00 and GDPG were negatively skewed, whereas TERT was positively skewed. Importantly, Table 1 shows a reasonable degree of dispersion among sample variables, which suggest that outliers did not exist. Thus, data were not transformed.

Table 1. Pairwise Granger causality test results.

Null Hypothesis	Observations	F-statistic	*p*-Value
LE00 does not Granger cause DTERT	32	0.4567	0.6382
DTERT does not Granger cause LE00		4.1626	0.0266 **
GDPG does not Granger cause DTERT	32	0.2863	0.7533
DTERT does not Granger cause GDPG		1.5757	0.2253
GDPG does not Granger cause LE00	32	0.5383	0.5897
LE00 does not Granger cause GDPG		2.5475	0.0963 *

Note: The asterisks **, * represent significance at 5% and 10% levels, respectively.

In terms of stationarity, the augmented Dickey–Fuller (ADF) results showed that economic growth (GDPG) and health (LE00) were stationary in levels at 5% and 1% significance levels, respectively, while education (TERT) was stationary at first difference, after which it is named DTERT. In terms of integration, GDPG and LE00 were integrated to order zero, whereas DTERT was integrated to the first order, implying no cointegration likelihood because variables were integrated to different orders. Thus, only an unrestricted VAR model could be estimated, whilst nullifying the use of VECM. Therefore, the variables were used to test for pairwise Granger causality and entered the VAR model according to their stationarity level. The AIC showed that the lag-length was 2. The table below shows the Granger causality results.

5.1. Granger Causality

The results indicate that there is a unidirectional causal relationship running from education (DTERT) to health (LE00), since the null hypothesis of non-causation was rejected at the 5% level of significance. This implies that education is a driving force of health improvements, as it results in increased life expectancy. However, the reverse causality from health to education was found to be insignificant. Moreover, the results showed a unidirectional causal relationship from health (LE00) to economic growth (GDPG). This is because the null hypothesis of non-causation was rejected at 10% level of significance. Thus, improvements in health cause improvements in economic growth rate. There was, however, no feedback effect from improved economic growth rate to health. The Granger causality results showed no support of a joint causation among education, health, and economic growth. This is because only two out of six of the non-causation claims were rejected. The results showed no direct causal effect of education on economic growth rate. Based on the causality results, it is reasonable to argue that education affects economic growth via its effect on health.

5.2. Vector Autoregression (VAR) Model Results

The distribution lag coefficients estimated using the VAR model did not offer a rich understanding of the implied dynamic model behavior (see Supplementary Table S5 for detailed VAR results). Thus, attention was paid to variance decomposition and impulse response function analysis, as argued by [61] and [22].

5.2.1. Variance Decomposition (VDC) Analysis

In line with the AIC lag length of 2, the VDC results are presented in Tables 2–4 below.

Table 2. Variance decomposition of LE00.

Period	S.E.	LE00	DTERT	GDPG
1	0.905530	100.0000	0.000000	0.000000
2	1.886895	99.41105	0.026835	0.562112
3	2.950110	97.29279	2.327870	0.379343
4	3.992233	95.01889	4.772048	0.209060
5	4.941190	93.13295	6.723439	0.143612
6	5.760569	91.36491	8.508101	0.126989
7	6.422258	89.85377	10.00877	0.137455
8	6.920124	88.58930	11.24872	0.161980
9	7.265399	87.52632	12.28020	0.193482
10	7.479976	86.66583	13.10636	0.227818

Extracted from E-Views 7. Note: S.E. refers to standard error.

Table 3. Variance decomposition of DTERT.

Period	S.E.	LE00	DTERT	GDPG
1	0.390596	0.033597	99.96640	0.000000
2	0.405555	0.326844	99.10655	0.566607
3	0.410463	0.540094	98.74875	0.711153
4	0.412011	0.709247	98.56906	0.721689
5	0.412662	0.934532	98.33384	0.731628
6	0.413337	1.130210	98.13948	0.730313
7	0.413672	1.278819	97.99012	0.731058
8	0.413964	1.387200	97.88253	0.730269
9	0.414172	1.453528	97.81622	0.730253
10	0.414273	1.485892	97.78341	0.730696

Extracted from E-Views 7.

Table 4. Variance decomposition of GDPG.

Period	S.E.	LE00	DTERT	GDPG
1	6.481474	0.730531	7.778917	91.49055
2	7.056049	1.713488	19.26416	79.02236
3	7.198392	4.133802	19.90286	75.96334
4	7.424177	7.680763	20.89789	71.42135
5	7.610347	11.34471	20.66771	67.98758
6	7.776326	14.75356	20.12791	65.11853
7	7.940684	17.56891	19.97766	62.45343
8	8.076188	19.66071	19.95358	60.38571
9	8.174526	21.06844	19.97802	58.95353
10	8.239790	21.89072	20.07472	58.03456

Extracted from E-Views 7.

The tables indicate that standard errors (SE) rose steadily to period 10, plausibly resembling the uncertainty effects over time. Of note is that own series shock explained most of the error variance, even though the shock will also impact the other variables in the model. The VDC analysis showed that there was no variable which was entirely self-explained or exogenous, since variables failed to explain all (100%) their shocks or innovations at period 10. More precisely, and as indicated in period 10 across all tables, the forecast error variance for health, education, and economic growth rate were 86.66%, 97.78%, and 58.03% respectively.

Table 1 indicates that over time, education (DTERT) gradually affected more of health (LE00). Interestingly, at period 1, health was entirely exogenous, as it was totally explained by its own innovations. More precisely, 13.1% of LE00 forecast error variance in a ten-year period was explained by disturbances in education. Thus, the variation in health can be explained by past education level in the long-run, while the slightest part (0.23%) of these variations are related to the economic growth rate.

This confirms other causality results, which indicated that education Granger causes health. Table 2 shows that less than 3% of shocks in education (DTERT) were attributed to health (LE00) and economic growth rate (GDPG) shocks throughout the period. Therefore, the predominant source of variation in education is education (DTERT) itself, thereby confirming that neither health nor economic growth rate cause education. From Table 3, deviations in economic growth rate were as a result of health (LE00) variations, with the health effect on economic growth significantly increasing over time. This attests to the fact that health causes economic growth. Specifically, at period 10, 21.89% of past health levels explained the variation in economic growth rate and 58.03% of past economic growth rates explained the same variation, while 20.07% of past education levels explained the variation in economic growth rate. This means that education shocks play a more significant role in explaining long-run economic growth rate, although health shocks account for about one-quintile.

5.2.2. Impulse Response Function (IRF)

The figure below indicates the results of the IRF.

In general, the IRF analysis complemented the Granger causality test results by signifying the dynamic effects of a shock both on itself and other variables. The system of equations was stable if any shock declined to zero; otherwise it was unstable if it produced an explosive time path. Figure 1 shows the IRFs for education (DTERT), health (LE00), and economic growth rate (GDPG), which are the responses of the three variables to each shock over a ten-year horizon. The following policy recommendations were drawn from the discussed results.

6. Policy Recommendations

The education–health one-way causal interaction is very much significant for policy formulation in Zimbabwe. This is because one may question why, despite Granger causality effects showing education causally affects growth, Zimbabwe is still characterized by poor population health, while it boasts of highly educated people. An immediate response would be because education alone cannot entirely improve population health. For instance, Zimbabweans may be highly educated, which implies being more health-conscious and aware of the significance of investing in quality health services, but may be limited in doing so because of unemployment and low per capita incomes.

Although education was observed to be important for health on one hand, health was also observed to be fairly important for economic growth on the other hand. Thus, the policy implication stemming from the causal interaction is that it is worthwhile for Zimbabwean policy makers to invest in education in order to improve the health of the population, which in turn is considered to be growth-enhancing. The causal effect of education on health would call for education to the extent that externalities exist. Thus, the paper advocates for an 'Education-for-Health' policy, which is anchored on the notion that highly educated people may create positive externalities economy-wide. This will provide a healthy life and better awareness to the people of Zimbabwe, which is envisaged to improve workers' quality of life and consequently their productivity. On the other hand, the Granger causality effects of health on economic growth suggest that policy makers should consider expenditure on health as an investment as opposed to a cost. In this regard, the Zimbabwean government is encouraged to align its expenditures with the Abuja (2001) declaration, which advocates for an allocation of at least 15% of the total budget to the health sector. Given the generally accepted stylized fact that health is a component of human capital, increasing it should, in turn, enhance worker productivity, which would then lead to greater output per worker and, ultimately, enhanced economic growth. In this sense, it is reasonable to argue that education and health policies do not have an effect within their own domain, but rather in a complementary way. These policies should not be looked upon in isolation, but rather in a more comprehensive and integrated way.

7. Conclusions

The major objective of the study was to establish the existence of a joint (trivariate) causation tendency among education, health, and economic growth in Zimbabwe. This was achieved using an unrestricted VAR framework, since unit root tests nullified the possibility of cointegration, and consequently a VECM was deemed inappropriate. More importantly, no specific theory could be attributed to addressing causal links among the three variables. As argued earlier, economic theory is mainly one-faceted in analyzing the human capital–growth nexus, devoting little or no attention to possible causal interlinks. Thus, the VAR/VECM methodological framework was considered suitable, since it requires no a priori theoretical specifications.

Empirical results indicated that education Granger causes health, while health Granger causes economic growth. However, no feedback effect running from health to education or from economic growth to health was observed. The results clearly refute a joint causation among education, health, and economic growth in Zimbabwe. Importantly, the VDC and IRF analyses supported the Granger causality results. These findings are significant because they indicate that none of the concerned variables are purely exogenous, although the degree of endogeneity varied depending on the variable.

An important conclusion drawn from the results is that the effect of education on economic growth is not direct, but works through health. What the results suggest is that better health in the form of higher life expectancy, enabled by better education, may lead to adults participating more extensively in the labor market, allowing them to obtain higher per capita incomes. Since the combined results found no support of a joint causality among education, health, and economic growth, an important conclusion stemming from the Granger causality tests and VAR analysis is that there is an interaction effect of education on health that is significant for economic growth.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/12/4/1357/s1, Table S1: Descriptive Statistics, Table S2: Stationarity test results, Table S3: Lag Selection Criterion, Table S4: Granger Causality test results, Table S5: VAR model results, Table S6: Variance Decomposition, Figure S1: Impulse Response Function.

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References

1. Dănăcică, D.-E.; Belaşcu, L.; Ilie, L. The Interactive Causality between Higher Education and Economic Growth in Romania. *Int. Rev. Bus. Res. Pap.* **2010**, *6*, 491–500.
2. Omojimite, B.U. Education and Economic Growth in Nigeria: A Granger Causality Analysis. *Afr. Res. Rev. Int. Multi-Discip. J. Ethiop.* **2010**, *4*, 90–108. [CrossRef]
3. Babalola, S.J. Long-Run Relationship between Education and Economic Growth: Evidence from Nigeria. *Int. J. Humanit. Soc. Sci.* **2011**, *123–128*.
4. Ray, S.; Pal, M.K.; Ray, I.A. Assessing Causal Relationship between Education and Economic Growth in India. *Vidyasagar Univ. J. Econ.* **2011**, *12*, 47–61.
5. Zivengwa, T.; Hazvina, F.; Ndedzu, D.; Mavesere, I.M. Investigating the Causal Relationship between Education and Economic Growth in Zimbabwe. *Asian J. Humanit. Soc. Sci.* **2013**, *1*, 399–410. Available online: https://www.ajouronline.com/index.php/AJHSS/article/view/535/392 (accessed on 20 August 2019).
6. Uche, E.; Ihugba, O.A.; Nwosu, C. Causal Relationship between Nigeria Budget Allocation to the Education Sectorand Economic Growth. *Discourse J. Educ. Res.* **2013**, *1*, 54–64. Available online: https://pdfs.semanticscholar.org/6b2a/6560ab8ba11a979275748fc92d0d51691b2e.pdf (accessed on 20 August 2019).

7. Pegkas, P. The Link between Educational Levels and Economic Growth: A Neoclassical Approach for the Case of Greece. *Int. J. Appl. Econ.* **2014**, *11*, 38–54.
8. Rashid, Y. A Note on Education-Led Economic Growth Hypothesis in Pakistan. *World Appl. Sci. J.* **2014**, *32*, 2291–2296.
9. Babatunde, M.A.; Adefabi, R.A. Long run relationship between Education and Economic Growth in Nigeria: Evidence from the Johansen Cointegration Approach. In Proceedings of the Regional Conference on Education in West Africa, Dakar, Senegal, 1–2 November 2005.
10. Mehrara, M.; Musai, M. Granger Causality between Health and Economic Growth in Oil Exporting Countries. *Interdiscip. J. Res. Bus.* **2011**, *1*, 103–108.
11. Tekabe, L.F. Health and Long Run Economic Growth in Selected Low Income Countries of Africa, South of the Sahara: Cross Country Data Analysis. Unpublished. Master's Thesis, Department of Social Sciences, Södertörns University, Huddinge, Sweden, 2013. Available online: http://www.diva-portal.org/smash/get/diva2:579350/FULLTEXT01.pdf?cv=1 (accessed on 15 November 2019).
12. Onisanwa, I.D. The impact of Health on Economic Growth in Nigeria. *J. Econ. Sustain. Dev.* **2014**, *5*, 159–166.
13. Bloom, D.; Canning, D. *Population Health and Economic Growth*; Commission Cambridge: Washington, DC, USA, 2008; pp. 287–311.
14. Vogl, T.S. *Education and Health in Developing Economies*; Princeton University and NBER: Princeton, NJ, USA, 2012; Available online: https://rpds.princeton.edu/sites/rpds/files/media/vogl_ed_health_review.pdf (accessed on 29 October 2019).
15. Eide, E.R. Showalter. Estimating the relation between Health and Education: What do we know and what do we need to know. *Econ. Educ. Rev.* **2011**. [CrossRef]
16. Grossman, M. On the Concept of Health Capital and Demand for Health. *J. Politi-Econ.* **1972**, *80*, 223–255. [CrossRef]
17. Ogundari, K.; Awokuse, T. Human capital contribution to economic growth in Sub-Saharan Africa: Does health status matter more than education? *Econ. Anal. Policy* **2018**, *58*, 131–140. [CrossRef]
18. Zivengwa, T. Investigating the Causal Relationship between Education and Economic Growth in Zimbabwe. *Glob. J. Manag. Bus. Res.* **2006**, *12*, 1–13.
19. Sen, H.; Kaya, A.; Alpaslan, B. *Education, Health and Economic Growth Nexus: A Bootstrap Panel Granger Causality Analysis for Developing Countries*; Economics Discussion Paper Series EDP-1502; The University of Manchester: Manchester, UK, 2015. [CrossRef]
20. Poças, A. *The Interrelations between Health, Human Capital and Economic Growth: Empirical Evidence from the OECD Countries and Portugal*; FEUC: Coimbra, Portugal, 2012.
21. Eggoh, J.; Houeninvo, H.; Sosson, G.-L. Education, Health and Economic Growth in African Countries. *J. Econ. Dev.* **2015**, 40. [CrossRef]
22. Gujarati. *Basic Econometrics*, 4th ed.; The McGraw-Hill Coys: Singapore, 2004.
23. Makochekanwa, A. *The Impact of Education Policy on Health in Zimbabwe: Policy Brief*; AERC: Gaborone, Botswana, 2012.
24. World Bank. *World Bank Development Indicators*; World Bank: Washington, DC, USA, 2015.
25. World Bank. *World Development Report; Investing in Health*; World Bank: Washington, DC, USA, 2015.
26. ZIMSTAT. *Zimbabwe Macroeconomic Indicators*; ZIMSTAT: Harare, Zimbabwe, 2015.
27. Finance, M.O. *Zimbabwe Report: From Stagnation to Economic Recovery*; Fidelity Printers: Harare, Zimbabwe, 2010.
28. UNICEF. *Political Economy of Zimbabwe*; UNICEF: Harare, Zimbabwe, 2015.
29. UNICEF. *Multiple Indicator Monitoring Survey (MIMS)*; UNICEF: Harare, Zimbabwe, 2009.
30. Solow, R. A Contribution to The Theory of Economic Growth. *Q. J. Econ.* **1956**, *70*, 65–94. [CrossRef]
31. Swan, T.W. ECONOMIC GROWTH and CAPITAL ACCUMULATION. *Econ. Rec.* **1956**, *32*, 334–361. [CrossRef]
32. Mankiw, G.; Romer, D.; Weil, D. A Contribution on the Empirics of Economic Growth. *Q. J. Econ.* **1992**, *107*, 407–437. [CrossRef]
33. Romer, D. Increasing Returns and Long Run Economic Growth. *J. Political Econ.* **1986**, *94*, 1002–1037. [CrossRef]

34. Lucas, R.E. On the mechanics of economic development. *J. Monetary Econ.* **1988**, *22*, 3–42. [CrossRef]
35. Ram, R. Intelligent Quotient (IQ) and Economic Growth: Further Augmentation of MRW model. *Econ. Lett.* **2007**, *94*, 7–11. [CrossRef]
36. Nelson, R.; Phelps, E. Investments in Humans, Technological Diffusion and Development and Growth. *Am. Econ. Rev.* **1996**, *56*, 69–75.
37. Aka, B.F.; Dummont, J.C. Health, Education and Economic Growth: Testing for Long Run Relationships and Causal Links. *Appl. Econom. Int. Dev.* **2008**, *8*, 101–110.
38. Badir, S. Healthcare Expenditure and Economic Growth in Developing Countries. *Adv. Econ. Bus.* **2016**, *4*, 76–86. [CrossRef]
39. Bloom, D.E.; Canning, D.; Kotschy, R.; Prettner, K.; Schúnermann, J.J. *Health and Economic Growth: Reconciling the Micro and Macro Evidence*; National Bureau of Economic Research Working Paper No. 26003; NBER: Cambridge, MA, USA, 2019. [CrossRef]
40. Schultz, T. Investments in human capital. *Am. Econ. Rev.* **1961**, *5*, 1–17.
41. Barro, J. Health and Economic Growth. *Ann. Econ. Financ.* **2013**, *14*, 305–342.
42. Basaki, K.; Alkumru, H.; De Souza, G.; Finer, Y. Accuracy of Digital vs Conventional Implant Impression Approach: A Three-Dimensional Comparative In Vitro Analysis. *Int. J. Oral Maxillofac. Implant.* **2017**, *32*, 792–799. [CrossRef]
43. Romer, P. Endogenous Technological Change. *J. Political Econ.* **1990**, *98*, S71–S102. [CrossRef]
44. Poças, A.; Soukiazis, E. Explaining the Interrelations between Health Education and Standards of Living in Portugal: A Simultaneous Equation Approach. *Int. J. Public Policy* **2012**, *9*. [CrossRef]
45. Aslan, A.; Menegali, A.N.; Tugcu, C.T. Health and Economic Growth in high income countries revisited: Evidence from an augmented production function for the period 1980–2009. *Qual. Quant.* **2016**, *50*, 937–953. [CrossRef]
46. Cremonini, L.; Taylor, J. Branding by Proxy? How Hubs Market (or not) Higher Education Systems Globally: The Example of Qatar. In *Competition in Higher Education Branding and Marketing*; Papadimitriou, A., Ed.; Palgrave Macmillan: Cham, Switzerland, 2018.
47. Rahman, M. Causal Relationship among Education Expenditure, Health Expenditure and GDP: A Case Study for Bangladesh. *Int. J. Econ. Financ.* **2011**, *3*. [CrossRef]
48. Khalim, R.; Hassan, M.S. The Triangular Causality among Education, Health and Economic Growth: A Time Series Analysis of Pakistan. *World Appl. Sci. J.* **2012**, *8*, 196–207.
49. Afzal, M.; Arshed, M.G.; Sarwar, K. Education, Health, Food Inflation and Economic Growth in Pakistan. *Pak. Econ. Soc. Rev.* **2013**, *51*, 109–138.
50. Bandara, A.; Dehejia, R.; Lavie_Rouse, S. The Nexus between Human Development and Economic Growth. *Econ. Soc. Res. Found.* **2014**. Discussion Paper 58. Available online: http://www.thdr.or.tz/docs/THDR-BP-4.pdf (accessed on 15 September 2019).
51. Mushkin, S. Health as an Investment. *J. Political Econ.* **1962**, *70*, 129–157. [CrossRef]
52. Granger, C. Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Econometrica* **1969**, *37*, 424–438. [CrossRef]
53. Granger, C.W. Developments in the study of Cointegrated Economic Variables. *Oxf. Bull. Econ. Stat.* **1986**, *48*, 213–228. [CrossRef]
54. Sims. Money, Income and Causality. *Econ. Rev.* **1972**, *62*, 540–552.
55. Stock, J.H.; Watson, M.W. Vector Autoregressions. *J. Econ. Perspect.* **2001**, *15*, 101–115. [CrossRef]
56. Tin-Chun, L. Education, Technical progress, and Economic Growth: The Case of Taiwan. *Econ. Educ. Rev.* **2003**, *22*, 213–220.
57. Tin-Chun, L. The role of Higher Education in Economic Development: An Empirical Study of Taiwan Case. *J. Asian Econ.* **2004**, *15*, 355–371.
58. Lin, T.-C. Alternative Measure for Education Variable in an Empirical Economic Growth Model: Is Primary Education Less Important? *Econ. Bull.* **2006**, *15*, 1–6.
59. Ware, J.K. Property Value as a Proxy of Socioeconomic status in Education. *Educ. Urban Soc.* **2017**. [CrossRef]
60. Wittrock, J.; Kimmel, L.; Hunscher BTrung Le, K. Proxy reporting in education surveys: Factors influencing accurate reporting in the 2012 Qatar Education Survey. *Int. J. Soc. Res. Methodol.* **2017**, *20*, 737–748. [CrossRef]

61. Blanchard, O.J. A Traditional Interpretation of Macroeconomic Fluctuations. *Am. Econ. Rev.* **1989**, *79*, 1146–1164.

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Sustainable Financial Education and Consumer Life Satisfaction

Fuzhong Chen [1,*], Jingxin Lu [1], Jiaying Li [2], Wenting Wang [3,*] and Horlane Bissielou [1]

1 School of International Trade and Economics, University of International Business and Economics, Beijing 100029, China; lujingxin2016@163.com (J.L.); horlane@aliyun.com (H.B.)
2 Department of Sociology, Tsinghua University, Beijing 100084, China; jacquelineljy@126.com
3 Institute of Mathematics, Department of Big Data and Internet, Shenzhen Technology University, Shenzhen 518118, China
* Correspondence: uibesitechen@uibe.edu.cn (F.C.); wangwenting@sztu.edu.cn (W.W.)

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Abstract: Sustainable financial education is defined as the continuous input of money and time on financial knowledge education after formal schooling. The purpose of this paper is to examine the impact of sustainable financial education on consumer life satisfaction. Utilizing the dataset of Household Consumer Finance of Chinese Urban Residents in 2012 by the China Financial Research Center of Tsinghua University, the variable of sustainable financial education is constructed through the variables of the necessity of financial education, the money spent on financial education, and the time spent on financial education. To improve the estimation results, order probit regression is utilized. The results indicate that financial education is significantly positive to consumer life satisfaction only for a consumer with higher education. Consumers who regard financial education to be of high necessity will feel more satisfied. The results also show that consumers who spend more money and time on financial education after formal schooling will be more satisfied. Moreover, the sustainable impacts of financial education on consumer life satisfaction are verified. In addition, this study provides empirical evidence that suggests that sustainable financial education positively contributes to consumer life satisfaction. The results have implications for policymakers to take measures in enhancing sustainable financial education to improve consumer life satisfaction.

Keywords: sustainable financial education; consumer life satisfaction; the necessity of financial education; ordered probit regression

1. Introduction

In recent decades, consumer financial education has drawn the attention of consumer financial researchers, policymakers, and practitioners [1–4]. Consumer financial education is related to forms of education in terms of basic financial knowledge for consumers in academic institutions and workplaces. Improving the degree of consumer financial literacy and their degree of financial capability through sustainable financial education is believed to play a significant role in enhancing consumer life satisfaction [5,6].

Life satisfaction is defined as a comprehensive psychological indicator that measures the quality of life of a person [7]. It can be divided into two kinds, namely, general life satisfaction and special life satisfaction [8]. General life satisfaction refers to the subjective evaluation that sets the standards for one's quality of life. Special life satisfaction refers to the specific evaluation that is based on different areas of life, such as family satisfaction, health satisfaction, job satisfaction, school satisfaction, community satisfaction, or consumer satisfaction. According to its definition and classification, special life satisfaction is more specific than general life satisfaction. This study differs from previous research

in that it focuses on the roles of sustainable financial education in a special domain of consumer life satisfaction.

As one aspect of consumer subjective wellbeing, consumer life satisfaction refers to a subjective state in which consumers allocate economic resources to live a desirable life [9]. Subjective wellbeing incorporates positive emotions, negative emotions, and life satisfaction, and is defined as a broad category of phenomena that includes people's emotional responses, domain satisfaction, and global judgments of life satisfaction [10]. Moreover, Malhotra [11] suggested that consumer life satisfaction is related to the consumers' subjective evaluation regarding their quality of life based on set criteria and is used to measure important parameters of a society's life. Although consumer life satisfaction is a specific domain of life satisfaction, it is usually interchangeable with consumer happiness or subjective wellbeing [12]. Hence, consumer life satisfaction is the content of the study of consumer subjective wellbeing and an important cognitive component of consumer subjective wellbeing. Consumer life satisfaction is also considered to be an important part of positive psychology [13], as well as a cognitive and judgmental sense of wellbeing based on personal expectations of how one's life matches certain internal standards [14]. Hence, consumer life satisfaction is a comprehensive judgment of consumers' daily life. As a cognitive factor, it affects consumers' emotional experiences, thereby affecting the orientation of consumer life goals and the orientation of behavioral pursuits, which will have an important impact on most consumers and even the society. In this study, consumer life satisfaction was measured by consumers' responses to their overall subjective evaluation of their current living situation, which incorporated the consumers' cognitive, judgmental, and emotional sense of subjective wellbeing.

Consumer financial education is defined as the basic financial knowledge education for consumers in high schools, universities, and workplaces [15]. In the United States, policymakers improve and strengthen consumer financial capabilities through education on basic financial knowledge. A survey from the undergraduates at an Australian university showed that financial education led to a positive increase in objective and subjective financial literacy, which improved personal financial decision-making [16]. In general, financial education can be divided into professional financial education and public financial education [17]. Professional financial education refers to the financial knowledge found in professional education for college students and other groups by the methods of teaching. Public financial education refers to education for all citizens about the common sense of financial knowledge and financial science. Public financial education has a wide range of content, mainly including educating citizens to correctly use financial knowledge, choosing a reasonable way for managing their money, effectively avoiding financial risk, and improving their financial awareness and financial literacy. In this study, financial education refers to consumers' professional knowledge from academic education as well as common knowledge and sense from public training and workplace education. With the emergence of more financial products, consumers make their financial decisions increasingly through financial knowledge. However, Wagner and Walstad [18] argued that financial education appeared to have more positive and stronger effects on long-term behaviors with less timely feedback, and the benefits of financial education may differ based on the time horizon for the financial behaviors. Hence, sustainable financial education is of significance for improving consumers' financial literacy and capability, which should end in good financial decision-making. Unlike prior research, this study focuses on the impact of the sustainability of financial education on consumer life satisfaction.

Previous studies primarily focused on the relationship between financial education and workplace satisfaction [19], job satisfaction [20], and financial satisfaction [21]. This paper further studies the impact of sustainable financial education on consumer life satisfaction. To the best of our knowledge, there is no study that focuses on the definition of sustainable financial education and its impact on consumer life satisfaction. In terms of the comprehensive definition developed by Moore et al. [22], sustainability is considered as follows: (1) after a defined period of time, (2) a program and/or implementation strategies continue to be delivered and (3) individual behavior change is maintained; (4) the program and individual behavior change may evolve or adapt while (5) continuing to produce benefits for individuals. To be more specific, in this study, sustainable financial education is defined as

after a period of time of learning financial knowledge, consumers improve their financial knowledge and behaviors, and are available to make rational financial decisions, which positively contributes to life satisfaction. It is practically significant for policymakers and consumers to investigate the impact of sustainable financial education on consumer life satisfaction. This study contributes to encouraging policymakers to formulate policies to strengthen the guidance and promotion of financial education, as well as promote financial intermediaries and practitioners to actively improve the level of consumer financial education and further enhance consumer life satisfaction.

The purpose of this study is to examine the impact of sustainable financial education on consumer life satisfaction. The remainder of this paper is structured as follows. Section 2 reviews the literature about financial education and consumer life satisfaction, and then presents the hypotheses with regard to the impact of sustainable financial education on consumer life satisfaction. Section 3 describes the sample data, model specification, variable measurements, and statistical descriptions of this study. Section 4 presents the empirical results. Section 5 offers the conclusions and implications.

2. Previous Research and Hypothesis

2.1. Previous Research on Consumer Life Satisfaction

Life satisfaction is a subjective and comprehensive evaluation index that is influenced by various factors. As early as the 1990s, Diener [23] discussed the factors influencing the life satisfaction of American residents from four aspects, including one's family relationships, entertainment, social life, and health status by self-evaluation. These factors have been divided into three categories: personal characteristics, microeconomic variables, and macroeconomic variables. In detail, the personal characteristics include sex, race, age, health, marital status, education level, personality, and interpersonal relationships. Microeconomic variables include income, employment status, and so on. Macroeconomic variables include the state of one's employment situation, inflation, social support, political system, and political identity. For cross-country level research, scholars investigated the determinants of life satisfaction from political, economic, institutional, and human development and cultural aspects [24].

More specifically, scholars have paid more attention to examine the influence factors of life satisfaction. Fu et al. [25] analyzed gender differences in life satisfaction in Taiwan and Australia and suggested that the life satisfaction of women in both countries was higher than that in men. Age and health status are also considered as important indicators of people's life satisfaction. Utilizing data from 1033 farmers in three areas of Beijing, Liaoning, and Hebei and an ordered logic model, Li et al. [26] suggested that age and health status had a significant positive impact on life satisfaction. They indicated that the positive correlation between age and life satisfaction can be explained by the expectation theory. The older people had experienced the development of China's reforms and opening-up to the world for more than thirty years and had a more profound experience of life change, so their life satisfaction was higher. Meanwhile, Li et al. also indicated that the healthier the residents, the higher the life satisfaction they would have.

Income situation is one of the most important factors affecting consumer life satisfaction in microeconomic variables. Vita et al. [27] compared the various household groups by testing the influence of socio-economic variables that were typically associated with consumer life satisfaction and suggested that the positive influence of income was verified. In general, income is positively correlated with consumer life satisfaction. Employment brings consumers not only an increase in income but also an improvement in their life satisfaction. Through an analysis of data from 94 countries, Stanca [28] suggested that in some wealthier and highly employed countries, unemployment had a greater negative impact on people's life satisfaction. Furthermore, after controlling for individual-specific fixed effects, previous studies indicated that unemployment has a large and negative effect on life satisfaction by creating non-pecuniary and psychological costs [29].

The two main goals of contemporary macroeconomic regulation and control are to increase employment and stabilize prices. Therefore, unemployment and inflation are negatively related to

consumer life satisfaction. Utilizing a Latin American dataset on life satisfaction, Ruprah and Luengas [30] found that the unemployment rate and inflation would reduce consumer life satisfaction. In addition, using data for 2001 to 2011, Abounoori et al. [31] investigated the impact of the unemployment rate and inflation on life satisfaction of European Union countries and Iran, and they concluded that the unemployment rate and inflation had a significant negative impact on life satisfaction, and the negative effect from unemployment was much higher than that of inflation. Therefore, in order to increase consumer life satisfaction, increasing employment is the preferred policy. In addition to the above two macroeconomic variables, social support, the political system, and political identity will affect consumer life satisfaction as well.

2.2. Previous Research on Financial Education

In recent decades, consumer financial education has been increasingly highlighted in the United States, and it has gradually developed globally as well. Policymakers consider financial education as a necessary solution to the increasingly complex financial decisions of consumers. In addition, financial education has a significant impact on the research of financial decision making [32]. Financial education enables consumers to learn financial knowledge and improve their financial literacy. With the continuous deepening of finance knowledge needed and the quantity of financial products continuing to increase, the financial market continues to present a trend of greater complexity, which puts forward higher requirements on consumers' financial knowledge. However, there is evidence that consumers lack this financial knowledge [33,34], and this often leads them to make mistakes in substantial financial decision-making. Prior studies have also suggested that even those with higher education may be as ignorant as those with lower education in financial knowledge [35,36]. Therefore, it is particularly important for consumers to strengthen financial education. Hastings and Mitchell [37] argued that consumers having trouble with financial decisions were specific to various cohorts; for instance, although the improvement in financial literacy through financial education was significantly correlated with wealth, it appeared to be a weaker predictor of sensitivity to framing in investment decisions. In addition, these financial education courses, which are related to financial knowledge, have a long-term positive effect on consumers [38]. Thus, sustainable financial education in the long-term is of significance in improving consumer life satisfaction.

Financial education positively contributes to increasing and improving consumer participation in the financial market and then enables consumers to choose financial assets rationally. With the development of the financial market, consumers are increasingly active in the financial market, and the field of consumer finance has been significantly focused on this [39]. Yin et al. [40], by using the dataset of the Chinese Household Finance Survey (CHFS), found that the promotion of financial knowledge would promote consumer participation in the financial market. Chen et al. [41] suggested that consumers with a higher education tend to participate in the financial market and are thereby more satisfied. With an increase in investment experience, the probability of consumer investments in risky assets also improves. More specifically, using the family survey data from the Central Bank of Holland, Rooij et al. [42] indicated that many family members have low financial knowledge. In particular, the lack of financial knowledge will restrict the participation of these families in the stock market, and the proportion of asset selection will be reduced accordingly.

Financial education is positive in promoting the stability of the market and further promoting the healthy development of national finances. By improving consumers' financial knowledge and then improving their financial literacy, financial education positively contributes to eliminate uncertainties and risks, and thereby to decrease consumer losses when investing in risky financial assets [43]. From the world financial crisis in 2008 and the turbulence of China's stock market in 2015, it is shown that most consumers do not invest rationally, so the coming of the financial crisis has brought serious shock to these consumers [44]. At the same time, the outbreak of the financial crisis also caused stock market unrest, leading to the paralysis of the national financial system. Prior studies have suggested that the improvement of the level of financial education for the residents of a country or region is

positive in enlarging the demand for complex financial products by local residents [45]. The experience of this kind of demand further promotes the country's continuous development of financial products, and thus promotes the positive development of national finance.

2.3. The Impact of Sustainable Financial Education and Consumer Life Satisfaction

Most previous studies have suggested that financial education is positive in increasing consumers' financial knowledge and financial literacy, cultivating consumers' sense of rational investment, and improving their life satisfaction [46–48]. There is evidence that higher requirements of financial education contribute to increase individuals' financial knowledge, and thereby, are positively associated with fewer defaults and higher credit scores among young adults [46]. It can also promote the stability of the market, and thus promote the healthy development of the national financial picture. In addition, financial education enables consumers to learn about financial knowledge and improve financial literacy, and thus to raise consumer life satisfaction. Hira and Loibl [47] examined the relationship between financial education and consumer life satisfaction in the workplace by analyzing the sample survey data of employees in the national insurance company, and the result revealed that employees who participated in financial education are more likely to have a high level of financial literacy. In addition, they also suggested that employees with financial education are more confident about future financial conditions, and therefore have higher job satisfaction and life satisfaction. In addition, Chin and Williams [48] examined the impact of online financial education on consumers' financial decisions, and the results showed that older participants and first-time home buyers are more likely to look up home-buying and mortgage education websites when framing financial decisions. Thus, financial education in the long-term is of importance in consumers' daily financial decisions, which are closely associated with their life satisfaction.

In this study, sustainable financial education is defined as after a period of time of learning financial knowledge, incorporating formal education in high school or university and informal education in workplaces, communities, and training programs organized by government sectors and financial institutions. In this way, consumers improve their financial knowledge and behaviors and are able to conduct desirable financial behaviors and thereby make rational financial decisions. More specifically, this study constructs two types of variables, subjective and objective, to measure sustainable financial education. The subjective measure is specific to consumers' overall evaluation about the necessity of financial education. Moreover, the objective measure is the resource input in financial education, such as time and money. Using the sampling data of survivors of domestic violence, Postmus et al. [49] indicated that survivors of domestic violence improved their personal financial management skills through training courses of financial education, and ultimately, improved their own life satisfaction. There is also evidence that some social workers had their living costs increased due to the global recession, and their real incomes had declined [50]. However, because of a lack of financial knowledge, these social workers found it difficult to make reasonable investment decisions and plan their own funds, and hence their life satisfaction decreased as well. Focusing on the disagreement regarding the effectiveness of financial education programs, Lusardi et al. [51] investigated how financial education programs optimally shape key economic outcomes and showed that the more effective programs provided a follow-up in order to sustain the knowledge acquired by employees via the program. In such an instance, financial education delivered to employees around the age of 40 can raise savings at retirement by close to 10%, while one-time education programs produced short-term and only a few long-term effects on life satisfaction. Hence, sustainable financial education is important and positive for improving consumer life satisfaction in the long-term. According to Peeters et al. [52], prior knowledge and intended behavior, namely, having accepted financial education and considering the necessity of financial education in this study, had positive effects on sustaining financial knowledge. In addition to the subjective measure of sustainable financial education, this paper proposes the two following hypotheses:

Hypothesis 1 (H1). *Given economic resources and other control variables, consumers who have accepted financial education have a higher life satisfaction.*

Hypothesis 2 (H2). *Given economic resources and other control variables, consumers who think it is more necessary to receive financial education will be more satisfied.*

Xiao and Porto [53] explored the direct or indirect effects of financial education on consumers' financial satisfaction by using the data of the National Financial Capacity Study (NFCS) in 2012, and the indirect effects were mediated by financial literacy, financial behavior, and financial capabilities. The results showed that financial education may indirectly affect consumers' financial satisfaction through financial knowledge, financial behavior, and financial capacity. Therefore, policymakers are encouraged to initiate and establish some effective financial education programs to improve consumer life satisfaction. Atkinson et al. [54] also indicated that financial education can improve the level of consumer financial literacy and encourage consumers to conduct rational financial behavior, thereby improving consumers' financial ability and improving their life satisfaction. It is evident that the changes in financial behaviors require a period of time, and programs involving financial education may cause an increase in training costs [52]. From the objective perspectives of measuring sustainable financial education, this implies that the higher the financial education level of consumers, the more money and time they spend on sustainable financial education after their formal schooling is complete, and the higher their life satisfaction is. Thus, we put forward the following hypotheses:

Hypothesis 3 (H3). *Given economic resources and other control variables, money and time input in financial education after formal schooling positively contributes to consumer life satisfaction.*

Hypothesis 4 (H4). *Given economic resources and other control variables, sustainable financial education is positively associated with consumer life satisfaction.*

3. Methodology

3.1. Data

The dataset in this study is from the survey data of Household Consumer Finance in China's Urban Residents in 2012. Because the survey has no updated dataset, only cross-sectional data from 2012 is used in this study, which was published by the Center of China Financial Research of Tsinghua University. The sample is distributed in 24 cities across China. The cities are Anqing, Baiyin, Baotou, Beijing, Guangzhou, Guilin, Haikou, Jilin, Jinan, Kunming, Luoyang, Nanchang, Panzhihua, Quanzhou, Shanghai, Shenyang, Shuozhou, Urumqi, Wuhan, Xi'an, Xuzhou, Yichun, Chongqing, and Zhuzhou. The cities in this study are from 24 provinces, respectively, that cover more than 75% of provinces all over China. Hence, the dataset can be considered to be nationally representative. The respondents were all over the age of 25. The survey involved family assets and liabilities, income and expenditure, financial planning, financial education, and so on. In order to avoid systematic errors caused by the inconsistency among questionnaires among household members, this study primarily utilizes the survey data of each household head. Therefore, the sample size is 3122. The dataset incorporates the basic information of the household members, the situation of the respondents' financial education, and their subjective attitudes.

3.2. Model Specification and Variables

This study primarily investigates the impact of sustainable financial education (*susfin_edu*) on consumer life satisfaction (*lifeSat*). Based on our hypotheses, the basic regression model is specified as follows:

$$lifesat_i = \alpha_0 + \sum_{j=1}^{N} \phi_j * susfin\_edu_{j,i} + \sum_{k=1}^{M} \varphi_k * cv_{k,i} + \varepsilon_i \quad (1)$$

In Equation (1), the subscript i of the variables represents sampling consumer individual, the superscript N stands for the numbers of sustainable financial education-related variables, and the superscript M is the number of control variables. In addition, ε represents the random disturbance term.

In detail, $lifesat$ indicates consumer life satisfaction and $susfin\_edu_j$ represents the related variables of sustainable financial education with the subscript j. For instance, sustainable financial education-related variables incorporate whether considering that financial education is necessary or not (*the necessity of financial education*), money and time spent on financial education after formal schooling (*the money spent on financial education* and *the time spent on financial education*) (see Table 1). In addition, whether household members have ever accepted financial education (*having accepted financial education*) is introduced as well. More specifically, cv_k denotes the control variable k. In this study, control variables incorporate age, gender (two categories: female vs. male), marital status (two categories: married and not married), education (three categories: high school or lower, undergraduate and some college, and master degree or higher), household size, health status of household members (1—not at all healthy, 4—very healthy), having stationary income (1—not at all stationary, 10—extremely stationary), and work in government or general firms. To address the associations between household assets and life satisfaction, the three asset-holding behaviors include having a house, having a private business, and having a car.

Table 1. Variable specification.

Variable label	Attribute
Consumer life satisfaction	"Are you satisfied with your current life?" 1—not at all satisfied, 10—extremely satisfied
Having accepted financial education	"Have you or your spouse ever received financial education about professional knowledge in national education?" 1 = yes, 0 = no
The necessity of financial education	"Do you think it is necessary for your household to receive financial education?" 0 = no answer, 1 = not necessary, 2 = ordinary necessary, 3 = necessary, and 4 = extremely necessary
The money spent on financial education	"How much monthly income does your household spend on financial education?" 1 = no money input, 2 = less than 5%, 3 = 5%–10%, 4 = 10%–15%, and 5 = more than 15%
The time spent on financial education	"How much time do you spend on learning financial knowledge each week?" 1 = no time input, 2 = less than 1 h, 3 = 1 to 2 h, 4 = 2 to 3 h, 5 = 3 to 5 h, and 6 = more than 5 h
Sustainable financial education	A sum of the products of *Z*-scores of the necessity of financial education, the money spent on financial education, and the time spent on financial education with their specific variance contribution ratios, respectively
Age	The age of the respondents; all of the sampling respondents are older than 25 years
Gender	1 = male, 0 = female
Being Married	1 = married, 0 = not married
High school or lower	1 = yes, 0 = no
Undergraduate and some college	1 = yes, 0 = no
Master degree or higher	1 = yes, 0 = no
Household size	The population size of the household
Health status of household members	1—not at all healthy, 4—very healthy

Table 1. *Cont.*

Variable label	Attribute
Monthly income	1 = 1001 to 1500 Yuan, 2 = 1501 to 2000 Yuan, 3 = 2001 to 2500 Yuan, 4 = 2501 to 3000 Yuan, 5 = 3001 to 4000 Yuan, 6 = 4001 to 5000 Yuan, 7 = 5001 to 6000 Yuan, 8 = 6001 to 10,000 Yuan, 9 = 10,001 to 15,000 Yuan, 10 = 5,001 to 20,000 Yuan, 11 = 20,001 to 30,000 Yuan, 12 = 30,001 to 50,000 Yuan, and 13 = greater than 50,000 Yuan
Having stationary income	"If the stability of your household income has been divided into 10 levels, which level is identical to your family?" 1—not at all stationary, 10—extremely stationary
Having a house	1 = yes, 0 = no
Having a car	1 = yes, 0 = no
Having a private business	1 = yes, 0 = no
Work in government or general firms	1 = yes, 0 = no

Note: All of the binary variables are appropriately recoded specifically to the corresponding variables from the original dataset.

3.3. Estimation Method

According to the survey data, the variable of consumer life satisfaction (*lifesat*) is not a continuous variable, but an ordered discrete variable (ranging from 1—not at all satisfied to 10—extremely satisfied). If the traditional OLS method is utilized for regression estimation, there may be problems of robustness and accuracy. Therefore, in this study, the OLS regression method is conducted and then ordered probit regression is applied to improve the estimated results. Let $lifesat* = X'\beta + u$, and *lifesat** is anon-observable variable, $X' \in (susfin\_edu, cv)$ and $u \in (u_1, u_2, \cdots, u_n)$. Meanwhile, assume that the choices of consumer life satisfaction (*lifesat**) follow the following rules,

$$lifesat_i = \begin{cases} = 1, \ if \ lifesat_i^* < u_1 \\ = 2, \ if \ u_1 < lifesat_i^* < u_2 \\ = 3, \ if \ u_2 < lifesat_i^* < u_3 \\ \vdots \\ = Q, \ if \ lifesat_i^* > u_n \end{cases} \tag{2}$$

In Equation (2), $u_1 < u_2 < u_3 \cdots < u_n$ are parameters to be estimated, which are also considered as the cutoff points. In addition, Q is the quantity of the choices of consumer life satisfaction. Assume that u follows the probit distribution N (0, 1), thus

$$\begin{aligned} \Pr(lifesat_i = 0 \big| X) &= \Pr(lifesat_i^* \le u_1 \big| X) \\ &= \Pr(X'\beta + \varepsilon \le u_1 \big| X) \\ &= \Pr(\varepsilon \le u_1 - X'\beta) = \phi(u_1 - X'\beta) \end{aligned} \tag{3}$$

Furthermore,

$$\begin{aligned} \Pr(lifesat_i = 1 \big| X) &= \phi(u_2 - X'\beta) - \phi(u_1 - X'\beta) \\ \Pr(lifesat_i = 2 \big| X) &= \phi(u_3 - X'\beta) - \phi(u_2 - X'\beta) \\ &\vdots \\ \Pr(lifesat_i = n \big| X) &= 1 - \phi(u_{n-1} - X'\beta) \end{aligned} \tag{4}$$

Through ordered probit regression to improve the results of OLS regression, the probability distribution function of consumer life satisfaction is more identical to the characteristics of dependent variable data, which ensures the robustness and accuracy of the empirical results. In addition, the ordered probit regression is utilized to solve the likelihood function, and the MLE estimator can be obtained, which further improves the accuracy of the empirical results.

3.4. Statistical Description

Consumer life satisfaction is a subjective indicator that reflects a consumer's attitude with regard to overall life evaluation. Therefore, this study primarily employs the subjective answer of "Are you satisfied with your current life?" to measure a consumer's level of life satisfaction (1—10 points scale, 1—not at all satisfied, 10—extremely satisfied). In terms of the survey data, 8.46% of the consumers are very satisfied, 31.90% are at the 8 and 9 points of satisfaction, 41.90% are at the 5–7 degree of satisfaction, 15.63% are at the 2–4 degree of satisfaction, and 2.11% of the consumers are not at all satisfied.

Table 2 presents the results of the descriptive statistics. For the dependent variable, the mean score of consumer life satisfaction is 6.6297 out of 10, which implies a significantly high degree of subjective life evaluation. More than one-half of the sampling respondents have accepted financial education with a mean value of 0.5317. The mean value of the variable to measure consumer's attitude with regard to the necessity of financial education is 3.2434 out of 4, which indicates that most of the consumers consider financial education to be important. In addition, the mean values of the variables to measure money and time spent on financial education are 2.1935 out of 5 and 2.8786 out of 6, which also indicates a comparatively high input in financial education after formal schooling.

Table 2. Descriptive Statistics.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Consumer life satisfaction	3122	6.6297	2.1751	1	10
Having accepted financial education	3122	0.5317	0.4991	0	1
The necessity of financial education	3122	3.2434	0.7247	0	4
The money spent on financial education	3122	2.1935	0.8248	1	5
The time spent on financial education	3122	2.8786	1.1958	1	6
Sustainable financial education	3122	0.0000	0.6403	−2.8020	1.5609
Age	3122	34.2425	7.6305	25	78
Gender	3122	0.7104	0.4536	0	1
Being married	3122	0.8395	0.3671	0	1
High school or lower	3122	0.1230	0.3285	0	1
Undergraduate and some college	3122	0.7601	0.4271	0	1
Master degree or higher	3122	0.1169	0.3214	0	1
Household size	3122	3.1038	1.3059	1	15
Health status of household members	3122	3.6730	0.5129	1	4
Monthly income	3122	8.1720	2.2129	1	13
Having stationary income	3122	5.4151	2.6561	1	10
Having a house	3122	0.9052	0.2930	0	1
Having a car	3122	0.5676	0.4955	0	1
Having a private business	3122	0.3738	0.4839	0	1
Working in government or general firms	3122	0.8238	0.3810	0	1

Source: The results of descriptive statistics are from the 2012 Household Consumer Finance in China's Urban Residents.

Table 3 presents the results of the frequency and percentage of categorical and dummy variables. A total of 53.17% of the consumers have accepted financial education, and 71.04% of household heads are male. For marital status, more than 80% are married. In terms of education, only 12.30% are at the level of junior school or lower. For household assets, 90.52% have a house, 57.76% have a car, and 37.38% have a private business. Moreover, more than 80% work in the government sectors or in general firms, which indicates that most of the consumers have stable work.

Table 3. Frequency and percentage of categorical and dummy variables.

Categorical Variable	Frequency	Percentage (%)
Having accepted financial education		
Yes	1462	53.17
No	1660	46.83
Gender		
Male	2218	71.04
Female	904	28.96
Marital status		
Being married	2621	83.95
Not married	501	16.05
Education		
Junior school or lower	384	12.30
High school and some college	2373	76.01
Undergraduate and higher	365	11.69
Having a house		
Yes	2826	90.52
No	296	9.48
Having a car		
Yes	1772	57.76
No	1350	43.24
Having a private business		
Yes	1167	37.38
No	1955	62.62
Working in government or general firms		
Yes	2572	82.38
No	550	17.62

Note: Sample size = 3122.

4. Empirical Results

4.1. Results of Correlation Analysis

Table 4 reports the correlations among the variables of having accepted financial education, sustainable financial education-related variables, and consumer life satisfaction. Most correlations are as expected. Consumer life satisfaction is positively associated with having accepted financial education, and the correlated coefficient is 0.0648 at a significance level of 1%. For sustainable financial education-related variables, consumers who consider financial education to be necessary are significantly satisfied, and the money and time spent on financial education are significantly and positively correlated with consumer life satisfaction. More specifically, sustainable financial education is significantly positive to consumer life satisfaction, and the correlated coefficient is 0.1681 at a significance level of 1%. Since sustainable financial education is constructed through the variables of the necessity of financial education, the money spent on financial education, and the time spent on financial education, the correlated coefficients are high and significant. To avoid multi-collinearity, sustainable financial education is independently introduced in empirical estimation. In addition, the variables of the necessity of financial education, the money spent on financial education, and the time spent on financial education are positively correlated at the significance level of 1%.

Table 4. Correlations between sustainable financial education and consumer life satisfaction.

Variables	Consumer Life Satisfaction	Having Accepted Financial Education	The Necessity of Financial Education	The Money Spent on Financial Education	The Time Spent on Financial Education	Sustainable Financial Education
Consumer life satisfaction	1.0000					
Having accepted financial education	0.0648 ***	1.0000				
The necessity of financial education	0.0968 ***	0.1452 ***	1.0000			
The money spent on financial education	0.1859 ***	0.1571 ***	0.1415 ***	1.0000		
The time spent on financial education	0.1862 ***	0.1447 ***	0.2197 ***	0.5257 ***	1.0000	
Sustainable financial education	0.1681 ***	0.1936 ***	0.8938 ***	0.5685 ***	0.4543 ***	1.0000

Notes: Sample size = 3112. ***, ** and * denote statistical significance at 1%, 5%, and 10%, respectively.

4.2. Financial Education and Consumer Life Satisfaction

Table 5 presents the estimation results of the regressions of financial education on consumer life satisfaction. In Column (1), only the control variables are entered. In Columns (2) and (3), whether or not household members have ever accepted financial education (*having accepted financial education*) is incorporated. More specifically, Column (2) shows the results of OLS regression, and Column (3) presents the results of ordered probit regression. In Column (4), the items of education interacting with having accepted financial education are added. To eliminate the impacts of city and year heterogeneity on estimation results, the dummy variables of city and year are controlled in all of the estimations. In addition, to get more accurate and robust regression results, robust standard errors are reported in the parentheses.

Table 5. Results of regressions of financial education on consumer life satisfaction.

	(1)	(2)	(3)	(4)
Variable	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**
Having accepted financial education		0.0903 (0.0743)	0.0465 (0.0371)	
Undergraduate and some college × Having accepted financial education				0.0431 (0.0389)
Master degree or higher × Having accepted financial education				0.2381 *** (0.0695)
Gender	−0.1994 *** (0.0773)	−0.1964 ** (0.0773)	−0.0861 * (0.0450)	−0.0856 * (0.0449)
Age	−0.1125 *** (0.0311)	−0.1105 *** (0.0310)	−0.0550 *** (0.0184)	−0.0546 *** (0.0184)
Squared_Age/100	0.1391 *** (0.0386)	0.1371 *** (0.0385)	0.0682 *** (0.0225)	0.0671 *** (0.0226)
Being married	0.2382 ** (0.1052)	0.2343 ** (0.1051)	0.1204 ** (0.0496)	0.1162 ** (0.0497)
Undergraduate and some college	0.2218 * (0.1291)	0.2163 * (0.1292)	0.0797 (0.0708)	
Master degree or higher	0.5618 *** (0.1612)	0.5531 *** (0.1615)	0.2645 *** (0.0865)	
Household size	−0.1117 *** (0.0346)	−0.1118 *** (0.0346)	−0.0541 *** (0.0172)	−0.0535 *** (0.0173)
Health status of household member	0.4467 *** (0.0740)	0.4431 *** (0.0741)	0.2264 *** (0.0373)	0.2271 *** (0.0374)
Monthly income	0.2125 *** (0.0215)	0.2118 *** (0.0215)	0.1065 *** (0.0119)	0.1094 *** (0.0114)
Having stationary income	0.1129 *** (0.0145)	0.1121 *** (0.0145)	0.0598 *** (0.0082)	0.0602 *** (0.0083)
Having a house	0.8602 *** (0.1357)	0.8513 *** (0.1363)	0.4174 *** (0.0726)	0.4195 *** (0.0728)

Table 5. *Cont.*

Variable	(1) Consumer Life Satisfaction	(2) Consumer Life Satisfaction	(3) Consumer Life Satisfaction	(4) Consumer Life Satisfaction
Having a car	0.3816 *** (0.0922)	0.3837 *** (0.0921)	0.1882 *** (0.0461)	0.1909 *** (0.0464)
Having a private business	0.4022 *** (0.0771)	0.3961 *** (0.0772)	0.2151 *** (0.0406)	0.2139 *** (0.0406)
Working in government or general firms	0.1827 * (0.0997)	0.1771 * (0.0997)	0.0820 * (0.0496)	0.0897 * (0.0491)
Constant	3.4865 *** (0.7141)	3.4498 *** (0.7138)		
Observations	3122	3122	3122	3122
City fixed	Yes	Yes	Yes	Yes
Adjusted *R*2	0.1405	0.1406		
Pseudo *R*2			0.0379	0.0375
Chi-squared			814.7994	793.7917

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5%, and 10% significance level, respectively, and the data in parentheses are robust standard errors. In Columns (3) and (4), since ordered probit regression is utilized, there is no result about constant items to be reported. For OLS regression utilized in Columns (1) and (2), the statistics of adjusted R^2 is reported. Additionally, for ordered probit regression, the statistics of pseudo R^2 and chi-squared are reported.

In Column (1), most of the control variables are significant. Accordingly, the coefficients for gender are all negatively significant, which is identical to prior studies [55]. Compared to female consumers, male consumers feel lower life satisfaction. For age and its squared item, the coefficients are significantly negative and positive, respectively, which implies that there is a nonlinear relationship between age and consumer life satisfaction. Consumers that are married are more satisfied since the coefficients are significantly positive. With regard to education, consumer life satisfaction tends to rise rather than for those who only accept high school or lower education. For household size, a greater household member population is significantly negative to consumer life satisfaction. The health status of a household member is positively associated with consumer life satisfaction. Meanwhile, consumers who have higher and more stationary income will be more satisfied. For household assets, such as having a house, having a car, and having a private business, all of them are significantly positive to consumer life satisfaction. Finally, consumers who work in the government sectors or general firms feel more satisfied.

In Columns (2) and (3), consumers who have accepted financial education insignificantly feel more satisfied. However, the signs for the coefficients are positive. To further investigate the relationship between whether a household member has ever accepted financial education or not and consumer life satisfaction, Column (4) reports the estimation results after adding the interacting item of education and having accepted financial education. For consumers who have accepted financial education and received the national education of undergraduate or some college, the coefficient is still insignificantly positive. However, for consumers who achieved a master's degree or higher, the coefficient is positive at the significance of 1%. This implies that a consumer who has received a higher education combined with financial education will be more satisfied. Thus, the result is identical to H1.

4.3. Sustainable Financial Education and Consumer Life Satisfaction

To further investigate the impacts of sustainable financial education on consumer life satisfaction, this study constructs one variable specific to sustainable financial education in terms of the subjective perspective of the necessity of financial education, and of the objective perspective of the money and time spent on financial education. Based on the approach of principle component analysis (PCA), the variance contribution ratios are calculated as the weights. Then, the index of sustainable financial

education equals a sum of the products of *Z*-scores of the above-mentioned variables with regard to the corresponding weights of variance contribution ratios. Moreover, to verify the sustainable impacts of financial education on consumer life satisfaction, the dependent variable of consumer life satisfaction is replaced by the variables of income expectation in the next year and consumer life satisfaction for the previous year. In addition, to check the long-term effects of financial education on consumer life satisfaction, this study also replaces the dependent variable by the variable of high return through own long-term efforts, since there is no question with regard to consumer life satisfaction in the long term in the survey of Household Consumer Finance in China's Urban Residents in 2012. It is evident that a high return is positively associated with consumer life satisfaction [55]. Thus, if sustainable financial education is positive to consumers' response of achieving high returns through their own long-term efforts, the indirect and long-term effects of financial education on consumer life satisfaction can be demonstrated.

Table 6 presents the results of the regressions of sustainable financial education on consumer life satisfaction. Similarly, ordered probit regression is utilized and robust standard errors are reported to get more accurate and robust estimation results. In Column (1), the variable of the necessity of financial education is entered. The result shows that consumers who consider financial education to be necessary will feel more satisfied. Thus, the result is identical to H2, namely, consumers who consider it is more necessary to receive financial education will be more satisfied. In Columns (2) and (3), the variables of money and time spent on financial education after formal schooling are introduced, respectively. The results indicate that both of them are significantly positive to consumer life satisfaction. Hence, the results primarily follow H3. Moreover, in Column (4), the variable to proxy sustainable financial education is added. According to the estimation result, the coefficient is positive to consumer life satisfaction at the significance level of 1%, which indicates that sustainable financial education is of substantial importance in improving consumer life satisfaction. Thus, H4 is also supported by constructing a new variable to proxy sustainable financial education. To further verify the sustainable impacts of financial education on consumer life satisfaction, two additional regressions are conducted in Columns (5) and (6). When the dependent variable is replaced by the variable of income expectation in the next year, the coefficient of sustainable financial education is positively significant. It implies that sustainable financial education sustains higher consumer life satisfaction, and the sustainable impacts of financial education on improving consumer life satisfaction are verified. In Column (6), the dependent variable is replaced by the variable of consumer life satisfaction for the previous year, and the coefficient of sustainable financial education is significantly positive and is less than the coefficient in Column (4). Thus, sustainable financial education sustains an increasing effect on consumer life satisfaction. Furthermore, to check the long-term effects of financial education on consumer life satisfaction, one additional regression is conducted in Column (7). When the dependent variable is replaced by the variable of high return through their own long-term efforts, the coefficient is significantly positive. It provides indirect evidence that financial education has positive and long-term impacts on consumers investing return, and thereby positively contributes to consumer life satisfaction in the long term.

Table 6. Results of regressions of sustainable financial education on consumer life satisfaction.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Income Expectation in the Next Year**	**Consumer Life Satisfaction for the Previous Year**	**High Return Through Own Long-Term Efforts**	**Consumer Life Satisfaction**
The necessity of financial education	0.0678 ** (0.0266)							
The money spent on financial education		0.1464 *** (0.0223)						
The time spent on financial education			0.0869 *** (0.0189)					
Sustainable financial education				0.1496 *** (0.0283)	0.1014 *** (0.0311)	0.1421 *** (0.0289)	0.2271 *** (0.0329)	1.1727 *** (0.2673)
age	−0.0546 *** (0.0183)	−0.0575 *** (0.0182)	−0.0550 *** (0.0180)	−0.0542 *** (0.0183)	−0.0937 *** (0.0189)	−0.0466 ** (0.0192)	−0.0519 *** (0.0196)	−0.0517 *** (0.0178)
Squared_Age/100	0.0676 *** (0.0225)	0.0717 *** (0.0223)	0.0685 *** (0.0221)	0.0675 *** (0.0225)	0.0993 *** (0.0231)	0.0592 ** (0.0238)	0.0564 ** (0.0245)	0.0724 *** (0.0218)
Gender	−0.0858 * (0.0453)	−0.0910 ** (0.0450)	−0.0933 ** (0.0456)	−0.0861 * (0.0456)	−0.0099 (0.0408)	−0.0631 (0.0423)	−0.0058 (0.0464)	−0.0817 * (0.0454)
Being married	0.1189 ** (0.0491)	0.1259 *** (0.0477)	0.1157 ** (0.0490)	0.1178 ** (0.0486)	0.0469 (0.0669)	0.0968 * (0.0503)	−0.0362 (0.0725)	−0.0216 (0.0586)
Undergraduate and some college	0.0818 (0.0714)	0.0593 (0.0703)	0.0699 (0.0704)	0.0729 (0.0716)	0.2111 *** (0.0683)	0.1220 * (0.0673)	0.2044 *** (0.0612)	0.0377 (0.0723)
Master degree or higher	0.2655 *** (0.0863)	0.2356 *** (0.0867)	0.2334 *** (0.0863)	0.2504 *** (0.0866)	0.3292 *** (0.0958)	0.2674 *** (0.0827)	0.2290 *** (0.0785)	0.1895 ** (0.0887)
Household size	−0.0527 *** (0.0171)	−0.0575 *** (0.0170)	−0.0546 *** (0.0172)	−0.0531 *** (0.0170)	0.0264 (0.0227)	−0.0468 *** (0.0173)	−0.0020 (0.0209)	−0.0544 *** (0.0171)
Health status of household member	0.2213 *** (0.0375)	0.2274 *** (0.0374)	0.2246 *** (0.0375)	0.2167 *** (0.0376)	0.0679 * (0.0405)	0.2528 *** (0.0364)	0.2280 *** (0.0420)	0.2261 *** (0.0368)
Monthly income	0.1046 *** (0.0118)	0.1012 *** (0.0121)	0.0996 *** (0.0121)	0.1011 *** (0.0120)	0.0273 ** (0.0119)	0.0855 *** (0.0116)	0.0457 *** (0.0119)	0.1013 *** (0.0121)
Having stationary income	0.0595 *** (0.0082)	0.0609 *** (0.0081)	0.0607 *** (0.0081)	0.0594 *** (0.0081)	0.0133 * (0.0077)	0.0629 *** (0.0074)	−0.0155 ** (0.0076)	0.0589 *** (0.0083)

Table 6. *Cont.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Income Expectation in the Next Year**	**Consumer Life Satisfaction for the Previous Year**	**High Return Through Own Long-Term Efforts**	**Consumer Life Satisfaction**
Having a house	0.4191 *** (0.0723)	0.4004 *** (0.0725)	0.4077 *** (0.0727)	0.4094 *** (0.0727)	0.0431 (0.0719)	0.3552 *** (0.0704)	0.0711 (0.0762)	0.4188 *** (0.0733)
Having a car	0.1837 *** (0.0459)	0.1640 *** (0.0464)	0.1638 *** (0.0454)	0.1726 *** (0.0460)	0.0812 (0.0531)	0.1478 *** (0.0453)	0.1235 ** (0.0516)	0.1756 *** (0.0459)
Having a private business	0.2146 *** (0.0402)	0.1897 *** (0.0407)	0.1886 *** (0.0425)	0.2015 *** (0.0405)	0.1693 *** (0.0433)	0.1379 *** (0.0399)	0.1396 *** (0.0490)	0.2231 *** (0.0400)
Working in government or general firms	0.0799 (0.0493)	0.0728 (0.0492)	0.0736 (0.0502)	0.0723 (0.0493)	−0.0044 (0.0638)	0.0637 (0.0528)	−0.0179 (0.0517)	0.0720 (0.0487)
City fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3122	3122	3122	3122	3122	3122	3122	3122
Pseudo *R*2	0.0383	0.0406	0.0398	0.0397	0.0293	0.0334	0.0335	0.0397
Chi-squared	773.1113	849.1438	813.3024	759.7835	291.6308	621.6645	292.6813	836.6658

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5%, and 10% significance level, respectively, and the data in parentheses are robust standard errors. In Column (8), the variables of spouse education and the knowledge for the rates of various saving types are considered as instrument variables, and 2SLS estimation is utilized to eliminate the endogeneity. For the first stage of OLS regression, the statistics of F (4, 3117) = 20.4500, which is larger than 10. Therefore, the influence of weak instrumental variables can be negligible.

4.4. Endogeneity and Robustness Check

This study also realizes that the problem of endogeneity may apply to the above regression models since the coefficients cannot determine the causality between sustainable financial education and consumer life satisfaction. For some consumers, it is possible for them to accept financial education after formal schooling since they are highly satisfied and have high incomes or substantial assets to be invested. Therefore, the potential endogeneity of sustainable financial education must be treated with care. This study employs the following instrument variables and conducts a 2SLS estimation to eliminate the impacts of endogeneity on the estimation results.

The 2012 Household Consumer Finance in China's Urban Residents designed two questions as follows. The first is about the education status of a consumer's spouse, and the second is with regard to the consumer's knowledge for the rates of various saving types. The spouse's education status is associated with consumer sustainable financial education and is almost exogenous. Meanwhile, the consumer's knowledge of the rates of various saving types is also correlated to consumer sustainable financial education, and that knowledge is also exogenous to consumer life satisfaction. This study first performed a regression on consumer sustainable financial education on a spouse's education and knowledge for the rates of various saving types. According to the result of first stage regression, the coefficients of the spouse's education and knowledge for the rates of various saving types are positively significant, and F (4, 3117) = 20.4500, which is far beyond the critical values. This implies that the impact of weak instrumental variables can be negligible. Then, an ordered probit model with instrumental variables was conducted (see Column [8] in Table 6). In terms of the 2SLS estimation result, the estimate of the coefficient on the instrument of sustainable financial education is positive and statistically significant, with the signs of other variables almost remaining unchanged. The coefficient of sustainable financial education in Column (8) is greater than that in Column (4), which implies that the endogeneity problem indeed exists, and instrument variables eliminate the impacts of endogeneity and make the estimation results more accurate. Thus, H3 and H4 are still supported.

To examine the robustness of the estimates, this study firstly replaced the independent variable by the variable of financial knowledge acquisition for the participating stock market. Second, this study also replaced the estimation approach of ordered probit regression by OLS and ordered logit regression. Third, to eliminate the impacts from outliers by age, this study kept the samples of age between the bottom 10% and the top 10%. Finally, this study also deleted the samples where the monthly income is 0 or greater than 50,000 Yuan, which will decrease the impacts from outliers of income. Table 7 presents the results of the robustness check.

Table 7. Robustness check.

Variable	(1)	(2)	(3)	(4)	(5)
	Consumer Life Satisfaction	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**	**Consumer Life Satisfaction**
Financial knowledge acquisition for participating stock market	0.1321 ** (0.0659)				
Sustainable financial education		0.2571 *** (0.0587)	0.2680 *** (0.0495)	0.1611 *** (0.0324)	0.1488 *** (0.0324)
Age	−0.0547 *** (0.0181)	−0.1089 *** (0.0312)	−0.1069 *** (0.0295)	−0.0227 (0.0676)	−0.0481 *** (0.0153)
Squared Age/100	0.0676 *** (0.0223)	0.1356 *** (0.0387)	0.1348 *** (0.0357)	0.0242 (0.0967)	0.0593 *** (0.0191)
Gender	−0.0875 * (0.0450)	−0.1961 ** (0.0770)	−0.1428 * (0.0798)	−0.0733 * (0.0422)	−0.0799 ** (0.0378)
Being married	0.1271 *** (0.0491)	0.2300 ** (0.1047)	0.2281 *** (0.0870)	0.1110 * (0.0594)	0.1362 ** (0.0558)
Undergraduate and some college	0.0846 (0.0706)	0.2043 (0.1289)	0.1923 (0.1199)	0.1555 ** (0.0735)	0.0702 (0.0654)
Master degree or higher	0.2687 *** (0.0862)	0.5264 *** (0.1605)	0.4670 *** (0.1467)	0.3319 *** (0.0918)	0.2249 ** (0.0875)
Household size	−0.0551 *** (0.0170)	−0.1098 *** (0.0344)	−0.0865 *** (0.0304)	−0.0516 ** (0.0210)	−0.0519 *** (0.0184)
Health status of household member	0.2270 *** (0.0371)	0.4255 *** (0.0741)	0.3675 *** (0.0655)	0.2424 *** (0.0399)	0.2032 *** (0.0367)
Monthly income	0.1066 *** (0.0118)	0.2018 *** (0.0215)	0.1773 *** (0.0208)	0.0891 *** (0.0115)	0.1003 *** (0.0110)
Having stationary income	0.0608 *** (0.0082)	0.1110 *** (0.0144)	0.1087 *** (0.0137)	0.0576 *** (0.0089)	0.0621 *** (0.0085)
Having a house	0.4215 *** (0.0720)	0.8366 *** (0.1357)	0.7065 *** (0.1268)	0.3420 *** (0.0735)	0.3793 *** (0.0686)
Having a car	0.1850 *** (0.0463)	0.3554 *** (0.0924)	0.3100 *** (0.0796)	0.2178 *** (0.0491)	0.1755 *** (0.0540)
Having a private business	0.2160 *** (0.0403)	0.3713 *** (0.0773)	0.3422 *** (0.0711)	0.1801 *** (0.0481)	0.1945 *** (0.0432)
Working in government or general firms	0.0844 * (0.0494)	0.1607 (0.0996)	0.1414 * (0.0838)	0.0639 (0.0716)	0.0846 (0.0523)
Constant		3.7094 *** (0.7185)			
City fixed	Yes	Yes	Yes	Yes	Yes
Observations	3122	3122	3122	2433	3004
Adjusted $R2$		0.1455			
Pseudo $R2$	0.0381		0.0416	0.0401	0.0362
Chi-squared	788.2551		817.9563	554.9422	655.7412

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5%, and 10% significance level, respectively, and the data in parentheses are robust standard errors. In Columns (1), (4) and (5), since ordered probit regression is utilized and ordered logit regression in Column (3) is utilized, there is no result about constant items to be reported. For OLS regression utilized in Column (2), the statistics of adjusted R^2 is reported. Additionally, for ordered probit and logit regression, the statistics of pseudo R^2 and chi-squared are reported.

In Column (1), the coefficient of financial knowledge acquisition for the participating stock market is positive and statistically significant. In Columns (2) to (5), the coefficients of sustainable financial education remain significantly positive for all specifications. In terms of the robust results reported in Table 7, there is a robust relationship between sustainable financial education and consumer life satisfaction, namely, sustainable financial education significantly and positively contributes to consumer life satisfaction.

5. Conclusions and Implications

In the process of the rapid development of the financial industry, substantial kinds of financial products have emerged and, meanwhile, higher requirements for consumers' financial knowledge and financial literacy have been put forward. However, consumers' financial knowledge is generally scarce, financial awareness is relatively weak, and financial planning ability is relatively low, such that most consumers cannot rationally participate in the financial market. This reality not only constrains the development of the financial industry but also produces serious shocks on consumer life satisfaction. Therefore, sustainable financial education after formal schooling can not only make consumers rationally participate in the financial market and then to promote the healthy development of financial markets but also has a positive impact on improving a consumer's life satisfaction. Therefore, utilizing the survey data of Household Consumer Finance in China's Urban Residents in 2012, this study examines the impact of sustainable financial education on consumer life satisfaction.

This study provides empirical evidence suggesting that accepting financial education, especially when the consumers already have a high level of education, is positively associated with greater consumer life satisfaction. The result is identical to H1, especially for consumers with a higher education level. The results also indicate that consumers who consider financial education to be necessary and also spend more money and time on financial education after formal schooling will be more satisfied, which is as hypothesized in H2 and H3. This study provides a systematic perspective to investigate the impacts of financial education on consumer life satisfaction, which will significantly enrich the literature in the related field. In addition, based on the variables of the necessity of financial education, the money and time spent on financial education, a variable to proxy sustainable financial education from subjective and objective aspects, are developed. The estimation results suggest that sustainable financial education positively contributes to consumer life satisfaction, which is identical to H4. The construct of the variable of sustainable financial education contributes to the literature on the effects of financial education in the long-term and provides a new insight to develop a variable of financial behavior from subjective and objective perspectives. In addition, the sustainable impacts of financial education on consumer life satisfaction are adequately verified.

This study has two limitations. The first is that this study employs cross-sectional data to investigate the impact of sustainable financial education on consumer life satisfaction. Moreover, there is almost no panel data of a related survey with regard to this topic. Hence, it is difficult to capture the dynamic changes in the relationships between sustainable financial education and consumer life satisfaction. Meanwhile, it is also difficult to eliminate estimation errors due to using cross-sectional data. However, this study has offered a comprehensive robustness check to make adequate and accurate results. For further study, more panel surveys and updated survey data need to be developed and conducted to support related research in this field. The second limitation is that ordered probit regression is the only data analysis used. More sophisticated approaches, such as panel ordered logistic regression, can be used in future research when panel data on sustainable financial education and consumer life satisfaction are available.

Based on the conclusions, how to enhance sustainable financial education to promote consumer life satisfaction may be strategically considered from the following perspectives. First, increase the input of financial education and highlight the necessity of financial education. Based on the results of this study, both the time and money spent on financial education positively contribute to consumer life satisfaction. Moreover, if consumers consider financial education being of necessity, they will be more satisfied. Therefore, increasing the input of money and time on financial education and making consumers aware of the necessity of financial education will be positive to consumer life satisfaction. Second, take the rapid development of the financial industry as an opportunity to increase financial knowledge publicly, improve consumer financial literacy and financial awareness, and improve financial behavior such as consumer financial planning. If consumers have low financial education ability, it is difficult for them to manage their assets rationally, which will degrade their life satisfaction. Third, the policymakers should properly carry out sustainable financial education after

formal schooling on financial market investment to help consumers accumulate experience in financial assets investment, and to improve consumer life satisfaction. In addition, developing sustainable financial education can enhance the cognition level of consumer financial risks, thereby improving consumer financial welfare and life satisfaction.

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References

1. CFPB. *Financial Well-Being by State: Using Data from the Financial Industry Regulatory Authority Foundation 2018 National Financial Capability Study*; Consumer Financial Protection Bureau: Washington, DC, USA, 2019.
2. PACFC. *Final Report: President's Advisory Council on Financial Capability*; President's Advisory Council on Financial Capability: Washington, DC, USA, 2013.
3. Xiao, J.J.; O'Neill, B. Financial education and financial capability. *Int. J. Consum. Stud.* **2016**, *40*, 712–721. [CrossRef]
4. Lusardi, A. Financial literacy and the need for financial education: Evidence and implications. *Swiss J. Econ. Stat.* **2019**, *155*, 1. [CrossRef]
5. Berry, J.; Karlan, D.; Pradhan, M. The impact of financial education for youth in Ghana. *World Dev.* **2018**, *102*, 71–89. [CrossRef]
6. Xiao, J.J.; Tang, C.; Shim, S. Acting for happiness: Financial behavior and life satisfaction of college students. *Soc. Indic. Res.* **2009**, *92*, 53–68. [CrossRef]
7. Veenhoven, R. *Conditions of Happiness*; Springer: Dordrecht, The Netherlands, 1984. [CrossRef]
8. Oliver, R.L. *Satisfaction: A Behavioral Perspective on the Consumer*; The McGraw-Hill Companies, Inc.: New York, NY, USA, 1997; Volume 2, pp. 285–286.
9. Xiao, J.J. *Consumer Economic Wellbeing*; Springer: New York, NY, USA, 2015.
10. Diener, E.; Suh, E.M.; Lucas, R.E.; Smith, H.L. Subjective well-being: Three decades of progress. *Psychol. Bull.* **1999**, *125*, 276–302. [CrossRef]
11. Malhotra, N.K. Consumer well-being and quality of life: An assessment and directions for future research. *J. Macromark.* **2006**, *26*, 77–80. [CrossRef]
12. Bucciol, A.; Zarri, L. Wounds that time can't heal: Life satisfaction and exposure to traumatic events. *J. Econ. Psychol.* **2020**, *76*, 102241. [CrossRef]
13. Gilman, R.; Huebner, E.S. Review of life satisfaction measures for adolescents. *Behav. Chang.* **2000**, *17*, 178–195. [CrossRef]
14. Diener, E.; Inglehart, R.; Tay, L. Theory and validity of life satisfaction scales. *Soc. Indic. Res.* **2013**, *112*, 497–527. [CrossRef]
15. Hensley, B.J. Enhancing links between research and practice to improve consumer financial education and well-being. *J. Financ. Couns. Plan.* **2015**, *26*, 94–101. [CrossRef]
16. Gerrans, P.; Heaney, R. The impact of undergraduate personal finance education on individual financial literacy, attitudes and intentions. *Account. Financ.* **2019**, *59*, 177–217. [CrossRef]
17. Purtell, R.; Fossett, J. Beyond budgeting: Public-service financial education in the 21st Century. *J. Public Aff. Educ.* **2010**, *16*, 95–110. [CrossRef]
18. Wagner, J.; Walstad, W.B. The effects of financial education on short-term and long-term financial behaviors. *J. Consum. Aff.* **2019**, *53*, 234–259. [CrossRef]
19. Bayer, P.J.; Bernheim, B.D.; Scholz, J.K. The effects of financial education in the workplace: Evidence from a survey of employers. *Econ. Inq.* **2009**, *47*, 605–624. [CrossRef]

20. Kevin, H.; Neil, C. Can applied entrepreneurship education enhance job satisfaction and financial performance? An empirical investigation in the Australian pharmacy profession. *J. Small Bus. Manag.* **2002**, *40*, 162–167. [CrossRef]
21. Atlas, S.A.; Lu, J.; Micu, P.D.; Port, N. Financial knowledge, confidence, credit use, and financial satisfaction. *J. Financ. Couns. Plan.* **2019**, *30*, 175–190. [CrossRef]
22. Moore, J.E.; Mascarenhas, A.; Bain, J.; Straus, S.E. Developing a comprehensive definition of sustainability. *Implement. Sci.* **2017**, *12*, 1–8. [CrossRef]
23. Diener, E. Traits can be powerful, but are not enough: Lessons from subjective well-being. *J. Res. Personal.* **1996**, *30*, 389–399. [CrossRef]
24. Bjørnskov, C.; Dreher, A.; Fischer, J. Cross-country determinants of life satisfaction: Exploring different determinants across groups in society. *Soc. Choice Welf.* **2008**, *30*, 119–173. [CrossRef]
25. Fu, S.-Y.K.; Anderson, D.; Courtney, M.; McAvan, B. The relationship between country of residence, gender and the quality of life in Australian and Taiwanese midlife residents. *Soc. Indic. Res.* **2006**, *79*, 25–49. [CrossRef]
26. Li, X.; Li, B.; Zhang, H. Research on the influencing factors of the living well-being of rural residents in different economic development levels in China. *J. Technol. Econ.* **2009**, *28*, 98–103.
27. Vita, G.; Ivanova, D.; Dumitrue, A.; García-Mirae, R.; Carrusf, G.; Stadlera, K.; Krauseg, K.; Wooda, R.; Hertwichah, E.G. Happier with less? Members of European environmental grassroots initiatives reconcile lower carbon footprints with higher life satisfaction and income increases. *Energy Res. Soc. Sci.* **2020**, *60*, 101329. [CrossRef]
28. Stanca, L. The geography of economics and happiness: Spatial patterns in the effects of economic conditions on well-being. *Soc. Indic. Res.* **2010**, *99*, 115–133. [CrossRef]
29. Knabe, A.; Rätzel, S. Quantifying the psychological costs of unemployment: The role of permanent income. *Appl. Econ.* **2011**, *43*, 2751–2763. [CrossRef]
30. Ruprah, I.J.; Luengas, P. Monetary policy and happiness: Preferences over inflation and unemployment in Latin America. *J. Socio-Econ.* **2011**, *40*, 59–66. [CrossRef]
31. Abounoori, E.; Eskandari, J. Comparison of the effects of unemployment and inflation on happiness. *Asian J. Res. Bus. Econ. Manag.* **2014**, *4*, 348–359.
32. Fernandes, D.; Lynch, J.G.; Netemeyer, R.G. Financial literacy, financial education, and downstream financial behaviors. *Manag. Sci.* **2014**, *60*, 1861–1883. [CrossRef]
33. Lusardi, A.; Mitchell, O.S. The economic importance of financial literacy: Theory and evidence. *J. Econ. Lit.* **2014**, *52*, 5–44. [CrossRef]
34. Lusardi, A.; Mitchell, O.S.; Curto, V. Financial literacy among the young. *J. Consum. Aff.* **2010**, *44*, 358–380. [CrossRef]
35. Tang, N.; Baker, A.; Peter, P.C. Investigating the disconnect between financial knowledge and behavior: The role of parental influence and psychological characteristics in responsible financial behaviors among young adults. *J. Consum. Aff.* **2015**, *49*, 376–406. [CrossRef]
36. Thomas, D.C. The Current State of Financial Education in the US: How is Higher Education Helping. In *Consumer Knowledge and Financial Decisions*; Lamdin, D.J., Ed.; Springer: New York, NY, USA, 2011; pp. 67–76. [CrossRef]
37. Hastings, J.S.; Mitchell, O.S. How financial literacy and impatience shape retirement wealth and investment behaviors. *J. Pension Econ. Financ.* **2020**, *19*, 1–20. [CrossRef]
38. Bernheim, B.D.; Garrett, D.M.; Maki, D.M. Education and saving: The long-term effects of high school financial curriculum mandates. *J. Public Econ.* **2001**, *80*, 435–465. [CrossRef]
39. Campbell, J.Y. Household finance. *J. Financ.* **2006**, *61*, 1553–1604. [CrossRef]
40. Yin, Z.; Song, Q.; Wu, Y. Financial literacy, trading experience and household portfolio choice. *Econ. Res. J.* **2014**, *4*, 62–75.
41. Chen, F.; Hsu, F.; Lin, A.; Li, A.H. Holding risky financial risky assets and subjective wellbeing: Empirical evidence from China. *N. Am. J. Econ. Financ.* **2020**. [CrossRef]
42. Rooij, M.V.; Lusardi, A.; Alessie, R. Financial literacy and stock market participation. *J. Financ. Econ.* **2011**, *101*, 449–472. [CrossRef]
43. Maman, D.; Rosenhek, Z. Facing future uncertainties and risks through personal finance: Conventions in financial education. *J. Cult. Econ.* **2019**, 1–15. [CrossRef]

44. Inderst, R. Retail finance: Thoughts on reshaping regulation and consumer protection after the financial crisis. *Eur. Bus. Organ. Law Rev.* **2009**, *10*, 455–464. [CrossRef]
45. West, J. Financial literacy education and behavior unhinged: Combating bias and poor product design. *Int. J. Consum. Stud.* **2012**, *36*, 523–530. [CrossRef]
46. Urban, C.; Schmeiser, M.; Collins, J.M.; Brown, A. The effects of high school personal financial education policies on financial behavior. *Econ. Educ. Rev.* **2018**, 101786. [CrossRef]
47. Hira, T.K.; Loibl, C. Understanding the impact of employer-provided financial education on workplace satisfaction. *J. Consum. Aff.* **2005**, *39*, 173–194. [CrossRef]
48. Chin, A.; Williams, A.K. Take-up of financial education: Demographic characteristics and prior knowledge. *J. Public Policy Mark.* **2019**, 1–15. [CrossRef]
49. Postmus, J.L.; Hetling, A.; Hoge, G.L. Evaluating a financial education curriculum as an intervention to improve financial behaviors and financial well-being of survivors of domestic violence: Results from a longitudinal randomized controlled study. *J. Consum. Aff.* **2015**, *49*, 250–266. [CrossRef]
50. Murr, A. The social work portfolio: A student's guide to evidencing your practice. *Soc. Work Educ.* **2015**, *35*, 117–118. [CrossRef]
51. Lusardi, A.; Michaud, P.; Mitchell, O.S. Assessing the impact of financial education programs: A quantitative model. *Econ. Educ. Rev.* **2020**. Forthcoming. [CrossRef]
52. Peeters, N.; Rijk, K.; Soetens, B.; Storms, B.; Hermans, K. A systematic literature review to identify successful elements for financial education and counseling in groups. *J. Consum. Aff.* **2018**, *52*, 415–440. [CrossRef]
53. Xiao, J.J.; Porto, N. Financial education and financial satisfaction: Financial literacy, behavior, and capability as mediators. *Int. J. Bank Mark.* **2017**, *35*, 805–817. [CrossRef]
54. Atkinson, A.; McKay, S.; Kempson, E.; Collard, S. *Levels of Financial Capability in the UK: Results of a Baseline Survey (Consumer Research Report 47)*; Financial Services Authority: London, UK, 2006.
55. Xiao, J.J.; Chen, C.; Chen, F.Z. Consumer financial capability and financial satisfaction. *Soc. Indic. Res.* **2014**, *118*, 415–432. [CrossRef]

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Applying an Evolutionary Growth Theory for Sustainable Economic Development: The Effect of International Students as Tourists

Kemal Soyer [1,*], Hale Ozgit [2] and Husam Rjoub [3]

[1] Department of Business Administration, Cyprus International University, 99258 Nicosia, North Cyprus, Mersin 10, Turkey
[2] Department of Tourism and Hospitality Management, Cyprus International University, 99258 Nicosia, North Cyprus, Mersin 10, Turkey; hozgit@ciu.edu.tr
[3] Department of Accounting and Finance, Cyprus International University, 99258 Nicosia, North Cyprus, Mersin 10, Turkey; hrjoub@ciu.edu.tr
* Correspondence: kemalsoyer11@gmail.com

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Abstract: In this globalized era of strict competition, all actors in countries must focus on their strengths for continuous growth, which would presumably lead to sustainable economic development. Amongst the three components of sustainable development, this paper focuses on the economic and social aspects. Many countries are becoming service-oriented for economic growth. Education is a form of human capital investment which significantly contributes to countries' national income via students, particularly international cross-border students in higher education institutions. While endogenous growth models dismiss the importance of governments in the growth process, in this paper, the Keynesian and new growth theories are combined to form an evolutionary growth theory. This research aims to analyze the short and long-term relationships between macroeconomic variables, international students, and their impact on the gross domestic product (GDP) of a small island with the intention of policy implications for stakeholders to reach or maintain sustainable economic development. Using an evolutionary growth theory with 34 years of time-series data on quarterly base, the vector autocorrection (VAR) model helps reveal the short and long-run relationships as well as impacts on the economy for sustainable economic growth. The results confirmed a long-run relationship via cointegration. Moreover, they approved bidirectional causality between student numbers, general secondary school enrolment, and GDP. Findings suggest significant implications for all stakeholders, particularly for higher education institutions, the government, and local citizens due to the importance of micro and macro-economic variables' effect on GDP. The results prove that educated human capital contributes to economic growth. Governments should continue their exiting strategy regarding secondary school enrolment rates as it is found to be the most effective variable in the long-run. As education, knowledge, and information transfer rises, it contributes to sustainable development through promoting social stability. Limitation of the unavailability of the total yearly population, GDP was opted instead of GDP per capita.

Keywords: economic growth; sustainable economic development; international students; human capital; higher education

1. Introduction

Economic growth assumedly contributes to human development and social welfare through enhanced employment, purchasing power, and production. Sustainable development is a multifaceted concept which could be defined in numerous ways. According to Jackson, the root philosophy

and social base for sustainable economies differ vastly from the basis of the current conventional economies [1]. The former entail various meanings [2]. Amongst the different perceptions of sustainable development, some view it as a possible radical philosophy to reshape the growth process and as a new framing concept [3]. Contrarily, other perspectives believe it to be a key to achieve increased progress within collective societal fairness and also in environmental protection. Further debates claimed that it is a biased conservative project intended to protect the current economic model that causes most of the global natural and social issues [1]. Amongst the three components of sustainable development, environmental, economic, and social [3], this paper focuses on the direct economic and indirect social aspects.

One of the critical income generation sectors which contribute to sustainable economic growth is the services industry [4]. Nevertheless, the services industry interconnects with other sectors in economies, consisting of various activities, and it is difficult to measure its impact on sustainable economic growth. As one of the subsectors of the service industry [5], higher education plays a vital role in developing quality human capital for sustainable growth. Education is a form of human capital investment, which is significant for countries contributing to increased national income via students [6], in particular, international cross border students in higher education institutions. Therefore, there is a need to ensure public investment in sustainable development and invest in education to reach high-quality [7]. We suggest that increasing international student flows will support institutions, also the country's technological progress, and its research and development, therefore, international students contribute to sustainable development [2].

It could be observed that the inequality of income distribution in nations has been enormous in the past [8] and still remains a global issue as the gap between the rich and the poor is globally enlarging [9]. In regard to the economic problems of North Cyprus, agriculture and manufacturing sectors have been weakened, and the yearly trade deficit is continuously increasing. Besides limited natural resources, strict trade barriers, tariffs, devaluing exchange rate, increasing budget deficit, and limited production, North Cyprus is not able to export sufficient goods [10], therefore, it exports a large proportion of services through international students and tourists. Moreover, international students contribute to most sectors of the economy, while budget deficits also benefit from this income via tax revenues collected [10], as well as increased foreign exchange flow. One way or the other, international students strengthen the higher education sector, which promotes new universities to rise in numbers as well as create new employment opportunities for the increasing workforce. This could be also visible in North Cyprus.

Since ecological, economic, and social systems are interconnected, the problem of sustainable economic development is not only a regional but also a global issue, as stated in several international policy documents [3].

This research focuses on the economic and social aspects of sustainable development with the assumption of testing impacts along with the relationship between secondary school enrolment rates (as a measurement of human capital), labor force (representing the available workforce), technological progress (essential for economic growth), government expenditure (on infrastructure, health, and education), exchange rates (adopted Turkish Lira), rising international student numbers (for economic growth), and GDP will benefit the society socioeconomically. In instances when the economy of a country fails, this will create problems and cause social instability [1]. Presumably, when macroeconomic indicators and essential stakeholders in the economy play their roles efficiently, sustainable growth of the services sector will lead to sustainable economic development. The main contribution of this article is using only international students as a representative of international student tourism and higher education institutions' effect. Additionally, we have created a new multi-factor evolutionary theory derived from relevant literature and adapted it to the North Cyprus economy, which could be tested for other similar demographical countries. Finally, to the best of our knowledge, sustainable economic development policy implications have not yet been suggested for the region.

Our work shares some similarities with previous research by Katırcıoğlu on North Cyprus, who used quarterly data of a 20-year span with four variables, including real GDP and exchange rate [10] and 45 years in different research on Cyprus, including international tourists [11]. Differently, our research holds a sustainable approach and utilizes the most commonly used variables combined in a single growth theory. Furthermore, this paper expands to more years and recent data. Notably, local students have been excluded from the higher education student numbers to examine the net impact of international students on economic growth. The main difference and originality of our theory are the multiple factors combined to test growth, which, to the knowledge of the authors no other theory is alike. Including local students would combine human capital and disable the significant contribution of using international higher education students as tourists. Other authors examined government expenditure, technological progress, and secondary school enrolment rates [12,13]. Labor force has been previously mentioned by many authors [14] and numerous economic growth researchers use GDP as a measurement of economic growth.

North Cyprus, a small microstate island, declared its independence in 1983 and officially is only recognized by Turkey [15]. Considering that the population is estimated to have doubled since 1983 [16,17], the increase in GDP in a small island state is worth examining since microstates have generally been neglected in the literature. Although GDP per capita would be a better measurement to see whether the income distribution is fair for the lower class, due to lack of data on the population number for North Cyprus, GDP represents economic growth. Additionally, it is a services-dominated economy, therefore several actors play vital roles for sustainable economic development. Initially, the macro variables (international students, government expenditure, technological progress, labor force, human capital, and exchange rate) should be examined to shed light on recommendations for stakeholders and policy implications for the government. Previous relevant literature review mentions other researchers using similar variables for different countries. Hence, these variables together have not yet been used for North Cyprus.

The objective of this paper is to test long-term effects, discover significant variables, and suggest implications for stakeholders to increase knowledge which is suggested to increase the welfare of the country as a whole. We argue that international students alone are unable to be sustainable, but need to be supported by strengthening human capital, labor force, increased technological process, and government support. International students contribute to sustainable development as they have effects on economic growth. Moreover, quality human capital and labor force are needed to supply this rising demand. Technological progress could contribute to research and development facilities. Finally, like most countries, the government plays a crucial role in maintaining economic and social stability through infrastructural investments, as well as contributing to research and development, and support related institutions. We suggest that if all the above-mentioned variables are processed in an interconnected, efficient manner, then, sustainable economic development could be reached.

Along with the above viewpoint, this research aims to use Solow's neoclassical growth theory as a base [18], and reaugment it to create an evolutionary new growth theory. Many island countries around the world have common characteristics. However, small island economies are somewhat dissimilar from larger countries regarding the structure and framework of their economic development. Besides the abandonment of small island state's development [19], also, their economic issues have been neglected in the literature.

The tested variables show a contribution to the short- and long-run growth of the GDP of a small island state, North Cyprus. They should contribute to the economy via strengthened human capital, continuous technological progress with the help of labor force, increased government expenditure, and rising international students. Sustainable economic development is concerned with economic growth as economic failure causes social instability.

2. Review of Relevant Research

Sustainable development is a multifaceted concept which could be defined in numerous ways. According to Jackson, the root philosophy and social base for sustainable economies differ vastly from the basis of the current conventional economies [1].This could be true in certain aspects since the inequality levels continue to rise, and the international economic system, when once thought to be safe, is continuing to create a disaster of a near collapse. However, the general goal of sustainable development addresses the significance of human needs, the necessity of social fairness, the importance of unselfish care towards forthcoming generations, and the importance of environmental dependency. Its goal is to increase the wellbeing of people in order to form strong, healthy, and fair social systems as a whole, which, in turn, would be sustainable for future generations. Therefore, social change and progress are essential for sustainable development [2]. In parallel, it should be noted that robust resilient economies are a precondition in this process since the failure of an economy will bring vital problems, such as social instability. Keynes stressed that the fundamental aim of economics is to provide societal stability [1].

Economies can be sustainable only when they simultaneously respond to people's needs as well as address the obliged limits to preserve the environment's capability in response to the current and future needs. This means that if the needs of people are not satisfied, there is apparent social instability. The foundations of the philosophy beneath a sustainable economy is the view of natural resources, excluding manufactured resources, as a mutual inheritance of humans, which necessitates equal distribution and availability to the current and future generations [20].

The conventional growth-led paradigm assumes tackling this issue lies within the growth itself. This view assumes that if the global economies grow collectively, the poorest will inescapably improve its welfare and could possibly reduce inequality. Simon Kuznets (cited in Jackson, 2011) [1] once asserted when countries develop, initially the inequality levels rise, hence when the highest levels of inequality are reached, afterwards, it starts to reduce to stable levels. However, a few, if not any evidence from countries prove this hypothesis [1] (p. 156).

One method of achieving long-term sustainable economic growth is to enable regulations to increase the level of production and exports. However, as a result of limited resources [10] and because of global competition, many island economies tend to shift towards services-dominated economies [12]. Tourism as an invisible export industry [21,22] contributes to a nation's economy because of different destination features and touristic activities demanded by travelers. Export-oriented services, specifically tourism, seem to provide a foundation for a probable comparative advantage in small islands or microstates [17]. Other authors consider international higher education students as tourists [20–22] and regarded as international student tourism [11]. Amongst many divisions or sub-divisions, international and domestic students enrolled in universities are a market segment of educational tourism [23] (p. 18). In a broader sense, tertiary education is related to economic expansion along with the increase in student populations around the world after World War 2 (p. 181). More information could be found in this source regarding how international students previously neglected in the literature, benefit the services industry because they consume intangible tourism products as well as tangible goods [23]. Regardless of their developmental levels, services play a crucial role in the contribution to GDP, are also a significant source of employment opportunities, and have a positive impact on the production processes of host countries [24].

Higher education institutions are vital actors in social change and development. Not only they produce skilled labor to meet economic needs, they also create research output to supply economic demands. Furthermore, universities form a platform for training and socializing people of possible new social elites as well as promoting new cross-border cultural morals [25] (p. 7). For these social reasons, they serve a great purpose towards sustainable development. Public research and innovation institutions continue to be critical contributors to valuable scientific production. Universities, in particular, are the backbone of knowledge-driven economies [25]. Scholars [5] mentioned that education is a vital subsystem under the socio-economic system of any nation. During their tertiary

education journey, presumably, cross-border international students directly contribute to the economy through the services industry (e.g., real estate, communications, entertainment, and recreation) in the host country. Within this context, this fact needs to be evaluated concerning its economic, and therefore, social contribution to the host country.

Barbier asserts that international students should contribute to sustainable development in numerous ways, and one of them is economic aspects. They increase capital flow in the economy, local consumption, and supplement for young workforce. Moreover, they contribute in societal ways as they help acculturation and, along this, aid knowledge transfer. The author also points out that as knowledge increases, communities seem to be more environmentally friendly, which indirectly contributes to sustainable development [2]. Furthermore, literature also suggested that higher education institutions differentiate within education systems of countries, but ultimately plays a crucial role in accumulating skilled human capital [6,26]. In this regard, a highly educated human capital will benefit employment opportunities, enhance competitiveness, and could be a catalyst for sustainable economic growth.

Moreover, low-income countries will attract higher international arrivals if the public expenditure is distributed amongst education as well as increased secondary school participation, which leads to higher-skilled human capital [27]. Accordingly, governments support their citizens to study abroad in terms of benefiting from the know-how of other countries [28].

After the 1960s, many small island economies declared their independence. Therefore, more focus has been put towards analyzing them [29–31]. The significant worry back then was whether small states could be economically sustainable in the long run [32]. However, being a sustainable economy in historical views was continuous economic growth. The new concept of sustainable economic development considers not only economic growth but growth which would contribute to social stability and preserving the environment. Although Romer [33] assumed that large countries may always grow faster compared to small countries, contrarily, Luxemburg is an example of a healthy economy showing continuous development with a population of around 600 thousand [34]. There are several microstates in the top 10 wealthiest countries with populations less than one million. Relatedly, literature is not specific whether being a small island is economically advantageous. Hence, they are generally economically vulnerable [30]. Contrarily, some authors [35] criticized general literature, stating that small size and being an island is less significant regarding economic issues.

The vulnerability of sustainable economic development may be a feasible concern within mini economies and therefore, most small islands as, generally, they have limited natural resources, reduced size of the domestic market, and benefiting from economies of scale is more difficult [35]. In contrast, other scholars argued against these assumptions, as several small states flourish and grow in the modern global system [36]. Sustainable economic development includes several bodies in societies acting towards a common goal to benefit the health and welfare of the society, create employment opportunities, being cautious about environmental matters and achieving continuous long-term growth [24], which will benefit future generations too.

Although North Cyprus is traditionally an agrarian economy [37], the share of agriculture showed a continual decline in previous decades [38]. Accordingly, it is highly difficult to benefit from exports and imports [37] attributable to the fact that production is limited mostly due to apparent strict trade barriers, insufficient resources, and vulnerable exchange rates. The economy has proven to benefit more from tourism and higher education services [39], which are combined as interconnected industries. Therefore, North Cyprus is currently a service-oriented economy. This small island state exports to over 50 countries [17] and hosts international students from more than 135 countries [40].

This is no surprise as the number of students studying abroad in OECD (Organization for Economic Co-operation and Development) countries has more than doubled between 2000 and 2011, rising from 1.3 million to approximately 4.3 million [41] reaching 4.6 million in 2017 [42]. All of the 20 countries hosting most inbound students have increased numbers from 2016 to 2017, hence a significant 58.9% for Mexico, 34.4% rise of New Zealand, and thirdly Spain with a 24.9% change. North Cyprus would be the eighth highest increase for the same period with 12% growth just after Australia. These numbers

are projected to double for Japan and Australia approximately, and also increase for Germany, France, among others by the year 2020 [43].

With eighteen higher education institutions, North Cyprus hosted over 87,000 cross-border international university students from more than 130 countries in the academic year of 2017–2018. This number accounts for just below thirty percent of the estimated population, which is an incredible ratio considering only about thirteen percent of the total 100,913 students are domestic students [17] (p. 33).

The literature stresses the importance of social capital, which should be incorporated into development theories along with policy implications that encompass the micro and macro actors' effect on economic growth [44] (p. 154). As human capital correlates with human development, both significantly affect the economic growth of a country [45], and it has been a critical variable in developmental economics [31,46–49]. Human capital, achieved using education, has also been highlighted as a crucial factor of economic development by several authors who assert the importance of human capital within the growth concept [47]. Furthermore, the key to economic growth lies within accumulating quality skills and knowledge for productive human capital. Assumedly, one reason for the differences within wealth and prosperity amongst countries is the disparity in the structure of human capital [50].

Barro [47] asserted that the growth rate per capita GDP is inversely associated with the initial level of per capita GDP when holding fixed measures for several variables. In addition, he found that growth is positively linked to the initial level of average years of schooling. The importance of education to development is immense through accumulating quality human capital and technical improvement through research and development.

A higher level of educational achievement creates stronger skills which result in higher levels of output of products and services. A high quantity of well-educated human resources promotes the transfer of advanced technology from developed nations [51]. Previously, it has been assumed that the combination of technological improvement and a better-educated labor force will lead to developing quality human capital [52]. In addition, proof from literature commonly reveals the statistical significance of human capital on the growth rate of per capita income [53]. Along with human capital, labor force also has been used to measure growth [53], and the Solow growth model also applies human capital, technological progress, and labor force [18].

In general, modern theories suggest that a country can improve its economy by adopting export-led growth policies that are appropriate for open market-oriented countries. Admittedly, a more open economy would grow at a faster pace, which in return will improve human development [53]. As mentioned earlier, due to limited production, North Cyprus is not able to export sufficient goods. However, exports a large proportion of services through international students. In addition, international students contribute to most sectors of the economy, while budget deficits also benefit from this income via tax revenues collected [12], as well as increased foreign exchange flow.

The connection between the exchange rate and economic growth, inflation, and purchasing power parity has been studied and much debated in the literature [54,55]. North Cyprus's currency uses Turkish Lira (TRY) as a local currency. Factually, the TRY is devaluing with time against the US Dollar and most other currencies [17,56], which negatively affect the purchasing power of the public. However, it could boost economic growth in the long-run [57,58]. This undervaluation may also cause income inequality. Nonetheless, it is suggested to have positive effects on technological improvement [59]. Previous theoretical research in regard to the impact of exchange rate volatility on the economic growth of countries continues to be a debatable topic [60]. Along with the exchange rate, the government's effect on growth is worth examining since they are presumed to have a relationship with economic development [8].

Primarily, amongst the stakeholders, the government plays a key role in sustainable development. Government spending is also taken into consideration as it can have a beneficial effect on sectoral growth through public infrastructure development. Temple [53] notes that government spending on infrastructures such as telephone networks and electricity has a significant effect on economic growth.

On the other hand, Easterly and Rebelo (as cited in Gani and Clemes, 2010) [12] found the share of public investment in transport and communication being robustly correlated with growth. Other authors examining different regions around the globe also used government spending as a variable. In the Caribbean Small Islands, Thacker et al. [61] used government spending along with many other variables to test the role of tourism and size on growth. Presumably, investing in infrastructure, education, health, technology, research, and development will be beneficial both in the short and long-run.

This article utilizes empirical analysis, therefore, research in previous empirical studies for different countries using varying variables and measurements will lead to choosing appropriate variables to make short and long-run analyses along with bilateral testing.

2.1. Review of Relevant Empirical Research

De Meulemeester and Rochat's [62], research and the results show a significant casualty from national higher education effort to economic development for four countries: Sweden, UK, Japan, and France. However, such a causality link has not been found for Italy or Australia.

Later research by Gyimah-Brempong et al. [63] used GDP, technology, physical and human capital also adding a civil war as a regressor with various levels of school enrolments, total population increase percentage, technical progress, and initial income. They found all levels of human capital, but notably higher education rates having a statistically significant impact on the growth of per capita income. Fadaee Khorasgani [64] also discovered that the higher education variable has a positive effect on the economic development for Iran in both the short and long run, adapting the model to relevant national variables. Although both of these studies applied different models and proxies, their findings reveal similarities by suggesting that higher education institutions have a mechanistic effect on the economic expansion of countries. Gani and Clemes [12] adopted a new growth theory as a base to analyze the relationship between the services industry and growth using 15 years of data in five Pacific Island countries. Results approve the positive and statistically significant correlation of the expansion of the services sector.

Furthermore, as the higher education industry grows, people studying in universities increase, global student mobility and tertiary education become more popular, attracting researchers to shed light on the effects. The first study using GDP, the total number of students studying in universities of North Cyprus, and the real exchange rate to analyze the impact of these service-oriented industries was conducted a decade ago [65]. Data from the period between 1979 and 2007 were used to reveal the long-run equilibrium relationship and also unidirectional causality from higher education to the growth of the Turkish Cypriot economy. Since then, international student numbers have more than doubled for North Cyprus [17]. This continuous increase could be because of the devaluing Turkish Lira against the Dollar and other currencies since this was observable in Malaysia [66] (p. 39), and in the Korean University of Korea (p. 42).

Eugenio-Martín et al. [27] discovered that the exchange rate and purchasing power parity are not statistically significant for all economies. In contrast, Lee and Chang [67] found that real effective exchange rate has significant effects on economic development from their panel cointegration technique for OECD and non-OECD countries. Results reflect varying results for OECD, non-OECD and Asian countries.

Nourudeen and Usman [68] also examined the growth and analyzed government expenditure effect on economic expansion in Nigeria. They found surprising results such as the government's total capital expenditure, recurrent, and educational expenditures had a negative effect on growth, whereas spending on transport, health alongside communication lead to economic growth. Furthermore, Katircioglu et al. [10] examined the connection between international tourism, higher education, and economic growth in Northern Cyprus and found a long-run equilibrium relationship for both with GDP growth. Later, Katircioglu [65] carried out an analysis utilizing different variables and found a positive effect of higher education, which was considered as student tourism.

We argue the reliability of proxies opted in these papers since the total number of university students is used as a measurement of student tourism, thus combining human capital with tourists in a single variable. Since international students are considered as educational tourists, local students must be subtracted from the total number of higher education students to reflect the effect of university student tourism most reliably. Similar research was carried out testing the higher education led growth with a new form of Solow growth model [10]. They tested the role of the stock of physical along with human capital, raw labor, technology, and university students, effecting real output. Granger causality tests revealed unidirectional causality from university students to real income growth in the Turkish Cypriot Economy between the years of 1980 and 2010.

Recently, other authors focused on the technological progress and scientific measurements on an extensive 160 countries. They considered per capita real GDP, human capital, government spending, and trade openness for the period of 1960–2009 [13]. Higher education institutions contribute to development through research, transfer of know-how, and may help accumulate quality human capital. Human capital alone has been examined to test its effect on economic growth for Mauritius [31]. To summarize, labor and human capital seem to be relevant determinants, significantly contributing to economic growth for the region.

Conversely, Bhorat et al. [14] found that degree cohort positively affects growth. However, universities and higher colleges do not productively contribute to economic growth in South Africa after examining the relationship between higher education, employment, and economic growth. In contrast, Obradovic and Lojanica [69] discovered a unidirectional causality among higher education and real GDP per capita for Sweden. Published in the same year, Ngware [70] criticizes new growth theories to have limitations. Including knowledge and technology, growth may also be influenced by infrastructural investment, institutional, and social frameworks. Consequently, government consumptions should be another internal variable to reflect the effect of the investments on infrastructure generally distributed between health, education, and communication, which, in turn, increases the profitability of firms as well as reducing production expenses and fostering productivity [35].

A different perspective was presented in a very recent research which focused on (Nomenclature of Territorial Units for Statistics, secondary level) NUTS-II Level European countries to see how the higher education institutions contributed to growth in the region between 1998 and 2008 [71] focusing on tertiary students. This empirical study showed a robust statistical significance relation among knowledge-intensive employment and research and development expenditures. Arguably, due to the need of students graduating first before they positively contribute to society, a time lag was apparent between the effect of human capital and economic growth.

Although empirical studies regarding economic growth and its determinants have generally been tested with few variables, Ridderstaat et al. [72] cited various authors who examined tourism development's effect on economic growth. In their empiric notes until 2011, out of the 17 cited authors, only five used over four variables. Until now, generally, theorists, including Solow [18], also utilized few variables, reflecting the gap in the literature for an evolutionary new growth theory abandoning single or two-factor analyses and shifting towards multifactor models suitable for the characteristics of the economy examined. To the best of the author's knowledge, the only research by Eugenio-Martin et al. [27] utilizes a multifactor theory of various variables for Latin American countries which do not include international students.

2.2. Growth Theories

Economic growth continues to remain the most relevant and significant sub-area in the world of economics. Regardless of which country is analyzed, the issue of economic growth still remains as vital as it used to be for modern humanity in general [28].

For numerous decades, a vast number of scholars attempted to determine the mechanisms to describe growth. Many of these new growth theories examined large states, whereas small states could

require alternative approaches depending on their structure and strengths [35]. Therefore, the need for evolutionary growth theories arise [73].

Perhaps, the main issue of economic growth is the enlarging gap between the rich and poor, causing inequalities within countries and also between countries around the world. Back in history, when Adam Smith first laid the foundation to theorize economics, the gap amongst the rich and the poor between countries used to be narrower. Since then, particularly after the industrial revolution [74], the disparity enlarged as come nations economically developed at a faster pace whereas some experienced the opposite. A few countries such as Japan, South Korea, and Singapore managed to economically develop at a more rapid pace compared to others, similar to developed regions [28].

First mentioned by Adam Smith, classical economy authors were mainly interested in the long-term patterns of growth of countries. Along with this viewpoint, new growth theories, also referred to as endogenous, modern or neoclassical, have been initiated by Roy Harrod in 1939 inspired by J. K. Keynes's General Theory (as cited in Hagemann, 2009) [75]. Neoclassical theories derived by Cobb-Douglas, then Solow et al., who suggested the level of growth in economies depend on the initial income levels. After Mankiw et al. [76] acknowledged the technological progress differences amongst countries, growth theories began to evolve. This has been referred to as "conditional convergence", and Eugenio-Martin et al. [27] mention example variables such as human/physical capital, technological change, financial factors, income allocation, openness to global trade and exchange rate amongst several more. There have also been studies carried out to see whether the Solow growth model is valid within the international across border differentiation of living standards. Furthermore, Mankiw et al. [76] discovered that, when population growth and capital accumulation were constant, countries seemed to converge at approximately the rate of the augmented Solow growth model predicts. They also state people with weaker human capital, in terms of educational levels, received a low wage while others higher qualified or skilled, received better wages.

In a different future study, Cohen and Soto [77] assert human capital could create long-term sustainable growth, which has been one of the critical attributes of the new growth literature initially commenced by Lucas [8] and later contributed to by Romer [78]. This significance has received further attention within time [79–81]. Debates regarding the reasons behind the disagreement between such authors are assumed to be because of the conceptual and empiric measurement of human capital and the form it should take to be a good representation. The number of years of being enrolled in school has been utilized as a measurement of human capital in various growth-related researches [77,82].

These new growth theories or endogenous growth theories suggest technological progress is created internally by the production of market forces, which leads to knowledge accumulation. Besides, if countries generate new knowledge, this will cause a spillover effect leading to sustainable development [70]. Consequently, education, technological progress, and growth are most probably interrelated [52]. However, recently, scholars have been debating against linkages within technical change and expansion through both social and technical innovations. Accordingly, this contradicts the new growth theory as scholars stress the importance of not only investing in technology but the technical improvement of all levels of firms being crucial for growth. Since science and technology are related, information transfer among universities and other research firms are necessary for technical progress. Both the former and the latter need to be given importance as new information develops necessary skills within all divisions of organizations [73]. Compatibly, the international student number flowing to North Cyprus has been increasing, as well as the rising number of higher education institutions from only 10 in 2000 to 18 in 2018 [17].

Generally, economic theories assume small countries experience intense challenges in the growth process compared to larger regions due to their small size. Therefore, this restricts attaining necessary economies of scale, hindering basic economic activities. As a result, instead of traditional growth theories, alternative approaches must be adopted for small state economic growth analyses [35].

The proposed model to investigate the relationship of international students, human capital, technical progress, labor force and exchange rate to GDP, adopting the new growth theory as a

base [18,78,83] is to reaugment the Solow growth theory into an evolutionary new growth theory adapted to a services-driven small island de-facto state's economy, North Cyprus. Although their significance in describing the contribution of higher education to economic expansion, new growth theories have been criticized for their limitations [70]. We propose the model to be mechanistic, reliable, and applicable for demographically similar countries.

While endogenous growth models dismiss the importance of governments in the growth process, in this research, the Keynesian and new growth theories are combined [68] to form an evolutionary growth theory.

3. Methodology and Data Analysis

The data series used in this research were extracted from the Northern Cyprus's official government website State Planning Organization (SPO), and exchange rates from the Republic of Turkey's Central Bank (TCMB) all on an annual basis. The time-series data were converted to a quarterly basis using E views software (quadratic match average). The analysis spans on a 34-year quarterly basis from 1983 to 2017. In order to maintain consistency and avoid outliers, log of independent variable GDP (LGDP) in US dollars accompanied by log of variables, such as number of tertiary students studying in higher education institutions (LSTNO), gross secondary school enrolment rate (LGSS), government expenditure in US dollars (LGEOVEXP), exchange rates against the US dollar (EXCH) and labor (LLAB) have altogether been utilized. Labor force was calculated by adding employment and unemployment numbers. The combination of these variables is invented as a result of the aforementioned previous research.

Technological change (TECH) is considered as mentioned before. It was calculated using Solow's [18] production theory:

$$A = \Delta 1\mathrm{n}\, Y - \alpha\, \Delta 1\mathrm{n}\, K - \beta\, \Delta 1\mathrm{n}\, L$$

Here, A signifies technology, K representing fixed capital, L for labor and Y reflects the GDP of the Turkish Cypriot economy. Therefore, the production function Cobb–Douglas is evolved to be compatible with other additional variables to test each variables effect on and relationship with GDP.

Due to times series data, we initially checked whether the data were stationary, i.e., unit root test was applied in order to avoid superiority and increase reliability [84–86]. The augmented Dickey–Fuller (ADF), Phillip–Perron (P&P), and Ng–Perron tests were adopted.

Inspired by Phillips and Perron, it is necessary to test if the data are stationary, and they also improved the Dickey–Fuller method into the augmented Dickey–Fuller (ADF) [87]. This procedure enables fairly mild assumptions regarding the allocation of the error term. Generally, the presumption of stationary economic variables could be assumed to hold following the series [86]. Therefore, analysis of the stationary data is a requirement to test long-term relationships.

Next, the VAR representation is tested as:

$$y_1 = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B_t + \varepsilon_t$$

After, the long-run cointegration vector is set as:

$$\begin{gathered}\mathrm{LGDP} = 0.053458\mathrm{LSTNO} + 0.934866\mathrm{LLAB} + 1.455271\mathrm{TECH} + \\ 0.566071\mathrm{LGSS} - 07\mathrm{EXCH} + 0.122350\mathrm{LGOVEXP} - 4.18\mathrm{E}\end{gathered}$$

Further, the corresponding VEC model is:

$$\Delta y_{1,t} = \alpha_1(y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{1,t}$$

$$\Delta y_{2,t} = \alpha_2(y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{1,t}$$

The VEC model is followed by impulse response tests for shock effects, and finally, Granger causality tests were carried out for bidirectional and unidirectional relationships.

The results could be found in the following section.

Table 1 presents the choice of the variables based on the aforementioned literature review, as well as the source and acronyms used in the above model.

Table 1. Variables, acronyms, and sources.

Variable	Acronym	Reference
Real Gross Domestic Product	D(LGDP)	Gyimah-Brempong et al. (2006)
Number of International Student Number in Universities	D(LSTNO)	Katircioglu et al. (2012) (University Students)
Labor Force	LLAB	Bhorat et al. (2016)
Technological Progress	TECH	Barro and Lee (2000)
Number of Secondary School Enrolment Rate	LGSS	Eugenio-Martin et al. (2004)
Exchange Rate	EXCH	Rodrik (2007)
Government Expenditure	LGOVEXP	Nourudeen and Usman (2010)

4. Results and Discussion

The results of these tests with and without trend is illustrated in Table 2 which reflects the unit root test indicating the time series data being stationary at first difference.

Table 2. With/without trend test results of ADF, P&P, and Ng–Perron.

Variable	K	ADF		P and P		NG–Perron	
		A	B	A	B	A	B
Set A at level I(0)							
D(LGDP)	2	−1.261.818	−2.363084	−0.940997	−1.259582	0.2392	−2.9677
D(LSTNO)	2	−2.049176	−3.2905807	−11.54244 ***	−18.12298 ***	1.5760	1.5680
D(LLAB)	2	−0471789	−3.566731 **	−0.439200	−2.445870	1.4250	−3.6098 ***
D(TECH)	3	−2.582262	−3.717490 **	−2.421430	−3.128320	−18.8829 ***	−42.1000 ***
D(LGSS)	2	−1.543462	−0.515649	8.766623	12.35826	2.62119	−2.0165
D(EXCH)	2	−2.580783	−2.550647	−1.652164	−1.600315	0.8082	−3.0675 **
D(LGOVEXP)	3	−2.238339	−0.098132	−4.667546 ***	2.266267	−2.6915	−3.3988
Set B at 1st difference I(1)							
D(LGDP)	2	−4.427714 ***	−4.482890 ***	−5.464894 **	−5498033 **	−5.04429 ***	−5.20322 ***
D(LSTNO)	2	−7.948663 ***	−7.697663 ***	−9.182523 ***	−8.245235 ***	−1.9910 **	3.8t692 **
D(LLAB)	2	−5.447051 ***	−5.426520 ***	−6.509779 ***	−6.486389 ***	−4.9075 ***	−4.9167 ***
D(TECH)	3	−10.34515 ***	−10.28798 ***	−7.073837 ***	−7.052630 ***	−36.9471 ***	−7.7992 ***
D(LGSS)	2	2.862886 **	2.593586 **	3.652851 **	3.064460 **	3.1868 **	−3.7642 **
D(EXCH)	2	−4.768472 ***	−4.765390	−5.921449 ***	−5.913990 ***	−2.9157 ***	−33537 **
D(LGOVEXP)	3	−1.748866	−2.721514 ***	−1.804180	−3.300919	−4.7839 ***	−4.9743 ***

*, **, and *** significant at level 1%, 5%, and 10%, respectively, based on the test critical values. K: Lag length, A: Intercept, and B: Intercept and trend.

Analyses regarding the vector autoregressive (VAR) modeling initiated to attract attention in the econometrics world since the end of the 1980s, including the decomposition of the forecast error variances [88]. Constructing variance decomposition connections entails several steps. In instances where endogenous variables are large, firstly, the VAR model must be estimated by utilizing regularization methods. Secondly, estimates derived from the VAR coefficients help to generate the generalized forecast error variance decomposition. Thirdly, this serves to determine the total significance of the dependent variables [89].

The representation of a VAR is as follows [90]:

$$y_1 = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B_t + \varepsilon_t$$

Visible in the above representation, the A_1's are (nxn) coefficient matrices, whereas ε_t is an unobservable i. i. d. mean error.

Subsequently, as the variables were entirely stationary at first difference, next the cointegration was tested using the Johansen cointegration test [72]. Within this framework, a reduced form of VAR was estimated, and at first, the lag order of VAR was determined through the data specifications (information criteria). The order of the vector autoregressive model was firstly determined by information criteria (Schwarz–Bayes criterion, Akaike information criterion, and Hannan–Quinn criterion) and the results of information criteria were conflicting. Due to conflicting results, we opted for a different criterion in order to determine the lag length based on VAR specification residuals until all the residuals of holograms were uncorrelated (white noise) [91]. In continuation of this technique, the optimal lag length was determined within the framework of the LM test, which was three lag length.

The results of the data in Table 3 mirror t-statistics accompanied by critical values for both eigenvalues and trace. The statistical trace and eigenvalues indicated that at least two variables are cointegrated in the long-run. Granger [92] asserted that in cases where two variables are cointegrated, then there should be a unidirectional causality.

Table 3. Johansen cointegration test results.

Hypothesis	R = 0	R = 1	R = 2	R = 3	R = 4	R = 5	R = 6
Trace	175.5907 *	103.1224 *	55.51559	31.46344	16.41066	6.435869	0.139068
Critical value	125.6154	95.75366	69.81889	47.85613	29.79707	15.49471	3.841466
Eigen, max	72.46828 *	47.60681 *	24.05215	15.05278	9.974792	6.296801	0.139068
Critical value	46.23142	40.07757	33.87687	27.58434	21.13162	14.26460	3.8411466

*, reject the null hypothesis of no cointegration at level 5%.

As stated earlier, the long-run cointegration vector was therefore set as follows:

$$\begin{gathered} \text{LGDP} = 0.053458\text{LSTNO} + 0.934866\text{LLAB} + 1.455271\text{TECH} \\ +0.566071\text{LGSS} - 07\text{EXCH} + 0.122350\text{LGOVEXP} \ - 4.18\text{E} \end{gathered}$$

The negative relation between exchange rates and economic growth is in line with Eugenio-Martín et al. [27] yet contradicts Lee and Chang's [67] extensive research. Presumably, one reason behind this negative relation could be due to the misalignment of the Turkish Lira, as discussed by Civcir [93].

From another perspective, instead of paying attention to exchange rate levels, the exchange rate volatility could be the reason for the negative effect for North Cyprus economy in the long-run. Literature suggests this volatility dampens trade, as well as investment, and unexpected falls in the exchange rate may have harsh economic outcomes. Eichengreen points out that this could then lead to currency crises, which, in return, affect growth negatively. Authorities must focus on minimizing exchange rate volatility for sustainable growth [94]. Consequently, this could be the reason for the negative sign result of the exchange rate for North Cyprus. Controversially, as North Cyprus authorities cannot have an effect on the adopted Turkish Lira, it could be assumed that this negative effect will remain a problem for the economy unless Turkish officials discover a method to reduce the volatility and form a competitive real exchange rate.

Moreover, the number of students reveals a positive impact on economic growth which signifies that international students do contribute to the GDP of North Cyprus. All other variables tested revealed similar results showing positive long-term effects on the economic growth of the country. For this reason, if all the stakeholders collectively focus on improving the efficiency of the variables, sustainable economic growth could be reached.

Once the data were stationary at first difference and in apparent cointegration with at least two variables cointegrated in the long run, it was appropriate to analyze the causation between student numbers, labor, technological change, human capital, exchange rate, government expenditure and GDP in the short-run through the vector error correction model (VECM) [95,96]. In line with the suggestion of Granger [92] we performed variance decomposition impulse response and causality tests.

As it can be seen in Table 4, in the short-run equilibrium, the leading independent variable happens to be human capital, followed by technology. The next most important is labor, followed by international student numbers, government expenditure, and the exchange rate is the least effective. The significance of quality human capital has been addressed in several previous studies [31,61], and our analysis also confirms the worthiness.

Table 4. Testing the variance decomposition.

Period	S.E.	D(LGDP)	D(LSTNO)	D(LLAB)	D(TECH)	D(LGSS)	D(EXCH)	D(LGOVEXP)
1	0.035897	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6	0.050916	80.51703	0.307620	1.257565	1.470090	13.93191	1.768738	0.747054
12	0.070257	43.08652	0.475575	2.754348	5.884468	44.85188	1.382633	1.564576
18	0.126107	14.60030	0.485115	3.842866	8.611329	71.05748	0.455503	0.947407
24	0.327684	3.073113	0.332386	4.028395	9.750170	82.38251	0.087737	0.345684
30	0.873575	1.553078	0.374172	4.287077	9.779582	83.73504	0.032929	0.238118
36	1.957557	1.817170	0.499770	4.387639	9.692457	83.20663	0.025958	0.370371
42	4.958357	1.363212	0.381168	4.114403	9.930739	83.85831	0.024250	0.327914
48	14.15501	1.139086	0.327806	4.206277	9.915520	84.17954	0.024322	0.207448
54	33.65901	1.607799	0.456375	4.410382	9.726644	83.47755	0.024525	0.296723
60	77.67912	1.627308	0.454164	4.220275	9.831368	83.46052	0.024108	0.382252

The corresponding VEC model [87] is:

$$\Delta y_{1,t} = \alpha_1(y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{1,t}$$

$$\Delta y_{2,t} = \alpha_2(y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{1,t}$$

Furthermore, impulse response in the bivariate vector autoregressive modeling may reveal additional confirmation regarding the short-run connection, which could not be tested through the Granger causality test. A particular strength of this is determining whether the shocks are temporary or permanent. As illustrated in Figure 1, the logarithmic response of GDP to GDP as a mirror implies both significant and negative in the fourth period, and positively significant in the seventh period. Similarly, the response logarithm of GDP to a shock from the secondary school enrolment rate is significant and negative in the fourth period.

Illustrated below (Table 5), a bidirectional relationship is apparent between both government expenditure, international student numbers, and GDP.

Table 5. Pairwise Granger causality test.

Null Hypothesis:	F-Statistic	Prob.
LSTNO does not Granger Cause LGDP	4.30361	0.0400 **
LGDP does not Granger Cause LSTNO	159.663	0.0000 ***
LLAB does not Granger Cause LGDP	1.86854	0.1740
LGDP does not Granger Cause LLAB	0.12585	0.7233
TECH does not Granger Cause LGDP	1.25176	0.2652
LGDP does not Granger Cause TECH	0.27580	0.6004
LGSS does not Granger Cause LGDP	7.91393	0.0057 **
LGDP does not Granger Cause LGSS	4.00893	0.0473
EXCH does not Granger Cause LGDP	7.93944	0.0056 *
LGDP does not Granger Cause EXCH	0.95776	0.3295
LGOVEXP does not Granger Cause LGDP	4.96038	0.0276 *
LGDP does not Granger Cause LGOVEXP	55.2645	0.0000 ***

*, ** and *** reject null hypothesis at 1%, 5% and 10%, respectively.

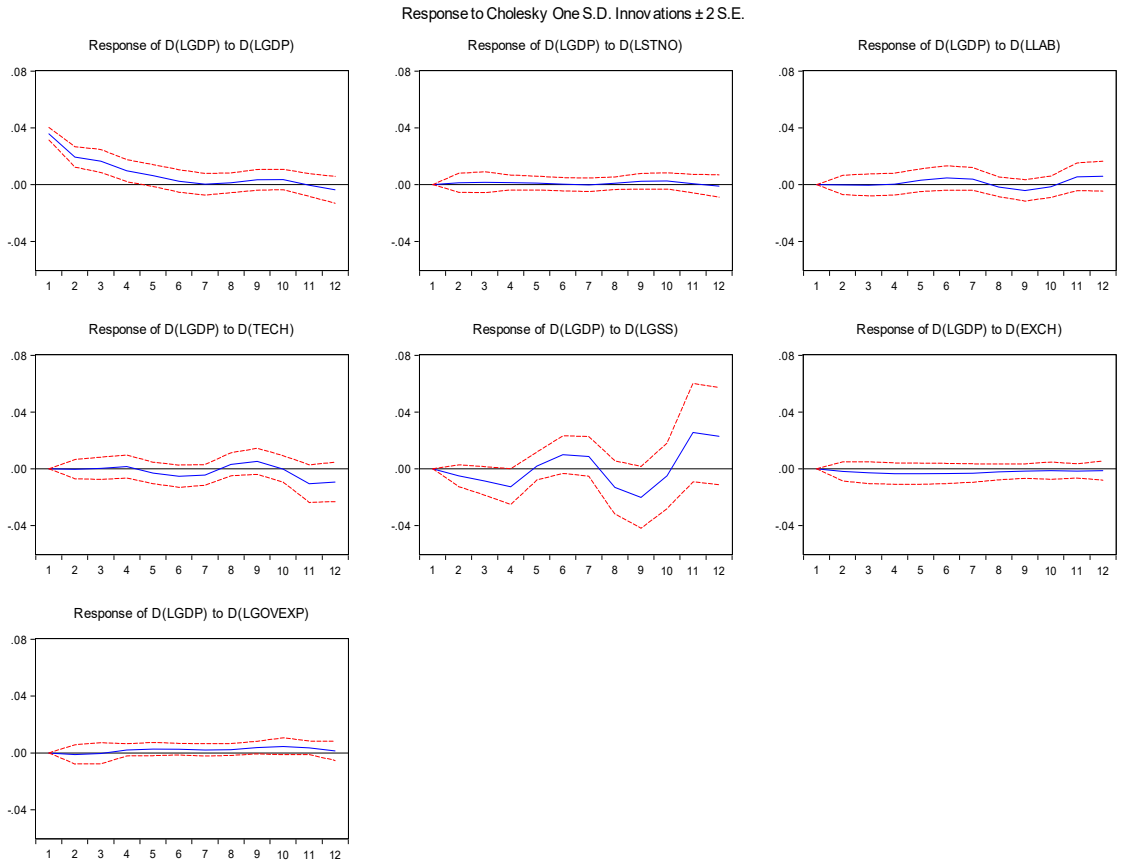

Figure 1. Impulse response.

It is visible that student numbers cause an increase in GDP levels. They reflect a bidirectional relationship. Therefore, this signifies an increase in student numbers will be leading to economic growth as well as increasing GDP leading to rising student numbers. Katircioglu et al. found [10] a unidirectional relationship, however, different from this study, they included domestic higher education student numbers in their time-series data. Contrarily, the available labor force, and technology have no causality relationship with GDP. Growing numbers of general high school enrolment rates (human capital) will lead to an increase in GDP for North Cyprus. This could be due to the economy being dominated by the services sector, in which employees require a certain level of education. Reversely, higher GDP will lead to more enrolment rates.

Furthermore, the results point to a unidirectional relationship between the exchange rate and GDP as exchange rate fluctuations will lead to an increase in GDP. Arguably, the devaluation of local currency leads to increased spending levels of most international students because their rising home currency strengthens their purchasing power parity in the host country. Increased spending levels should lead to more tax revenue for the government, which, in turn, leads to higher government expenditure. Furthermore, the results show that government expenditure causes GDP with a bidirectional relationship. Sensibly, spending on infrastructure, education, and health will lead to accumulating quality human capital forming a cycle flow of benefits.

As seen in Table 5, we aimed to discover the causal relationships between all variables of interest in the short-run. Results indicate a shock from technology and labor force does not contribute to GDP. Contrarily, a shock from secondary school and exchange rate causes growth in GDP in the short-run. Moreover, a bidirectional relationship is visible between international students, government expenditure, and GDP.

Presumably, government spending on infrastructure, education, and health helps stakeholders attract more international student tourists. Most significantly, human capital, labor force and

technological progress strongly appear important, which are yet again interrelated. The more educated the workforce is, the higher the chance they would be ready for work and perform more efficiently [52]. The results prove that educated human capital contributes to economic growth.

Our results confirm Gyimah-Brempong et al.'s research since human capital and technological process has been found to have a significant impact on GDP. They tested their effects on GDP per capita [63]. After our results, we agree with Fadaee Khorasgani's analysis since higher education is essential for development [64]. Gani and Clemes's investigation regarding the effect of the services industry on development [12] has also been approved for North Cyprus since higher education sector and tourism are the two primary services sector in North Cyprus. Lee and Chang's results of the exchange rate [67] have not been found to apply for North Cyprus since we found a negative relation to GDP. However, this could be because of the adopted currency. Our results are in line with Eugenio-Martin et al.'s findings regarding the exchange rate since they discovered the exchange rate is not statistically significant for all economies.

Malta is another small Mediterranean island with similar demographic features and also has around 87,000 international students [97] just like North Cyprus. Differently, Malta specializes in English Language schools, yet, until now, the effects of international students on economic growth or sustainable development have not been researched, reflecting a gap in the literature. We propose our model could be applied for Malta to help a strategic plan for longer-term sustainable development.

5. Conclusions and Policy Implications

Overall, the results of this research suggest significant implications for all stakeholders, particularly for higher education institutions, governments, and the local citizens due to the importance of the micro and macro-economic variables' effect on the GDP of North Cyprus. It is recommended that stakeholders must sustain enhanced value towards international students for sustainable development of the economy and the services sector. Debatably, high numbers of international students also reflect the openness of an economy since foreign exchange flow increases along with knowledge, know-how, and technology between institutions, locals, and educational tourists. They also aid diversity, acculturation, and shared cultural values contributing to societal means. International higher education students' account for approximately one-third of the general population in North Cyprus, therefore, interconnected bodies should be aware of the short- and long-term effects they have on the local economy.

The tested variables show a contribution to short- and long-run growth of the GDP of a small island state, North Cyprus. They should contribute to improved knowledge via strengthened human capital, continuous technological progress with the help of labor force, increased government expenditure and rising numbers of international students. These would promote research and development that contribute to social stability, therefore, promoting sustainable economic development. The results prove that educated human capital contributes to economic growth. Governments should continue their exiting strategy regarding secondary school enrolment rates as it is found to be the most effective variable in the long-run. Consequently, the number of local citizens enrolled in higher education institutions could be used as a measurement of human capital in future research as increased skills would promote quality human capital and labor force. Moreover, since the labor force, technological progress, and government spending also contribute to GDP, government bodies should reform policies and increase spending on infrastructure and education, as well as focusing on educational events for all the actors dealing with students. Additionally, policies must be reformed towards becoming a knowledge economy focusing on research and development, sustainability, and faster sustainable technological progress.

Our results show a negative long-term connection with GDP and the exchange rate. For this reason, the government should form more policies to be less affected by the devaluation of the local currency against foreign currencies. Sensibly, vulnerability against exchange rate volatility must be dealt with for sustainable development.

There are numerous conclusions the authors believe could be drawn from this study. Observably, as the economic conditions of countries vary, classical growth theories do not apply to every country, at least not without augmentation. Consequently, they must be formed after discovering the driving factors and economic conditions of the country studied. The conventional mindset must be replaced with sustainable development perspective. For North Cyprus, this evolutionary growth theory proves internal variables and external tourists' namely international students, play vital roles in economic enhancement. Sustainable economic development is concerned with economic growth as economic failure causes social instability. Noticeably, parallel to the increasing international student numbers, the number of higher education institutions also increases. As a result, extra job opportunities, foreign exchange flow, and an increase in consumption levels also benefit GDP and presumably reduce social instability.

In-depth research of both theoretical and empirical literature revealed conflicting results for different countries as well as changing models and methods chosen by various authors across the globe. We, therefore, preferred to create an evolutionary growth theory and initially tested for causality between numerous variables through secondary data gathered from 1983 to 2017. The evidence discovered of Granger-causality running from international students, secondary school enrolment rates, technological progress, labor, and government expenditure to GDP confirms significant relationships. The exchange rate proved to be different.

Sustainability must involve positive impacts on the economy and society. Literature also asserts the validity of increasing economic growth, technical progress and knowledge should indirectly decrease social instability. Governments must aim to reach both economic growth and sustainable development. This could be difficult as sustainable economic development entails social welfare, environmental protection, and care towards future generations. Economists and decision-makers should aim to balance this growth with harmony. Educating the public and governmental bodies to be more aware of the concept of sustainable economic development could aid sustainability in order for future generations to live in welfare. All humans must collectively search for a mutual path which values the goal of global sustainable development.

We prove short- and long-run positive economic effects of international students, human capital, labor force, government expenditure, and technological progress. Accordingly, this should increase awareness for the government and higher education institutions, which could shed light on further research to investigate the awareness of international students regarding sustainability and perceptions on social and environmental factors.

Our research focused on the economic aspect of sustainable economic development. Future research could examine the environmental awareness of international student tourists, also their direct and indirect effect on the environmental and social aspects of sustainability.

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References

1. Jackson, T. Societal transformations for a sustainable economy. *Nat. Resour. Forum* **2011**, *35*, 155–164. [CrossRef]
2. Barbier, E. The Concept of Sustainable Economic Development. *Environ. Conserv.* **1987**, *14*, 101–110. [CrossRef]
3. Sinakou, E.; Boeve-de Pauw, J.; Van Petegem, P. Exploring the concept of sustainable development within education for sustainable development: implications for ESD research and practice. *Environ. Dev. Sustain.* **2017**, *21*, 1–10. [CrossRef]

4. Kanapathy, V. Services Sector Development in Malaysia: Education and Health as Alternate Sources of Growth. In Proceedings of the AT120 Research Conference, Tokyo Club Foundation for Global Studies, Tokyo, Japan, 20–21 February 2003.
5. Ozgit, H.; Caglar, M. The effectiveness of the tourism and hospitality management programmes in the professional careers of their graduates in North Cyprus. *Anthropologist* **2015**, *22*, 397–404. [CrossRef]
6. Schultz, T.W. Investment in human capital: Reply. *Am. Econ. Rev.* **1961**, *51*, 1035–1039.
7. European Commission. Investment in Human Capital—Assessing the Efficiency of Public Spending on Education. Technical Note Prepared by European Commission Staff for the Eurogroup of 6 November 2017. 2017. Available online: https://www.consilium.europa.eu/media/31409/investment-in-human-capital_eurogroup_31102017_ares.pdf (accessed on 11 March 2019).
8. Lucas, R.E., Jr. On the mechanics of economic development. *J. Monet. Econ.* **1988**, *22*, 3–42. [CrossRef]
9. Dang, G.; Pheng, L.S. *Infrastructure Investments in Developing Economies*; Springer: Singapore, 2015; Volume 10, pp. 978–981.
10. Katircioğlu, S.; Fethi, S.; Caner, H. Testing the higher education-led growth hypothesis in a small island: An empirical investigation from a new version of the Solow growth model. *Qual. Quant.* **2012**, *48*, 729–744. [CrossRef]
11. Katircioglu, S. Tourism. trade and growth: the case of Cyprus. *Appl. Econ.* **2009**, *41*, 2741–2750. [CrossRef]
12. Gani, A.; Clemes, M. Services and economic growth in Pacific Island countries. *Int. J. Dev. Issues* **2010**, *9*, 113–130. [CrossRef]
13. Elgin, C.; Çakır, S. Technological progress and scientific indicators: A panel data analysis. *Econ. Innov. New Technol.* **2014**, *24*, 263–281. [CrossRef]
14. Bhorat, H.; Cassim, A.; Tseng, D. Higher education, employment and economic growth: Exploring the interactions. *Dev. S. Afr.* **2016**, *33*, 312–327. [CrossRef]
15. Özgit, H.; Silman, F. Evaluation of the organizational personalities of the tourism schools in Cyprus: A comparative case study. *Qual. Quant.* **2018**, *52*, 115–128. [CrossRef]
16. State Planning Organization. *Economic and Social Indicators*; TRNC State Planning Office: Nicosia, Cyprus, 2017; pp. 2–35.
17. State Planning Organization. *Economic and Social Indicators*; TRNC State Planning Office: Nicosia, Cyprus, 2018; pp. 2–44.
18. Solow, R. A Contribution to the Theory of Economic Growth. *Q. J. Econ.* **1956**, *70*, 65–94. [CrossRef]
19. Veenendaal, W.P.; Corbett, J. Why small states offer important answers to large questions. *Comp. Political Stud.* **2015**, *48*, 527–549. [CrossRef]
20. Lorek, S.; Spangenberg, J. Sustainable consumption within a sustainable economy—Beyond green growth and green economies. *J. Clean. Prod.* **2014**, *63*, 33–44. [CrossRef]
21. Buckley, P.J.; Mirza, H.; Witt, S.F. Japan's international tourism in the context of Its international economic relations. *Serv. Ind. J.* **1989**, *9*, 357–383. [CrossRef]
22. Vasile, V.; Bănică, E. Cultural Heritage Tourism Export and Local Development. Performance Indicators and Policy Challenges for Romania. In *Caring and Sharing: The Cultural Heritage Environment as an Agent for Change*; Vasile, V., Ed.; Springer: Cham, Switzerland, 2019; pp. 271–290.
23. Ritchie, B.W.; Carr, N.; Cooper, C.P. *Managing Educational Tourism*; Channel View Publications: Bristol, UK, 2003; pp. 1–283.
24. ICTSD. *Services and Sustainable Development: A Conceptual Approach*; International Centre for Trade and Sustainable Development (ICTSD): Geneva, Switzerland, 2016.
25. Brennan, J.; King, R.; Lebeau, Y. Association of Commonwealth Universities & The Open University. In *The Role of Universities in the Transformation of Societie*; Centre for Higher Education Research and Information and Association of Commonwealth Universities: London, UK, 2004.
26. Arbo, P.P.; Benneworth, P. Understanding the Regional Contribution of Higher Education Institutions: A Literature Review. *OECD Educ. Work. Pap.* **2007**, *9*, 1–78.
27. Eugenio-Martin, J.L.; Martín Morales, N.; Scarpa, R. Tourism and economic growth in Latin American countries: A panel data approach. *FEEM Work. Pap.* **2004**, *26*, 1–28. [CrossRef]
28. Acemoglu, D.; Dell, M. Productivity differences between and within countries. *Am. Econ. J. Macroecon.* **2010**, *2*, 169–188. [CrossRef]
29. Connell, J. Island Microstates: The Mirage of Development. *Contemp. Pac.* **1991**, *3*, 251–281.

30. Azzopardi, R. Small islands and Economic Viability. In Proceedings of the Islands of the World VIII, Kinmen Island, Taiwan, 1–7 November 2004; pp. 805–824. Available online: https://www.researchgate.net/profile/Rose_Marie_Azzopardi/publication/228592038_Small_Islands_and_Economic_Viability/links/59f821f0458515547c24e709/Small-Islands-and-Economic-Viability.pdf (accessed on 10 March 2019).
31. Neeliah, H.; Seetanah, B. Does human capital contribute to economic growth in Mauritius? *Eur. J. Train. Dev.* **2016**, *40*, 248–261. [CrossRef]
32. Demetriaes, P.; Al-Jebory, A.; Kampers, G. Manufacturing Exports, Economic Growth and the Current Account in a Small Island Economy: Simulation Results from an Econometric Model for Cyprus. *World Dev.* **1993**, *21*, 259–268. [CrossRef]
33. Romer, P. Increasing Returns and Long-Run Growth. *J. Political Econ.* **1986**, *94*, 1002–1037. [CrossRef]
34. Luxembourg Data. Available online: https://data.worldbank.org/country/Luxembourg (accessed on 17 February 2019).
35. Armstrong, H.W.; Read, R. The determinants of economic growth in small states. *Round Table* **2003**, *92*, 99–124. [CrossRef]
36. Baldacchino, G.; Bertram, G. The beak of the finch: Insights into the economic development of small economies. *Round Table* **2009**, *98*, 141–160. [CrossRef]
37. Katircioglu, S. Trade and growth in a non-recognized small island state: Evidence from the Turkish republic of Northern Cyprus. *J. Bus. Econ. Manag.* **2010**, *11*, 112–130. [CrossRef]
38. Günçavdi, Ö.; Küçükçiftçi, S. Economic Growth Under Embargoes in North Cyprus: An Input-Output Analysis. *Turk. Stud.* **2009**, *10*, 365–392. [CrossRef]
39. Mehmet, O.; Tahiroglu, M. Growth and equity in microstates: Does size matter in development? *Int. J. Soc. Econ.* **2002**, *29*, 152–162. [CrossRef]
40. Higher Education Planning, Evaluation, Accreditation and Coordination Council. *2018 YILI FAALIYET RAPORU*; Higher Education Planning, Evaluation, Accreditation and Coordination Council: Nicosia, Cyprus, 2018; pp. 2–23.
41. OECD. *Education Indicators in Focus*; Organisation for Economic Co-operation and Development: Paris, France, 2013; pp. 1–4.
42. UNESCO. *Global Education Monitoring Report 2019: Migration, Displacement and Education—Building Bridges, not Walls*; UNESCO: Paris, France, 2018.
43. Mapping the Trends that Will Shape International Student Mobility. 2017. Available online: https://monitor.icef.com/2017/07/mapping-trends-will-shape-international-student-mobility/ (accessed on 13 May 2019).
44. Woolcock, M. Social capital and economic development: Toward a theoretical synthesis and policy framework. *Theory Soc.* **1998**, *27*, 151–208. [CrossRef]
45. Ranis, G.; Stewart, F.; Ramirez, A. Economic Growth and Human Development. *World Dev.* **2000**, *28*, 197–219. [CrossRef]
46. Becker, G.; Murphy, K.; Tamura, R. Human Capital, Fertility, and Economic Growth. *J. Political Econ.* **1990**, *90*, 12–36. [CrossRef]
47. Barro, R.J. Education and Economic Growth. In *The Contribution of Human and Social Capital to Sustained Economic Growth and Well-Being*; Helliwell, J.F., Ed.; OCED: Paris, France, 2001.
48. De la Fuente, A.; Doménech, R. Human capital in growth regressions: how much difference does data quality make? *J. Eur. Econ. Assoc.* **2006**, *4*, 1–36. [CrossRef]
49. Murphy, K.M.; Topel, R.H. Human capital investment, inequality, and economic growth. *J. Labor Econ.* **2016**, *34*, 99–127. [CrossRef]
50. Lucas, R. Making a Miracle. *Econometrica* **1993**, *61*, 251–272. [CrossRef]
51. Barro, R.J.; Lee, J.W. International data on educational attainment: Updates and implications. *Oxf. Econ. Pap.* **2000**, *53*, 541–563. [CrossRef]
52. Nelson, R.; Phelps, E. Investment in Humans, Technological Diffusion and Economic Growth. *Am. Econ. Assoc. Pap. Proc.* **1966**, *56*, 69–75.
53. Temple, J. The new growth evidence. *J. Econ. Lit.* **1999**, *37*, 112–156. [CrossRef]
54. Balassa, B. The Purchasing-Power Parity Doctrine: A Reappraisal. *J. Political Econ.* **1964**, *72*, 584–596. [CrossRef]

55. Rodrik, D. *The Real Exchange Rate and Economic Growth: Theory and Evidence*; Kennedy School of Government Harvard University: Cambridge, UK, 2007.
56. TCMB—Exchange Rates. 2018. Available online: https://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Statistics/Exchange+Rates (accessed on 8 May 2018).
57. Sweidan, O. The Effect of Exchange Rate on Exports and Imports: The Case of Jordan. *Int. Trade J.* **2013**, *27*, 156–172. [CrossRef]
58. Razzaque, M.; Bidisha, S.; Khondker, B. Exchange Rate and Economic Growth: An Empirical Assessment for Bangladesh. *J. South Asian Dev.* **2017**, *12*, 42–64. [CrossRef]
59. Ribeiro, R.; McCombie, J.; Lima, G. Does real exchange rate undervaluation really promote economic growth? *Struct. Chang. Econ. Dyn.* **2019**, *48*, 1–22. [CrossRef]
60. Alagidede, P.; Ibrahim, M. On the Causes and Effects of Exchange Rate Volatility on Economic Growth: Evidence from Ghana. *J. Afr. Bus.* **2016**, *18*, 169–193. [CrossRef]
61. Thacker, N.; Acevedo Mejia, S.; Perrelli, R. Caribbean Growth in an International Perspective: The Role of Tourism and Size. *IMF Work. Pap.* **2012**, *12*, 1. [CrossRef]
62. De Meulemeester, J.L.; Rochat, D. A causality analysis of the link between higher education and economic development. *Econ. Educ. Rev.* **1995**, *14*, 351–361. [CrossRef]
63. Gyimah-Brempong, K.; Paddison, O.; Mitiku, W. Higher education and economic growth in Africa. *Econ. Educ. Rev.* **2006**, *42*, 509–529. [CrossRef]
64. Fadaee Khorasgani, M. Higher education development and economic growth in Iran. *Educ. Bus. Soc. Contemp. Middle East. Issues* **2008**, *1*, 162–174. [CrossRef]
65. Katircioğlu, S. International Tourism, Higher Education and Economic Growth: The Case of North Cyprus. *World Econ.* **2010**, *33*, 1955–1972. [CrossRef]
66. Varghese, N. *Impact of the Economic Crisis on Higher Education in East Asia*; Unesco, International Institute for Educational Planning: Paris, France, 2001.
67. Lee, C.; Chang, C. Tourism development and economic growth: A closer look at panels. *Tour. Manag.* **2008**, *29*, 180–192. [CrossRef]
68. Nurudeen, A.; Usman, A. Government Expenditure and Economic Growth in Nigeria, 1970–2008: A Disaggregated Analysis. *Bus. Econ. J.* **2010**, *4*, 1–11.
69. Obradović, S.; Lojanica, N.; Janković, O. The Influence of Economic Growth on Regional Disparities: Empirical Evidence from OECD Countries. Zbornik Radova Ekonomskog Fakulteta U Rijeci: Časopis Za Ekonomsku Teoriju I Praksu. Proceedings of Rijeka Faculty of Economics. *J. Econ. Bus.* **2016**, *34*, 161–186. [CrossRef]
70. Ngware, M.W. A Critical Assessment of "Higher Education and Economic Development: The Importance of Building Technological Capibilities". *Int. Perspet. Educ. Soc.* **2016**, *30*, 201–219.
71. Lilles, A.; Rõigas, K. How higher education institutions contribute to the growth in regions of Europe? *Stud. High. Educ.* **2015**, *42*, 65–78. [CrossRef]
72. Ridderstaat, J.; Croes, R.; Nijkamp, P. Tourism and Long-run Economic Growth in Aruba. *Int. J. Tour. Res.* **2013**, *16*, 472–487. [CrossRef]
73. Kruss, G.; McGrath, S.; Petersen, I.; Gastrow, M. Higher education and economic development: The importance of building technological capabilities. *Int. J. Educ. Dev.* **2015**, *43*, 22–31. [CrossRef]
74. Deane, P. The Industrial Revolution and Economic Growth: The Evidence of Early British National Income Estimates. *Econ. Dev. Cult. Chang.* **1957**, *5*, 159–174. [CrossRef]
75. Hagemann, H. Solow's 1956 contribution in the context of the Harrod-Domar model. *Hist. Political Econ.* **2009**, *41*, 67–87. [CrossRef]
76. Mankiw, N.G.; Romer, D.; Weil, D.N. A Contribution to The Empirics of Economic Growth. *Q. J. Econ.* **1992**, *107*, 407–437. [CrossRef]
77. Cohen, D.; Soto, M. Growth and human capital: Good data, good results. *J. Econ. Growth* **2007**, *12*, 51–76. [CrossRef]
78. Romer, P.M. Endogenous technological change. *J. Political Econ.* **1990**, *98*, 71–102. [CrossRef]
79. Benhabib, J.; Spiegel, M. The role of human capital in economic development evidence from aggregate cross-country data. *J. Monet. Econ.* **1994**, *34*, 143–173. [CrossRef]
80. Bils, M.; Klenow, P. Does schooling cause growth? *Am. Econ. Rev.* **2000**, *90*, 1160–1183. [CrossRef]
81. Pritchett, L. Where has all the education gone? *World Bank Econ. Rev.* **2001**, *15*, 367–391. [CrossRef]

82. Rjoub, H.; Abu Alrub, A.; Soyer, K.; Hamdan, S. The Syndrome of FDI and Economic Growth: Evidence from Latin American Countries. *J. Financ. Stud. Res.* **2016**, 1–8. [CrossRef]
83. Barro, R. Economic Growth in a Cross Section of Countries. *Q. J. Econ.* **1991**, *106*, 407. [CrossRef]
84. Dickey, D.; Fuller, W. Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica* **1981**, *49*, 1057. [CrossRef]
85. Granger, C. Developments in the Study of Cointegrated Economic Variables. *Oxf. Bull. Econ. Stat.* **1986**, *48*, 213–228. [CrossRef]
86. Engle, R.F.; Granger, C.W.J. Cointegration and error correction: Representation, estimation and testing. *Econometrica* **1987**, *50*, 987–1007. [CrossRef]
87. Phillips, P.; Perron, P. Testing for a Unit Root in Time Series Regression. *Biometrika* **1988**, *75*, 335. [CrossRef]
88. Lutkepohl, H. Asymptotic Distributions of Impulse Response Functions and Forecast Error Variance Decompositions of Vector Autoregressive Models. *Rev. Econ. Stat.* **1990**, *72*, 116. [CrossRef]
89. Chan-Lau, J. Variance Decomposition Networks: Potential Pitfalls and a Simple Solution. *IMF Work. Pap.* **2017**, *17*, 1. [CrossRef]
90. Lütkepohl, H. Testing for Causation Between Two Variables in Higher-Dimensional VAR Models. In *Studies in Applied Econometrics*; Physica-Verlag HD: Heidelberg, Germany, 1993.
91. Rjoub, H. Stock prices and exchange rates dynamics: Evidence from emerging markets. *Afr. J. Bus. Manag.* **2012**, *13*, 6. [CrossRef]
92. Granger, C. Some recent development in a concept of causality. *J. Econom.* **1988**, *39*, 199–211. [CrossRef]
93. Civcir, I. The Monetary Models of the Turkish Lira/U.S. Dollar Exchange Rate: Long-run Relationships, Short-run Dynamics, and Forecasting. *East. Eur. Econ.* **2003**, *41*, 43–63. [CrossRef]
94. Eichengreen, B.; Gupta, P. *The Real Exchange Rate and Export Growth: Are Services Different?* The World Bank: Washington, DC, USA, September 2013; pp. 1–36.
95. Mark, W. Vector Autoregressions and Cointegration. In *Handbook of Econometrics*; Engle, R.F., McFadden, D.L., Eds.; North-Holland: Amsterdam, The Netherlands, 1994; Volume 4, pp. 2843–2915.
96. Ojo, B.Y.; Yusofu, R.N.R. Edutourism: International students' decision making process in selecting a host university in Malaysia. *Eur. J. Bus. Manag.* **2013**, *5*, 51–54.
97. National Statistics Office—Malta. Available online: https://nso.gov.mt/en/News_Releases/View_by_Unit/Unit_C4/Documents/News2018_042.pdf (accessed on 3 June 2019).

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The Effect of Parental Economic Expectation on Gender Disparity in Secondary Education in Ghana: A Propensity Score Matching Approach

Prince Donkor [1,2,*], Ya Ding [1] and Gideon Adu-Boateng [3]

[1] School of Management and Economics, University of Electronic Science and Technology of China, Chengdu 611731, China; dingya@uestc.edu.cn
[2] Liberal Studies Department, Kumasi Technical University, P.O. Box 854, Kumasi 0023, Ghana
[3] Department of Social Studies, Prempeh College, P.O. Box KS 1993, Kumasi 0023, Ghana; gideonaduboateng@gmail.com
* Correspondence: pdonkor86@yahoo.com

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Abstract: Ghana, like most sub-Saharan African countries, continues to face gender disparity at the higher levels of the educational hierarchy. This paper seeks to investigate whether gender disparity in senior secondary schools in Ghana is influenced by the economic expectations that parents have for their children's education. Using data from Ghana Living Standard Survey round 6 (GLSS 6), the study employs Propensity Score Matching in its analysis. Intra-household income inequality was used as a for measure parental expectations of the economic returns of education. The results revealed that, on the average, Ghanaian parents expect their male children to reap more economic benefits from education than girls. This attitude culminates in higher investment in boys' education to the disadvantage of their female counterparts at senior secondary schools. It is therefore recommended that appropriate policies should be implemented to ensure that the barriers that prevent women from occupying high-earning positions in the labor market are expunged. With this, parents will believe that girls can have the same economic opportunities as boys and hence will invest equal resources in children's education irrespective of their gender.

Keywords: gender disparity; education; Propensity Score Matching; Intra-household income inequality; senior secondary school; parental economic expectation

1. Introduction

Ensuring gender equality in all dimensions of life has become a top priority for many governments and international organizations. Since being brought into the international frontline by Convention on the Elimination of All forms of Discrimination Against Women (CEDAW) in 1976, there has been tremendous efforts to narrow and, if possible, eliminate all forms of gender inequalities especially in education [1]. Equal access to education, for boys and girls, is not only a fundamental human right; it also has economic, social, civil, and political benefits [2]. It is not surprising that gender equality in education features in two of the Sustainable Development Goals (SDGs). Goal 4 of the SDGs aims to ensure equitable and inclusive education of quality and also promotes lifelong educational opportunities for all. Goal 5 also seeks to empower all girls and women and achieve gender equality.

Equal access to education, for both genders, benefits both the current and future generations [3]. It is evident in the literature that education is associated with a higher flow of income, so education for all is a beacon of hope for alleviating poverty, especially among the marginalized (and women in particular). There is a ripple effect on the younger and unborn generations, as educating women

lowers fertility and mortality rates and other forms of inequalities for their children, thereby helping to create a sustainable planet [4,5].

It also fosters economic growth and development [6]. In this contemporary world, nations that want to maintain their competitiveness and comparative advantage focus on education for all as a tool. Educating all potential members of the labor force, be they boys or girls, men or women, is the engine of economic growth and development, as it ensures the efficient utilization of all economically active citizens. A knowledge-based labor force is a crucial determinant of the pace and sustainability of a country's economic transformation [7–10].

Equality in education is the agent of change for a more civilized global economy. When the citizens of an economy are well educated, there tends to be a reduction in the crime rate, domestic violence and other forms of gender inequalities. It also improves the social, political, and civic participation of the populace [8,11]. Education is therefore the new game-changer that underpins the achievement of most of the Sustainable Development Goals stipulated by the United Nations [12].

Even though education is seen as the fundamental solution to all forms of gender inequalities, girls and women continue to be disadvantaged in this sector. Despite the reduction in the number of girls out of school by 40% compared to the 1994 figure since the inception of the Millennium Development goals, girls still constitute the higher percentage of school dropouts [2]. Women account for about 60% of the world's illiterates. The UNESCO Institute for Statistics (UIS) estimates that more than 17 million girls will never enter a classroom to receive formal education [13]. These figures are alarming and represent a vast number of untapped and wasted human resources.

The educational disparity between boys and girls worsens in most sub-Saharan African and South Asian countries. Women and girls continue to lag behind their male counterparts at most levels of the educational hierarchy. More than half of the world's 58 million school-aged children who are not in school are girls, and about 75% of them are from these regions [13]. There is an average 10% completion gap between boys and girls at the primary level in sub-Saharan Africa, and the advantage goes to boys. Though there has been an increase in the secondary and tertiary school enrolment of girls, a substantial gap still persists [2]. This accounts for the high levels of domestic violence against women and girls, as well as the low political, social, and civic patronage of women in these regions [14]. The high level of untapped resources also explains the state of under-development of most of these countries and their non-convergence toward their developed counterparts [15].

There are numerous reasons why women and girls are discriminated against in terms of education in the sub-Saharan African region. Prominent among them are division of domestic chores based on gender, child labor, early marriage, and early pregnancy, among others [16].

In sub-Saharan Africa, children, especially girls, are an essential source of labor at homes. Due to cultural values and beliefs that consider male children as superior and therefore should not partake in many of the household activities, girls perform most of the domestic chores. A bulk of the household chores, such as cooking, washing, hauling water, and caring for younger siblings and sick family members, are performed by girls, while boys usually run errands. These activities are time-consuming and physically demanding, which affect girls' academic performance and consequently impede them from schooling [17–19].

Early marriage and its associated consequence of early motherhood also increase the dropout rate of girls in this region. Most girls, especially those in the rural areas, are forced to marry early once they reach puberty or become sexually active. One of the reasons for early marriage in sub-Saharan Africa is the desire to prevent the negative tag associated with unmarried girls who get pregnant. Families that have more girls also gain economically from the bride prices or dowries paid for their daughters. This situation is more pronounced among poverty-stricken families with more children to feed. Parents are therefore not willing to invest their scarce resources in the education of a girl-child who will in a short period be married off to another family. In addition, their new roles as wives, mothers, and caregivers for the extended families of their husbands after marriage exert pressure

on them. The time-consuming nature of these new roles contributes to the low enrolment and high dropout rates of girls from schools [18,20].

Girls who get pregnant or become mothers at an early age are often stigmatized and ridiculed by their teachers, friends, and schoolmates, which makes it difficult for them to return to school after childbirth. Some school do not even permit pregnant pupils or early mothers to be in class, as they are seen as bad influences on the rest of the students. In Ghana, girls who are pregnant are mostly not allowed to write the Basic Education Certificate Education (BECE) which is the prerequisite for senior secondary education. Even when schools allow these mothers to return, their re-entry depends on getting caretakers for their children, which they often cannot afford [18,21,22].

Another significant determinant of gender disparity in education is parents' expectation of the economic returns on the educational investments they make in their children. The economic worth and value of boys and girls are not genetically or biologically determined; it is placed on them by society. Most parents in sub-Saharan African countries (including Ghana) have different expectations for the economic value of their children's education. In most cases, higher value is placed on boys' education. This is so because, in Ghana for instance, men continue to earn more income than women in the labor market. Even when both sexes have the same educational background, men tend to be dominant in the high-paying jobs [23]. Most employers offering top-position jobs prefer men to women because of the high rate of absenteeism among the latter due to maternity leave, the need to care for sick family members, etc. [24]. Furthermore, the patriarchal nature of Ghanaian society gives men an upper hand over their female counterparts on the job market [25]. Men, therefore, gain more economically from education than women. If, in a household, a husband earns more than his wife, it will confirm to the parents that men have better economic value from education and hence it is worth investing more in their sons' education than their daughters.

Even though the parental economic expectation for girls from high-income families may exceed that of boys from low-income families, within each family, parents have higher expectations for sons than daughters due to the patriarchal nature of the Ghanaian labor market. Also, the magnitude of intra-household income inequality causes different levels of expectation. If parents of the same educational background work in a sector that is highly male-dominated, and as a result the gap between their incomes is very wide, the difference between the economic expectation for their sons and daughters will be higher than those of parents who work in a less male-dominated sector and have lower income inequality.

This paper aims to investigate whether gender disparity in senior secondary education in Ghana is influenced by the economic expectation parents have for their children's education. The study adds to the literature by providing an alternative measure for the economic expectations parents have for the education of their male and female children. A lot of studies that included this important variable in the analysis of education used qualitative measures [26–30]. This paper, however, employs a quantitative measure of parental economic expectation for education. The authors believe that intra-household income inequality between the father and mother is a good measure of this variable.

Another significance of the study is that it applied the Propensity Score Matching (PSM) method to the analysis of education. Economics provides a quantitative approach in analyzing the behaviors and decisions of economic actors by mostly estimating the causal relationship between variables [7]. However, most of these causal claims are plagued with endogeneity which nullifies the potency of the causal estimates [31]. One solution to eliminating the effect of endogeneity from causation is the PSM. This method is therefore used to find out whether there is a significant relationship between parents' expectations of the economic value of boys' and girls' education, measured by intra-household income inequality, and gender disparity in senior secondary education in Ghana.

The rest of this paper is as follows: Section 2 discusses gender inequality in Ghana's educational system, while the Section 3 reviews existing literature. Section 4 looks at the methodology used, Section 5 explores the dataset, Section 6 details the analysis of the data, and the last section discusses the results and concludes the study.

2. Gender Inequality in Ghana's Educational System

Ghana's successes in the educational sector in the initial years after the nation's independence in 1957 was marred by the economic recession it experienced in the early 1980s. The Structural Adjustment Programs (SAPs) the nation implemented in the early 1980s necessitated a drastic reduction in government expenditure in all sectors of the economy including education. Coupled with the introduction of the user fees in education, school enrolment for both boys and girls plummeted at all levels. For instance, girls' enrolment in primary school for the eligible age group dropped from 71% in 1980 to 68% in 1983. Those who enrolled in the secondary schools also fell to 28% in 1983 from the 1980's figure of 31%. A similar observation was made for boys. Primary school enrolment for boys declined from 89% in 1980 to 87% in 1983. The percentage of boys at the eligible age group who enrolled at the secondary schools decreased from 51 in 1980 to 47 in 1983 [32].

The end of the SAPs was marked by great achievements in the educational sector in general and for girls in particular. The period after the SAPs was met with the global advocacy for gender parity in all spheres of life. Ghana committed itself to ensuring gender equality in all aspect of the economy. It ratified several human right treaties, including the Convention on Rights of the Child (1989), the World Declaration for All (1990), the Beijing Declaration and Platform for Action (1995), and the Dakar Framework for Action (2000), which are against discrimination of all forms [2]. The 1992 constitution of Ghana also has a provision that makes education, especially at the primary level, free and compulsory for all children [33].

Several reforms and interventions have been made by the government to achieve Universal Primary Education (UPE) and also eliminate the disparity between boys and girls in the educational sector. Paramount among these interventions is the implementation of the Free Compulsory and Universal Basic Education (FCUBE) in 1997. To ensure the success of the FCUBE, the Girls' Education Unit (GEU) was created under the Ghana Education Service (GES). Its aim was to ensure that there is equal enrolment of girls and boys in basic education and also to reduce the percentage of girls who drop out of both primary and lower secondary schools. In addition, it was tasked to improve the rate of girls' enrolment in the senior secondary schools. Also, the government established the Capitation Grant in 2005, which abolished the user fee system and made education easily accessible to all [33].

These reforms catapulted the enrolment rate for both boys and girls at all levels of the educational ladder and even put girls at the advantageous position at the primary school level. The gross primary school enrolment of boys shot up from 74.7% in 2008 to 87.47% in 2014 before dropping to 82.87% in 2018. Same can be said about girls as their number increased to 87.81% in 2014 from the 2008 figure of 74.34% and afterward declined to 84.33% in 2018. Thus, the enrollment rate for girls in primary schools in recent years outweighs their male counterparts. It is worth noting that girls also outperform boys in terms of the progression rate to lower secondary schools. Figures from the World Bank's World Development Indicators (WDI) shows that 97.81% of girls progressed to the lower secondary school while the rate for boys stood at 92.66% in 2017 [34].

Despite the successes achieved in the enrolment of girls at the primary school, they lag behind boys at the senior secondary and tertiary levels of education. The percentage of boys' enrolment at the senior secondary and tertiary schools figured around 72.73 and 18.68, respectively, in 2018 as against 71.72 and 13.53 for girls. Furthermore, the literacy rate of men in Ghana outstrips that of women. The 2014 GDHS indicated that 82% of Ghanaian men are literate compared to the 67% for women. These rates, however, indicate an improvement in the 2008 figures for men and women which were 77% and 63%, respectively [35].

Several socio-economic factors account for the gender imbalance at the higher levels of education in Ghana. First of all, girls are over-burdened with domestic chores before and after school which affect their academic performance thereby causing them to drop out of school before attaining senior secondary education. Data from the Ghana Living Standard Survey round 6 (GLSS 6) indicates that the workload at homes for girls is three times more than that of boys. The proportion of girls who are out of school due to domestic chores in 2014 stood at 13.1, while the figure for boys was 3.2 [23].

Another factor that adversely affects the enrolment of girls in higher levels of education in Ghana is early marriage. Girls of secondary and tertiary school-going age are considered ripe for marriage. Apart from the economic gains from the dowries receive on their daughters, families of these girls attain social recognition if their female children marry before giving birth [21]. About 40% of girls of secondary and tertiary school-going age in Ghana are married, and one-fifth of them are mothers. The corresponding figures for boys are ten times lower [23]. Early marriage and motherhood burden child-brides financially and also in terms of time, which hinders their schooling. Furthermore, families in Ghana tend to place more economic value on the education of boys than girls. There is still a widely held belief that boys are superior to girls and will generate more income from schooling. This assertion encourages parents to invest more in their sons' education.

Gender inequality in Ghana's educational sector has a spatial dimension. The urban centers have a narrower gap between boys and girls in terms of those who attain higher level of education compared to the rural areas. The gender disparity gap between men and women in the rural communities stood around 16.4%, which is higher than the 11% recorded in the urban centers [23]. More so, urban women are more likely to have more education than their counterparts in the rural areas. The median years of schooling by urban women in 2014 was 8.5 years, which exceeded the 5.7 years by rural women [35].

Girls residing in rural areas in Ghana are more likely to marry at an early age compared to their counterparts in the urban centers. Due to the high incidence of poverty in the rural communities, parents usually pressure their daughters to marry early to relieve them of financial burdens. Again, the rate of teenage pregnancy and early motherhood in the rural areas surpass that of the urban centers because of the low patronage of family planning services in these areas. The higher rate of dropout of girls due to early marriage and motherhood in the rural areas cause gender disparity in education to be wider in those communities than in the cities [21].

3. Literature Review

Parental expectations of their children's education play a critical role in the academic successes of their wards. Jacob (2010) [30] posited that its impact on the education attainment of children is the most pronounced among the four dimensions of parental involvement which include parental engagement in school-related activities, supervision at home and parent–child communication about school. Parental expectations, as defined by Yamamoto and Holloway (2010) [36], are realistic beliefs or judgments that parents have about their children's future achievement as reflected in course grades, highest level of schooling attained, or college attendance. It is what parents actually believe their children can achieve in education. There are numerous research findings that support a positive relationship between parental expectation and educational achievements.

Yamamoto and Holloway (2010) [36] explained four trajectories through which parents' expectations influence their children's performance at school. First, parental expectations signal to children the confidence their parents have in them in terms of their academic achievements. This confidence becomes the norm that the children strive to attain. Second, children's confidence about their own competence and capacities is boosted by the high expectations from parents and vice versa. Also, parents with higher expectations tend to be more involved in their children's education. They invest quality time and resources in their schooling. They tend to spend more time helping their children with their homework, partake in school activities, communicate more with their teachers, and provide counselling and support. Finally, the performance of teachers is influenced by the expectations that parents have for their children. If teachers perceive that parents have high expectation for their children's academic achievement, they will be motivated to work harder, as they know their effort will be complemented by parents at home.

The inclusion of parental expectations in the analysis of education is mostly in the domain of sociology and psychology. Most research in these academic fields that studied expectations of parents employed qualitative measures before re-coding them to be used in the analysis.

The measurement approach includes the usage of categorical variables, constructs, and (in some cases) continuous variables.

A number of authors who studied the effect of parents' expectation of educational attainments used a categorical variable for its measurement. For instance, using the Growing Up in Ireland (GUI) survey, Banks et al. (2016) [28] explored the effect of parental expectation on the academic success of disabled children who were 13 years old. Those included in their study suffered from general learning/intellectual disability, specific learning disability (such as dyspraxia, dyslexia), socio-emotional disability, and physical disability (such as mobility, visual and hearing impairment). Children whose parents who said they do not expect their children to attain more than Leaving Certificate education had poor academic performance compared to those whose parents had higher expectations. A similar approach was used by Einglund et al. (2004) [37], who investigated the impact of parents' expectation on the educational success of 187 children from low-income families. Using a semi-structured interview, parents ranked how far they think their children would go in school. The responses ranged from "will not complete high school," which was coded as 1, to "will go to graduate or professional school," which had a code of 5. It was found out that the educational achievement of children from homes where parents have high expectations surpassed their counterparts. Studies by Kim et al. (2017) [27] and Gill and Reynolds (1999) [38] were not different from that of Einglund et al. (2004) [37].

In the case of O'Donnell (2007) [39], parents chose the probability that their children would 1) obtain a high school diploma by age 20, 2) obtain a college degree by age 30, 3) be employed by age 30, 4) be in jail by age 20, and 5) be a parent by age 20. The first three options were classified as positive expectations, and the remaining two were viewed as negative. The study used data from National Longitudinal Survey of Youth (NLSY97), and the participants included children who were aged 12–16 on 31 December 1996 and their parents. It was revealed that the positive expectations were associated with good outcomes, while the negative ones brought bad achievements.

Other studies used a construct in the measurement of parental expectation. For example, Jacob (2010) [30] examined the effect of parental expectation on the educational attainment of their wards using the Scale of Educational Aspirations and Expectations for Adolescent (SEAEA). Parents answered to 29 questions with each response ranging from strongly disagree to strongly agree. The responses were then loaded onto a single factor, and a path analysis was used for the exploration. In all, 598 parents of eighth to 10th grade students were sampled for the study. The result was the same as the other studies stated above. Weerasinghe and Panizzon (2015) [40] and Leung and Shek (2011) [41] employed a similar strategy to investigate why children from Asian lineage attain better performance in mathematics than others. Their constructs revealed that the "tiger" parents from Asia have high expectations for their kids and this accounts for their (children's) higher performance and educational attainment.

Only a few studies used a continuous variable in the measurement of parental expectations. Zhan (2006) [42] transformed the categorical variable he used to measure parents' expectation into a continuous variable. The question was "looking ahead, how far do you think your child will go in school?" The response by parents ranged from "leave high school before graduation," coded as 1, to "take further training after college," coded as 5. The author argued that the distribution of the response approached normality and there was a slight negative skew so the variable was treated as a continuous variable. The dataset used was the National Longitudinal Survey of Youth (NLSY79). The results showed that there is a direct relationship between expectations of parents and school performance. Clophus (2018) [26], on the other hand, employed the Career-Related Parent Support Scale (CRPSS) to measure parental expectations. The CRPSS contains 27 questions on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Parents who had a score of 27 were classified as those with the least expectations, while a score of 135 was seen as the highest. The participants included 58 males and 95 females from two high schools in Southwest Louisiana and their parents. The findings revealed that parental expectations had no significant effect on general educational successes as well as that of boys and girls.

It is worth noting that, although the expectations of parents positively impact on the educational achievement of their children, setting unrealistic target for children can be counterproductive. If children feel too much burden as a result of very high expectation from parents, they may work beyond their abilities and capabilities, which can cause emotional breakdowns, depression, etc. They may be demotivated if their relentless efforts do not achieve what their parents expected.

4. Methodology

The purpose of most evaluation studies is to make causal claims, i.e., to determine the effect of a treatment, an intervention or a program on an outcome variable. Counterfactuals are the key to understanding causal inferences. A counterfactual is simply the unobserved outcome of a studied agent. To obtain an unbiased causal estimate, the estimation technique used should be able to reconstruct a counterfactual for the observed outcomes [43–45].

Randomized controlled trials (RCTs) or experiments are the gold standards in generating counterfactuals for estimating causal effects. With this method, there is a random assignment of those who received the treatment (henceforth, the treated group/subject) and those who did not (henceforth, the untreated/control group) to either group making them similar in terms of their pre-treatment baseline characteristics. Technically, the control group serves as a counterfactual to the treated subjects in RCTs or experiments [31].

4.1. Observational Study

Most researchers in management studies use observational data. This is because large volumes of data can be obtained at a relatively cheaper cost compared to experiments. Others resort of this type of data due to ethical reasons. However, observational data often suffer from self-selection bias, which results in endogeneity [46]. Self-selection bias arises because there are often some baseline characteristics that influence some subjects to be selected into the treated group and others into the control group. There is mostly a systematic difference between the treated and untreated subjects even before the treatment is applied. The control group cannot be used as a counterfactual of the treated group since the two groups are not similar prior to the treatment. This makes the computation of the average treatment effect from the mean difference in the outcome variable between the two groups biased. The estimate will be uninterpretable and is not attributable to the treatment.

Self-selection bias threatens the internal validity of the variable or construct. It acts as an excluded or omitted variable from the model, and if not addressed, it will cause the treatment variable and the error term to correlate, leading to endogeneity [46].

4.2. Propensity Score Matching (PSM)

A good estimation technique to deal with the endogeneity resulting from self-selection biasedness is the Propensity Score Matching (PSM) introduced by Rosenbaum and Rubin (1983) [47]. This approach mimics RCTs by reconstructing counterfactuals for the treated studied agents from the observational data. For each subject in the treated class, PSM finds an observation(s) in the control group that has (have) similar characteristics to act as counterfactual(s). It does this by combining propensity score with an appropriate matching algorithm.

Propensity score, as defined by Rosenbaum and Rubin (1983) [47], is the likelihood that a studied agent will be assigned to a treatment class based on its pre-treatment characteristics. In estimating the propensity score (PS), the treatment variable (which is binary) is used as the dependent variable in the PS model, while the covariates serve as the independent variables. The logit or probit regression is then fitted using the measured values of the covariates. Once it has been computed, an agent in the control group whose propensity score is the same or close to the propensity score of another subject in the treated group is deemed as its counterfactual. It is recommended that the studied subjects should be stratified into five or more classes using their estimated PS, as this reduces about 90% of the bias in the covariate(s) between the treated and the control groups within each class [48]. The study used 1:1

matching. With this approach, each treated subject is paired to only one observation in the control group. After that, matching without replacement where an untreated agent that has been paired to a treated subject is not used again for matching was used.

Once the aforementioned procedure is done, the average treatment effect on the treated (ATT) can be computed as the mean difference in the outcome variable between treated group and their paired untreated counterparts after the treatment has been applied. Figure A1 in the Appendix A summarizes the steps used in PSM.

5. Dataset

5.1. Source of Data

The data set used for the analysis of this study is the sixth round of the Ghana Living Standard Survey (GLSS 6). GLSS 6 is a secondary data set that concentrates on the household as the main socio-economic unit. The survey used a two-stage stratification procedure to select the participating households. First of all, Ghana is divided into 10 strata according to the number of regions. Within each region, households are grouped in accordance to their place of residence, i.e., whether they reside in an urban or rural area.

In all, 18,000 households, which is a nationally representative sample, were covered in the survey. Only 16,772 out of the 18,000 households were successfully enumerated, which accounts for the 93.2% response rate. The GLSS 6 provides a detailed insight on the living conditions of the households involved. The data covers demographic characteristics, educational attainment, housing and income of household members.

The study considered all boys and girls of senior secondary/high school (SSS/SHS) age who still reside in their parents' home and have no missing value for any of the variables used. As a result, 1368 boys and 1111 girls were used in the data analysis. Separate propensity score matching models were estimated for each gender.

5.2. Treatment and Outcome Variables

The study used enrolment in senior secondary/high school (SSS/SHS) as the outcome variable in its analysis. Boys and girls of relevant school age who have ever been enrolled in SSS/SHS were coded as 1 and 0 if otherwise. The treatment variable, which is parental economic expectation for child's education, measured by intra-household income inequality, is obtained by subtracting the child's father income from the income of his/her mother. A positive real number, implying a higher income for the father relative to the mother, was coded as 1 and 0 if otherwise.

5.3. Selection of Covariates

It is important to choose the right covariates in modeling the propensity score. Empirical studies and Monte Carlo simulations have proved that only true confounders (covariates that simultaneously influence the treatment and the outcome variables) and potential confounders (covariates that influence the outcome variable) should be included in the propensity score model. The exclusion of true confounders from the model violates the strongly ignorable assumption and will make the ATT estimate biased [44,49].

Following the steps of Moheyuddin (2005) [16], father's and mother's educational level (years spent in school), age of the child, place of residence (whether rural or urban), and wage earned by the child were used as confounders. Other covariates used include average minutes spent on domestic chores daily, marital status, and whether or not the respondent has a child. Thus, the aforementioned variables were used as independent variables in the propensity score model where economic expectations of parents served as the dependent variable. However, to achieve a balance in the covariates between the treated and control groups within each stratum, the square of the father's

education and the interaction of the father's and mother's education were included in the re-specified PS models.

6. Analysis of Data

6.1. Descriptive Statistics

This sub-section discusses the descriptive statistics for variables used in the separate PS models for boys and girls. The data confirms that parents in Ghana expect their sons to reap more economic benefits from education than girls. It was revealed that on a scale of 0 to 1, boys had an average of 0.53 in terms of expectation from parents, compared to 0.49 for girls. Table 1 displays the statistics for the continuous variables while Table 2 portrays that of the categorical variables. As shown in Table 1, the mean years of schooling of parents of girls outweighed that of boys. Fathers of girls spent an average of 8.92 years in school, while their mothers have 6.84 schooling years. The number for fathers and mothers of boys stood at 8.86 and 6.68 years respectively. Also, girls of SSS/SHS going age earned more weekly wages (₵111.74 GH ≈ $21.4 USD) and spend more minutes on domestic chores (169 min) than their male counterparts. The respective figures for boys are ₵99.51 GH ≈ $18.15 USD and 55 min, respectively.

Table 1. Descriptive statistics of continuous variables.

Variables	BOYS		GIRLS	
	Mean	Std. Dev.	Mean	Std. Dev.
Father's education	8.86	4.10	8.92	4.40
Mother's education	6.68	3.99	6.84	3.90
Child's wage	99.51	41.34	111.74	38.05
Av. minutes on domestic chores	55	8.07	169	34.86

Table 2. Descriptive statistics of categorical variables.

	BOYS		GIRLS	
Variables	**Number**	**Percent (%)**	**Number**	**Percent (%)**
SSS/SHS Enrolment				
No	960	70.18	785	70.66
Yes	408	29.82	326	29.34
Residence				
Urban	344	25.15	273	24.57
Rural	1024	74.85	838	75.43
Age Cohort				
15–19	1102	80.56	931	83.80
20–24	226	16.52	154	13.86
25–29	40	2.92	26	2.34
Marital Status				
Yes	78	5.70	476	42.84
No	1290	94.30	635	57.16
Do you have a Child				
Yes	33	2.41	211	19.0
No	1335	97.59	900	81.0

The percentage of boys who have ever been enrolled in a senior secondary slightly surpassed proportion for girls. Table 2 showed that 29.82% of boys of the relevant age have obtained senior secondary education. The rate for girls was 29.34%. The percentage of boys who reside in urban areas (25.15%) marginally exceeded their female counterparts (24.57%). More girls than boys aged between 15 and 19 years have been enrolled in senior secondary schools. However, the proportions of boys of age cohort 20–24 and 25–29 years old who have had senior secondary education are more than girls of

the same age groups. The ratio of secondary and tertiary school-going age girls who are married and have at least a child to boys is 10:1.

6.2. Covariate Balance Diagnosis

A critical component of propensity score matching is the balancing of covariates between the treated and untreated groups. If the covariates between the two groups are not balanced, the average treatment effect on the treated (ATT) cannot be computed as the difference in the means (in the case of continuous outcome variable) or proportions (in case of dichotomous outcome variable) of the outcome variable. There are several statistical tools used in checking the balance of these pre-treatment variables between the two groups. They include the t-test, the standardized difference, and other graphical displays such as the box plots and cumulative frequency function. In the event where these tools prove that there is no equality between the covariates in the treated and untreated groups, the PS model has to be re-specified to include higher-order moments of covariates and/or interactions between covariates [43,44].

The PS model of the study initially used the father's and mother's education together with residence of household, the respondent's age, and their weekly wages as the pre-treatment characteristics. After classifying the subjects into strata, the balancing diagnosis revealed that the covariates between the two groups were not balanced. The "troublesome" variable was father's education, which was not balanced in most of the strata. The square of father's education and an interaction between the former and mother's education were included in the re-specified PS model.

Results from the simple t-test indicated that the difference between means of each covariate in the treated and control groups within each stratum was not statistically significant as portrayed by Table A1 in the Appendix A. Table A1 reports the p-values of the t-test for the mean difference of each of the pre-treatment variables within each stratum. All the p-values exceeded 5% implying that there was no significant difference between the control and treated classes at 5% significant level. Balancing of covariates in the boys' PS model was achieved with six strata, while five blocks were enough for the girls' model to attain equality. Table A2, which showed the standardized difference before and after the matching, confirmed the results from the t-test (readers can resort to Li (2013) [43] for a detailed explanation on standardized difference). A standardized difference (SD) of less than 0.1 is considered negligible and hence no significant difference between the means of variable in the two groups [44]. All the variables had SD values of more than 0.1 before the matching was done. The matching, however, reduced the SD for each of the covariates to figures less than the threshold value.

Numerical analysis of balance of covariates takes into account the means of the variables and in some cases their standard deviations. This approach has a limitation as it considers only one or two dimensions of the variable. The means of the variable between the two groups may be the same but their mode, median, quantiles and other statistical summaries may differ. Linden (2015) [50] proposed the use of graphical displays to assess how equal the variable is between the two groups in terms of multiple dimensions. Since the estimated propensity score summarizes the distribution of all the covariates, the study employed the box plot and the cumulative frequency function of the estimated propensity score of the treated and untreated groups to assess the equality of the covariates. Figure A2 shows the box plots for boys and girls, while Figure A3 displays the cumulative frequency of their estimated propensity scores between the groups. The figures demonstrated that, in the case of both boys and girls, there is no statistical difference of the composite covariates (estimated PS) between the treated and control groups.

6.3. Estimating Causal Effect

After the covariates between the treated and control groups have been balanced within each stratum, the average treatment effect on the treated (ATT) was computed using the stratified matching. The formula for stratified matching is expressed as

$$ATT = \sum_{q=1}^{Q}\left(\frac{\sum_{i\in I(q)} Y_i^T}{N_q^T} - \frac{\sum_{j\in I(q)} Y_j^C}{N_q^C}\right) * \frac{N_q^T}{N^T} \quad (1)$$

where Q is the number of strata used to achieve a balanced covariate, and Y_i^T and Y_j^C represent the value of the outcome variable for subject i in the treated group and its paired subject j in the control group respectively. N_q^T and N_q^C are the number of treated and control subjects in block q. N^T, on the other hand, is the number of treated subjects in the entire study.

Estimates from the stratified matching showed that the ATT effect of parental expectation of the economic benefit of education on boys' enrolment in senior secondary is 0.048 while the effect on girls figured around 0.029. The estimate for boys is significant at 5%, while that of girls is 10%.

6.4. Sensitivity Test

The last step in PSM analysis is to assess the sensitivity of the causal estimates to unobserved confounders. The ideal way is to compare the ATT estimate with the results of a similar study that used an experimental data. However, such results may be unavailable in a practice setting. An alternative approach is to re-specify the PS model by dropping or adding higher-order covariates such as quadratic or interaction terms. If the original estimated effect does not differ significantly from the re-specified model, then the ATT estimate is less sensitive and hence unbiased [43].

The squared of father's education as well as the interaction of the former and mother education were dropped to re-calculate the propensity score and ATT. The estimation results after dropping those variables indicated that parental economic expectation increase boys' senior secondary education by 0.043, and the effect for girls stood at 0.027. The new estimates pointed out that the original ATT estimates are insensitive and therefore unbiased.

Furthermore, Figure A4 in the Appendix A indicated that there is an overlap in the distribution of covariates between the treated and untreated group for both genders. This validates the results obtained in Table 3.

Table 3. Estimation results of stratified matching.

Outcome Variables: Enrolment in SSS/SHS	**BOYS**			**GIRLS**		
	ATT	**Std. Error**	**P**	**ATT**	**Std. Error**	**P**
Treatment Variable:						
Parental economic expectation	0.048	0.023	0.036	0.029	0.017	0.087

7. Discussion and Conclusions

Ghana, like most sub-Saharan African countries, continues to bedevil with gender imbalance at the higher levels of the educational hierarchy. Among the several socioeconomic factors that account for why more girls than boys do not attain secondary education is parental expectation of the economic benefits their sons and daughters will gain from education. This study investigated the role that this variable plays on gender disparity in the senior secondary schools. The data revealed that, on the average, Ghanaian parents expect their sons to reap more economic benefits from education than their daughters. The higher expectation for boys encourages parents to invest more in their sons' education compared to their daughters. Results from Table 3 showed that parental expectation for sons increase the probability of boys' enrolment in a senior secondary school by 0.048 while the figure for girls is 0.029 [51]. The estimate for boys is significant at 5%, while that of girls is 10%. Thus, boys are 1.66

times more likely than girls to attain senior secondary education due to parents' expectation that they (boys) will gain more economically from education than girls.

The finding is consistent with the assertion in the literature that there is a positive relationship between parental expectation on education and academic achievements [26–30]. Ghanaian parents invest more monies and spend quality time on their sons' education as against that of their daughters because they believe that top positions and high-paying jobs on the labor market is male-dominated and therefore boys will gain more economically from education than girls. Also, the confidence of boys is boosted because they know their parents expect more from them academically than girls. This confidence becomes the norm, which motivates them (boys) to attain higher levels of education [36].

The study employed propensity score matching (PSM) in its analysis. This estimation technique is preferred to other methods because it overcomes the problem of self-selection bias inherent in observational data. Self-selection bias—the likelihood that some subjects will be selected into the treated group and others into the control group based on some pre-treatment characteristics—threatens the validity of causal estimates. If not solved, estimated results will be biased and uninterpretable. PSM is a good estimation method that eliminates the endogeneity that arises from self-selection bias. PSM is becoming increasingly proper because of its ability to reconstruct observational data to mimic an experiment, which is the gold standard for making causal inferences. Our estimates are therefore free from bias resulting from self-selection and hence are unbiased and interpretable. The sensitivity analysis allowed us to test how susceptible the estimates are to other cofounders. The results showed that our estimates are less sensitive to the inclusions or exclusions of other variables.

The findings from the study revealed that a plausible solution to combat gender inequality in Ghana's educational system, especially at the higher levels, is to eliminate gender imbalances at the workplace. Men continue to be over-represented at top positions and high-paying jobs. This deepens the negative traditional view parents have about the future prospects of the female children. Appropriate policies should be implemented to ensure that barriers that prevent women from occupying such positions are expunged. With this, parents will believe that girls can have the same economic opportunities as boys and hence will invest equal resources in their children irrespective of their gender.

It is, however, important that Ghanaian parents change their stereotypical notion that girls from household where there is income inequality in favor of men will earn less income from education. This is so because, if given an equal opportunity, girls from such homes can outperform their male counterparts in the pursuit of higher levels of education that can consequently eliminate the gender gap in wages on the Ghanaian labor market.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

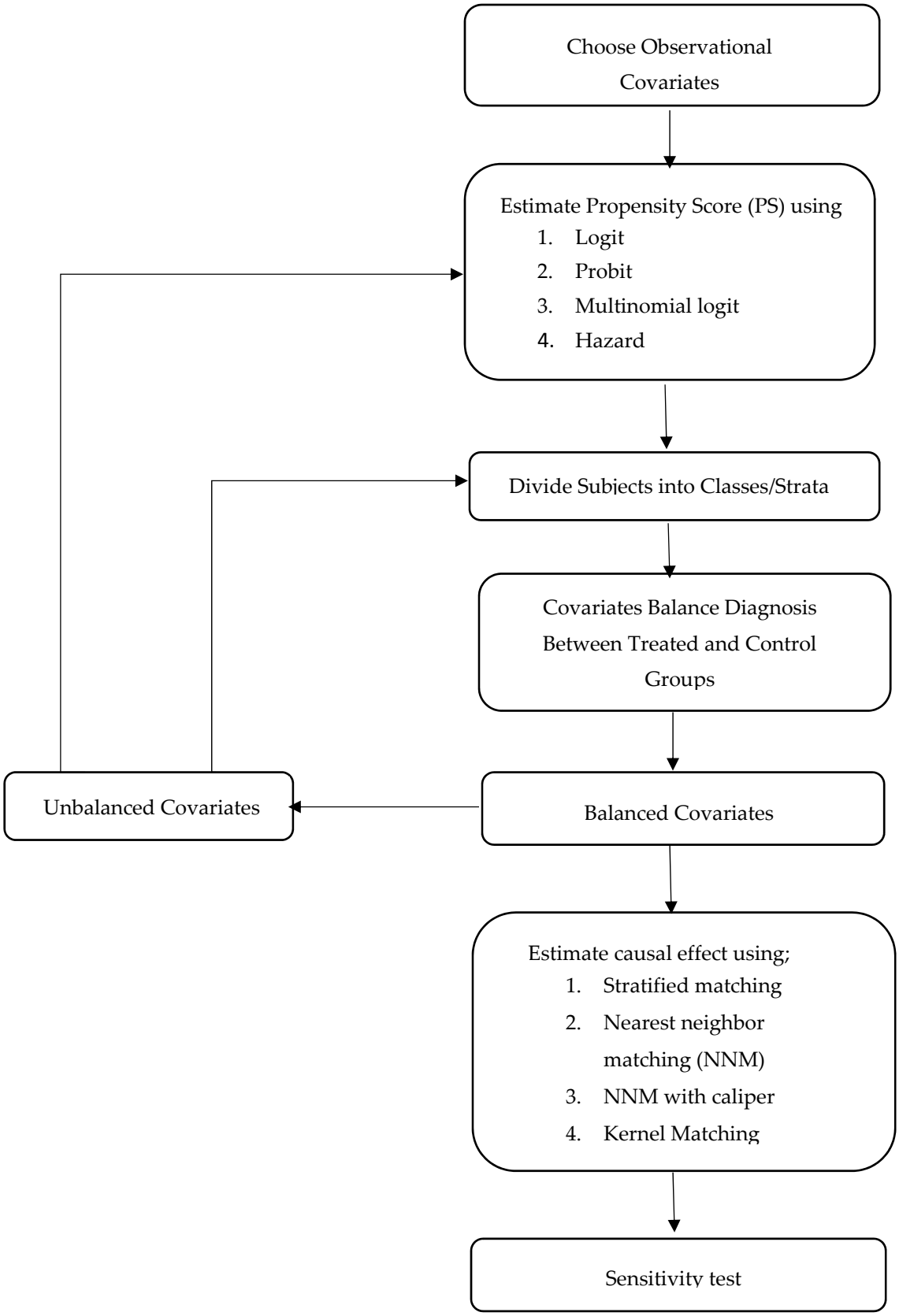


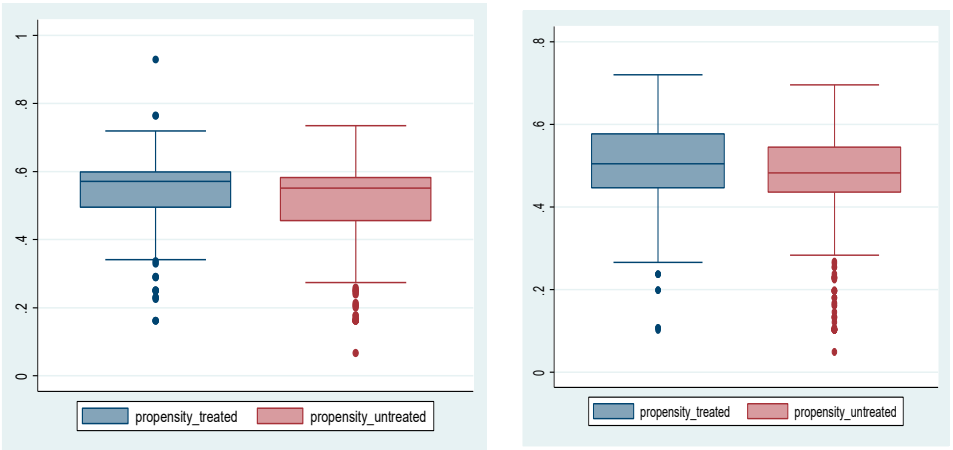
Figure A1. Steps for estimating treatment effect. Source: Li (2013) [43].

Table A1. Simple t-test for a balancing covariate diagnosis within each block/stratum.

	BOYS						GIRLS				
	BLOCKS						BLOCKS				
Covariates	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**
Father's education	0.558	0.479	0.186	0.712	0.743	0.634	0.271	0.456	0.378	0.487	0.436
Mother's education	0.462	0.334	0.183	0.486	0.558	0.523	0.251	0.612	0.734	0.911	0.861
Father's education squared	0.623	0.678	0.217	0.567	0.849	0.734	0.379	0.780	0.374	0.442	0.156
Father's education * mother's education	0.634	0.754	0.237	0.487	0.778	0.321	0.265	0.623	0.278	0.746	0.192
Age cohort											
20–24	0.436	0.643	0.742	0.487	0.543	0.321	0.263	0.434	0.446	0.251	0.532
25–29	0.345	0.231	0.666	0.442	0.521	0.438	0.334	0.276	0.430	0.428	0.174
Urban	0.329	0.342	0.267	0.633	0.361	0.236	0.982	0.192	0.534	0.357	0.242
Child's wage	0.374	0.734	0.323	0.234	0.442	0.723	0.623	0.293	0.634	0.147	0.542
Av. minutes on domestic chores	0.436	0.589	0.443	0.678	0.111	0.456	0.671	0.231	0.432	0.387	0.789
Married	0.547	0.182	0.206	0.421	0.657	0.231	0.875	0.145	0.213	0.553	0.331
Has a child	0.324	0.475	0.396	0.392	0.775	0.423	0.666	0.452	0.334	0.213	0.423

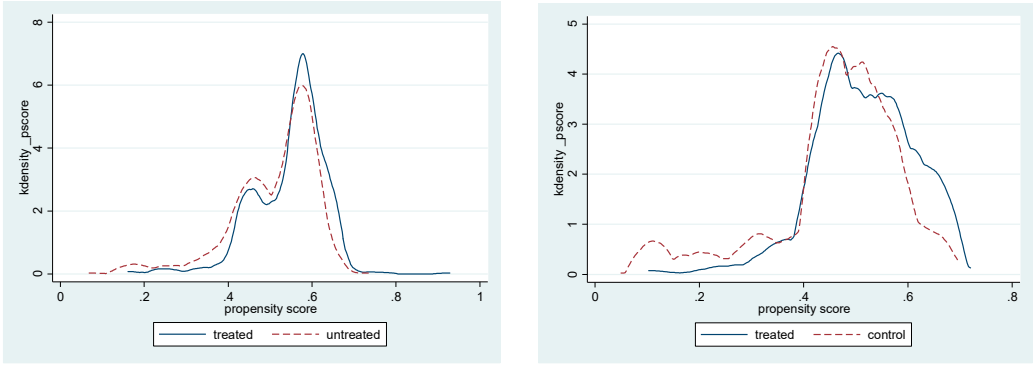
Table A2. Standardized difference of covariates before and after matching.

	BOYS		GIRLS	
	Standardized Difference		Standardized Difference	
Covariates	**Unmatched**	**Matched**	**Unmatched**	**Matched**
Father's education	10.3	0.002	3.2	−0.03
Mother's education	3.2	0.035	3.1	0.007
Father's education squared	7.9	−0.073	4.8	0.057
Father's education * mother's education	−8.3	0.024	1.7	0.003
Age cohort				
20–24	−13.7	−0.032	5.7	−0.06
25–29	2.6	0.048	−10.5	0.047
Urban	−9.5	−0.003	5.2	−0.038
Child's wage	6.9	0.019	−9.8	0.028
Av. minutes on domestic chores	8.9	0.076	−10.6	0.068
Married	−1.7	−0.002	4.1	0.005
Has a child	2.4	0.056	6.2	−0.045



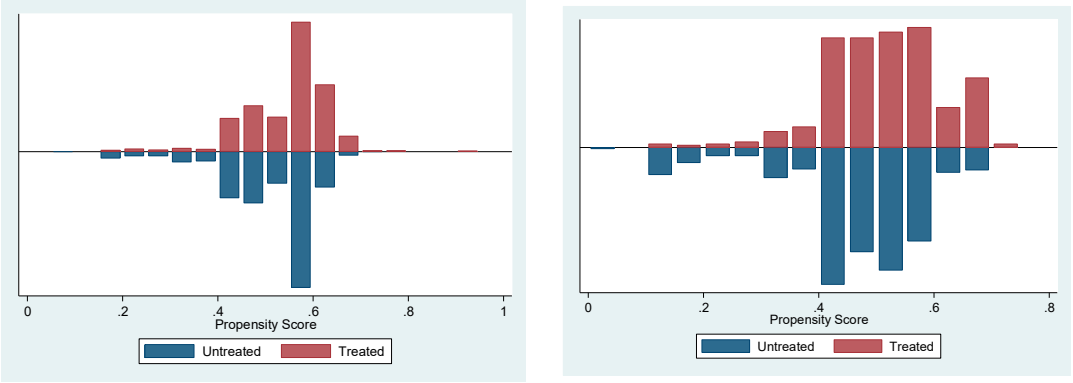
(a) BOYS **(b) GIRLS**

Figure A2. Box plots of estimated propensity score for treated and untreated class.



(a) BOYS **(b) GIRLS**

Figure A3. Cumulative density function of estimated propensity score for treated and untreated class.



(a) BOYS **(b) GIRLS**

Figure A4. Distributional overlap of covariates between untreated and untreated groups.

References

1. Reeves, H.; Baden, S. *Gender and Development: Concepts and Definitions*; BRIDGE—Institute of Development Studies, Report No. 55; University of Sussex: Brighton, UK, 2000.
2. GCE. Gender Discrimination in Education: The Violation of Rights of Women and Girls. Available online: www.campaignforeducation.org/docs/reports/GCE_INTERIM_Gender_Report.pdf (accessed on 15 June 2019).
3. USAID. Education from a Gender Equality Perspective. 2008. Available online: www.ungei.org/resources/files/Education_from_a_Gender_Equality_Perspective.pdf (accessed on 13 June 2019).
4. USAID. Gender and Extreme Poverty: Getting to Zero. 2015. Available online: https://www.usaid.gov/sites/default/files/documents/1870/Gender_Extreme_Poverty_Discussion_Paper.pdf (accessed on 13 June 2019).
5. Sheehan, K. Does Gender Inequality in Education Affect Educational Outcomes? Bachelor's Thesis, University of Connecticut, Storrs, CT, USA, 2012.
6. Bandiera, O.; Natraj, A. Does gender inequality hinder development and economic growth? Evidence and policy implications. In *Policy Research Working Paper WPS6369*; The World Bank Group: Washington, DC, USA, 2013.
7. Burgess, S. *Human Capital and Education: The State of the Art in the Economics of Education*; IZA DP No. 9885; Institute for the Study of Labor: Bonn, Germany, 2016.
8. Marimuthu, M.; Arokiasamy, L.; Ismail, M. Human capital development and its impact on firm performance: Evidence from developmental economics. *J. Int. Soc. Res.* **2009**, *2*, 265–272.
9. Kwon, D.-B. Human Capital and Its Measurement. In Proceedings of the 3rd OECD World Forum on "Statistics, Knowledge and Policy" Charting Progress, Building Visions, Improving Life, Busan, Korea, 27–30 October 2009.
10. Krasniqi, F.X.; Topxhiu, R.M. The importance of investment in human capital: Becker, Schultz and Heckman. *J. Knowl. Mgt. Econ. Inf. Technol.* **2016**, *6*, 1–18.

11. McConnell, R.C.; Brue, S.L.; Macpherson, D.A. *Contemporary Labour Economics*, 11th ed.; McGraw Hill Education: New York, NY, USA, 2016.
12. OECD. *The ABC of Gender Equality in Education: Aptitude, Behaviour, Confidence*; PISA, OECD Publishing: Paris, France, 2015.
13. UN. *The World's Women 2015: Trends and Statistics*, 6th ed.; Department of Economic and Social Affairs, Statistics Division: New York, NY, USA, 2015.
14. Wodon, Q.; De la Briere, B. *The Cost of Gender Inequality Unrealized Potential: The High Cost of Gender Inequality*; The World Bank Group: Washington, DC, USA, 2018.
15. Baah-Boateng, W. Human capital development: The case of education as a vehicle for Africa's economic transformation. *Leg. J. Int. Aff. Dip.* **2013**, *7*, 31–55.
16. Moheyuddin, G. *Gender Inequality in Education: Impact on Income, Growth and Development*; MPRA Paper No. 685; Munich Personal RePEc Archive: Munich, Germany, 2005.
17. Chimombo, J.; Chibwanna, M.; Dzimadzi, C.; Kunkwenzu, E.; Kunje, D.; Namphota, D. *Classroom, School and Home Factors That Negatively Affect Girls' Education in Malawi*; A Report Submitted to UNICEF; CERT: New York, NY, USA, 2000.
18. Shahidul, S.M.; Karim, A.H.M.Z. Factors contributing to school dropout among the girls: A review of literature. *Eur. J. Res. Reflect. Educ. Sci.* **2015**, *3*, 25–36.
19. Emmanuel, L. The Influence of Household Chores on Girls' Academic Performance in Secondary School in Morogoro Rural District. Master's Thesis, The Open University of Tanzania, Arusha, Tanzania, 2015.
20. Okepechi, P.A.; Eloma, U.E.; Bassey, E.E. Negative effects of domestic chores on role performance of academic women in tertiary institutions and the need for effective management and counselling in Cross River State—Nigeria. *Int. J. Educ. Learn. Dev.* **2016**, *4*, 12–22.
21. Adam, S.; Adom, D.; Bediako, A.B. The major factors that influence basic school dropout in rural Ghana: The case of Asunafo South District in the Brong Ahafo Region of Ghana. *J. Educ. Pract.* **2016**, *7*, 1–8.
22. Kipkulei, B.C.; Chepchieng, M.C.; Chepchieng, M.J.; Boitt, L.M. Selected factors affecting girls' participation in primary school education in Kenya. *J. Educ.* **2012**, *48*, 52–61.
23. GSS. *Ghana Living Standards Survey (GLSS 6)*; Ghana Publication Ltd.: Accra, Ghana, 2014.
24. Anku-Tsede, O. Maternity leave policy and work-family balance: Evidence from working mothers in Ghana. *Bus. Mgt. Res.* **2015**, *4*, 1–7.
25. Nyantakyiwaa, A. Leadership styles practiced by females in leadership positions in the University of Cape Coast. *Int. J. Res. Soc. Sci.* **2014**, *4*, 52–58.
26. Clophus, L.M.K. The Relationship between Parental Expectations and Post-Secondary Choices of High School Seniors. Ph.D. Thesis, Liberty University, Lynchburg, VA, USA, 2018.
27. Kim, Y.; Huang, J.; Sherraden, M.; Clancy, M. Child development accounts, parental savings, and parental educational expectations: A path model. *Child. Youth Serv. Rev.* **2017**, *79*, 20–28. [CrossRef]
28. Banks, J.; Maitre, B.; McCoy, S.; Watson, D. *Parental Educational Expectations of Children with Disabilities*; Research Series No. 50 Dublin 2; The Economic and Social Research Institute: Dublin, Ireland, 2016.
29. Wang, X. The Influences of Parental Expectations on Children's Academic Achievements: A Comparative Analysis of the United States and China. Master's Thesis, Loyola University, Chicago, IL, USA, 2013.
30. Jacob, M.J. Parental Expectations and Aspirations for Their Children's Educational Attainment: An Examination of the College-Going Mindset among Parents. Ph.D. Thesis, University of Minnesota, Minneapolis, MN, USA, 2010.
31. Antonakis, J.; Bendahan, S.; Jacquart, P.; Lalive, R. On making causal claims: A review and recommendations. *Leadersh. Q.* **2010**, *21*, 1086–1120. [CrossRef]
32. Baden, S.; Green, C.; Otoo-Oyortey, N.; Peasgood, T. Background Paper on Gender Issues in Ghana. Available online: https://pdfs.semanticscholar.org/ddee/86acfcd0087228b142ff469155aa27c696f3.pdf (accessed on 23 July 2019).
33. Wolf, S.; McCoy, D.C.; Godfrey, E.B. Barriers to school attendance and gender inequality: Empirical evidence from a sample of Ghanaian schoolchildren. *Res. Comp. Int. Educ.* **2016**, *11*, 178–193. [CrossRef]
34. The World Bank. World Development Indicators. Available online: https://data.worldbank.org/country/ghana?view=chart (accessed on 18 July 2019).
35. GSS. *Ghana Demographic and Health Survey*; Ghana Publications Ltd.: Accra, Ghana, 2014.

36. Yamamoto, Y.; Holloway, S.D. Parental expectations and children's academic performance in sociocultural context. *Educ. Psychol. Rev.* **2010**, *22*, 189–214. [CrossRef]
37. Englund, M.M.; Luckner, A.E.; Whaley, G.J.L.; Egeland, B. Children's achievement in early elementary school: Longitudinal effects of parental involvement, expectations, and quality of assistance. *J. Educ. Psychol.* **2004**, *96*, 723–730. [CrossRef]
38. Gill, S.; Reynolds, A.J. Educational expectations and school achievement of urban African-American children. *J. Sch. Psychol.* **1999**, *37*, 403–424. [CrossRef]
39. O'Donnell, C. Impact of parental expectations on education and employment outcomes. In *Virginia Policy Review*; University of Virginia: Charlottesville, VA, USA, 2007; pp. 14–22.
40. Weerasinghe, D.; Panizzon, D. A cross-cultural comparison of parental expectations for the mathematics achievement of their secondary school students. In *Mathematics Education in the Margins, Proceedings of the 38th Annual Conference of the Mathematics Education Research Group of Australasia*; Mathematics Education Research Group of Australasia (MERGA): Adelaide, Australia, 2015; pp. 635–642.
41. Leung, J.T.Y.; Shek, D.T.L. Expecting my child to become "dragon"—Development of the Chinese parental expectation on child's future scale. *Int. J. Disabil. Hum. Dev.* **2011**, *10*, 257–265. [CrossRef]
42. Zhan, M. Assets, parental expectations and involvement, and children's educational performance. *Child. Youth Serv. Rev.* **2006**, *28*, 961–975. [CrossRef]
43. Li, M. Using the propensity score method to estimate causal effects: A review and practical guide. *Organ. Res. Methods* **2013**, *16*, 188–226. [CrossRef]
44. Austin, P.C. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivar. Behav. Res.* **2011**, *46*, 399–424. [CrossRef]
45. Morgan, S.L.; Winship, C. *Counterfactuals and Causal Inference: Methods and Principles for Social Research*, 1st ed.; Cambridge University Press: Cambridge, UK, 2007.
46. Clougherty, J.; Duso, T. *Correcting for Self-Selection Based Endogeneity in Management Research: A Review and Empirical Demonstration*; Working Paper No. 1465; German Institute of Economic Research: Berlin, Germany, 2015.
47. Rosenbaum, P.R.; Rubin, D.B. The central role of the propensity score in observational studies for causal effects. *Biometrika* **1983**, *70*, 41–55. [CrossRef]
48. Cochran, W.G. The effectiveness of adjustment by subclassification in removing bias in observational studies. *Biometrika* **1968**, *24*, 295–313. [CrossRef]
49. Caliendo, M.; Kopeinig, S. *Some Practical Guidance for the Implementation of Propensity Score Matching*; IZA DP No. 1588; Institute for the Study of Labor: Bonn, Germany, 2005; Available online: http://ftp.iza:dp1588.pdf (accessed on 25 November 2019).
50. Linden, A. Graphical displays for assessing covariate balance in matching studies. *J. Eval. Clin. Prac.* **2015**, *21*, 242–247. [CrossRef] [PubMed]
51. Austin, P.C. A tutorial and case study in propensity score analysis: An application to estimating the effect of in-hospital smoking cessation counseling on mortality. *Multivar. Behav. Res.* **2011**, *46*, 119–151. [CrossRef] [PubMed]

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Gender and Academic Rank in the UK

Georgina Santos [1,*] and Stéphanie Dang Van Phu [2,3]

[1] School of Geography and Planning, Cardiff University, Cardiff CF10 3WA, UK
[2] Department of Economics, École Polytechnique ParisTech, 91128 Palaiseau, France; stephanie.dang-van-phu@polytechnique.org
[3] Nexialog Consulting, 75011 Paris, France
* Correspondence: SantosG@Cardiff.ac.uk

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Abstract: This paper fills in a research gap in what concerns gender and academic rank at UK universities, where women are not far from reaching the 50% share of all academic and research staff, but not even close to reaching such a share at (full) professorial level. Using an ordered logit model and the results of a survey conducted in 2013 with 2270 responses from academics from all fields of knowledge at the 24 Russell Group universities, we find three consistent results. First, being a woman has a negative and significant association with academic rank, except for the case when parenthood is timed with career considerations in mind. Second, the percentage of time spent on teaching and teaching-related activities has a negative and statistically significant association with academic rank. This association is more pronounced in the case of women, who spend a higher percentage of their working time on teaching and teaching-related activities than men, as do those in lower academic ranks. Since women tend to be in lower ranks, the percentage of time spent on teaching and teaching-related activities may be considered both a cause and a result of the gender gap. Third, we find a positive and significant association between the number of children under the age of 18 years and the academic rank of both men and women, as long as babies were timed with career considerations in mind, and a non-significant association when they were not. A possible explanation for this is unlikely to be that children have a positive impact on academic rank, but rather that they arrived after a certain rank had been secured. We conclude with some policy recommendations to help reduce the gender gap.

Keywords: gender discrimination; academic progression; women faculty; female professors; maternity penalty; gender gap

1. Introduction

In 2011/2012, 44.5% of all the academic staff employed at UK Higher Education Institutions were female, yet only 20.3% of professors, which is the highest academic rank in the UK, were women [1]. Focusing on the 24 Russell Group universities in the UK, which are research-intensive universities, in 2011/2012, 40.7% of all academic staff at these 24 universities were female (a share somewhat lower than that at all UK universities) and from all professors only 18.9% were women [2].

Although all universities in the UK value diversity and are committed to equality of opportunity, women are under-represented at senior academic grades. If current trends continue, it will be decades before gender equality at professorial level is reached.

Using an ordered logit model and a new rich and detailed data set, which we collected in 2013, with 2270 observations of academics of both genders at all levels in all fields of knowledge at the 24 Russell Group universities in the UK, we contribute to the literature by examining the association between gender and academic rank, controlling for a number of variables, including but

not limited to, respondent's year of birth, number of children, responsibility for household chores, academic degrees, number of publications, grants, percentage of working time spent on teaching and teaching-related activities, and main area of research. This is timely and relevant, given that the last empirical quantitative study to include UK-based academics of all fields of knowledge was conducted in the year 2000; the results of that study are reported in [3].

We find some results in line with previous work conducted for other countries or for specific fields of knowledge and some novel ones. First, being a woman has a negative association with academic rank, even after controlling for year of birth (i.e., age), marital status, responsibility for household chores, area of research, timing of babies, number of children under the age of 18 years, holding a PhD or not, percentage of working time spent on teaching and teaching-related activities, and a number of research productivity variables. The only case where the variable gender is not significant is when only men and women who timed their children with career considerations in mind are included in the sample. Importantly, we also find that the percentage of time spent on teaching and teaching-related activities, which is higher for women than for men, is negatively associated with academic rank. In addition, and this can be seen as our most important and novel finding, there is a positive association between the number of children under the age of 18 years and the academic rank of both men and women, as long as babies were timed with career considerations in mind. A possible explanation for this is unlikely to be that children help academic career progression, but rather that they arrived after a certain rank had been secured. Timing of children seems to be crucial.

The paper proceeds as follows. Section 2 reviews the most recent and prominent literature on the topic, which, apart from [3], lacks any quantitative study specifically designed for the UK. Section 3 explains how the data were collected. Section 4 presents the model. Section 5 discusses the results. Section 6 concludes and gives some policy recommendations.

2. Previous Work

The potential explanations for the gender imbalance in academia tend to fall under two categories: (a) Women work fewer hours than their male counterparts because their time constraints are more stringent, and as a result progress at a slower rate than men, with a lower percentage making it to the grade of professor; and (b) Women are discriminated against, and inadvertently, denied opportunities that could give them access to high rank positions.

The time constraints hypothesis argues that women need to, want to, or choose to devote time to raising their children and/or taking responsibility for household chores, whilst their male counterparts devote this time to productive work or leisure. The idea is essentially that women with responsibilities for housework and childcare have less energy available for remunerated work than men have, and this affects their job opportunities and productivity [4]. Some authors argue that many high-end jobs require virtually complete commitment to work, and go on to assert that more men than women are prepared to devote themselves to work so fully [5,6]. As a side note, some also hold controversial views regarding innate cognitive and temperamental differences between men and women [5,6]. This topic, however, falls under the remit of sociology, psychology, biology, and related sciences, and is therefore not discussed in the present study.

It has also been argued that women, especially those with children, face more family-work -balancing challenges than men [3,7]. A number of studies carried out in different Schools at MIT [8] and a European Commission report [9] also found that family and career tensions were greater for women than for men.

The association between marriage and children and academic rank, salary, and research productivity, however, is far from clear. One study finds that children have a negative effect on academic careers of women and a positive effect on academic careers of men [10]. On somewhat similar lines, another study finds that marriage and young children (under 6 years of age) reduce the probability that women get a tenure-track job [11]. Two further studies find a non-significant association between marriage and promotion, and a positive and significant association between

children and male promotion but a negative, albeit non-significant, association between children and female promotion (in the humanities) (p. 400 [12]) and (p. 51 and p. 62 [13]). Another study finds a positive and significant association between young children and male economists' promotion chances and a negative association between marriage and children and female economists' tenure chances [14]. On the other hand, academics who have older children (aged 6 to 17 years) have been found to have a greater chance of getting tenure, relative to academics without children in this age range, regardless of their gender, probably because children trigger the need to secure ongoing employment [11]. There may also be selection effects because these children were under the age of six years when their parents were completing their doctorates or securing tenure-track positions, and academics, especially women, who manage to do all that whilst simultaneously caring for young children may be especially good at managing their time and the demands of work and family or may have received more support from their partners (p. 400 [11]).

Another study, in turn, finds that having children and having a spouse or partner employed at the same institution are unrelated to tenure and rank among women faculty but having children has a positive association with both tenure and rank for men, who also benefit from being married in terms of their academic rank (p. 301 [15]). Other research finds a positive association between being married or living with a partner and salary [16].

One point that a number of studies find is that academic women are less likely to be married with children, relative to academic men [3,10,13–15], or they are more successful if they delay or forgo marriage and children [11]. It is not clear, however, whether this is a decision women make because they fear that by having children they will jeopardize their careers, even though in reality having children may have made no difference, or whether thanks to the decision of not having children they were able to progress, something they would have not been able to do had they had children. Although intuition would point towards a negative impact of children on the academic progression of women, and this is supported by solid microeconomic theory such as that presented in [4], the evidence, as shown above, is far from conclusive.

Publications are typically considered a key factor for academic progression. In general, publications have a positive association with rank and promotion [13,14,17–20], although there is also some evidence that male economists on tenure-track positions get tenure regardless of their publications (p. 203 [14]). At the same time, on average men produce more publications than women, and this is found across different disciplines [12,14,17,21–28], although the results reported in [13] suggest very small differences.

Women spending more time with their children than men do, especially when they are of preschool age, could potentially be linked to lower publication rates [7,25]. One study, for example, concludes that untenured male economists become substantially more productive after having a first child but female economists with two and three children have, on average, a research record reflecting a loss of two and a half years and four years of research output, respectively, by the time all of their children have reached their teens [28].

On the other hand, a review examining the relationship between marriage, children, and research productivity concludes that there is no evidence of a negative effect of family factors on the research productivity of women (p. 18, p. 99 and p. 189 [29]), in line with [14,27,30,31]. Interestingly, though, another study finds a positive relationship between having children and research productivity for female economists but no relationship for male economists [32]. This same study also finds that women with children are more productive than women without children, as well as some evidence of self-selection that may explain this counterintuitive result: only the most productive women dare to pursue an academic career and have children at the same time [32].

Grants are also typically considered important for promotion, and indeed there is a positive association between grants and promotion [18]. Blake and La Valle [3], whose study actually focuses on grant applications, find that in the five-year period prior to their survey, from those who were eligible to apply, women were less likely than men to have applied for grants, with 56 per cent applying in contrast to 67 per cent of men (p. 36), and women with children were also less likely to have applied

for grants than men with children, with 50 per cent applying in contrast to 62 per cent of men (p. 104). Having said all that, Blake and La Valle find that the success rate for grant applications is virtually the same for men and women and conclude that there is no gender bias in the awarding processes (p. 37 [3]). The main difference between men and women, they argue, "lies in application behaviour rather than in success once applications have been made" (p. 37 [3]). This finding of no gender differences in the outcomes of grant applications is in line with [33–35], but in contrast with [36–39].

Notwithstanding all of the above, lower grant application activity and lower number of publications in absolute and relative terms may be explained not just by time constraints due to housework or childcare but also by time constraints imposed in the very workplace, for example, with higher teaching or administrative workloads [3,18,20,22,23,25,27]. Higher teaching or administrative workloads on women could be the result of subtle discrimination. Needless to say, very rarely is there any blatant open discrimination in academia but a theme that emerges from the literature is that there may be forms of (sometimes unconscious) discrimination that are concealed, almost unnoticeable, and therefore harder to identify. Examples of studies which point towards this unconscious bias against women include [10–13,15,17,19,40], all of which find a gender gap in academic rank or salary, which remains unexplained after controlling for credentials, productivity and/or family circumstances, amongst other variables. One study, however, finds unexplained differences in promotion to tenure in some disciplines, but discrimination in favour of women in engineering [14]. Bias in grant awarding has also been found, as mentioned above, in [36–39].

Given the importance that the hypotheses of time constraints and workplace discrimination have received in the literature, we concentrate on these two perspectives as prime suspects to help explain the low representation of women in higher academic ranks. Despite the rich literature on gender and academic progression, this is the largest quantitative study to have been carried out for the UK case since Blake and La Valle's in 2000 [3].

3. Data

We conducted a questionnaire amongst male and female academics, which can be found in Appendix A, and is virtually the same as that conducted by Blake and La Valle in 1999/2000 [3]. After piloting it, it went live and was open for responses from 29 May to 1 July 2013.

The sample was drawn from the 24 Russell Group universities in the UK, which were arranged in alphabetical order. The Research Excellence Framework (REF) in the UK is the system used for assessing the quality of research in UK higher education institutions. Submissions to the REF in 2013 were made in 36 units of assessment, or fields of research. Up to ten out of the 36 REF areas, which are listed in Appendix B, were randomly chosen for each of the 24 universities. The departmental websites representing the randomly selected REF areas were then used to identify all members of academic and research staff. In some cases, REF areas include more than one area, which meant a number of departments were contacted. For example, REF area 4 includes Psychology, Psychiatry and Neuroscience. If that area was randomly selected for a university, staff at all three departments were contacted if all three were represented at the institution in question. If not all departments were represented, then those that were, were the ones contacted. If an area was randomly selected for a university but had no presence at that university, another number between 1 and 36 was randomly selected. Typical cases include the London School of Economics and Political Science and Imperial College London, which are institutions with some degree of specialization where many of the 36 REF areas are missing.

A total of 13,556 names and e-mail addresses were manually collected. No scraping software of any sort was used at any point. These potential participants were then contacted by e-mail and invited to complete a survey online. Due to a number of people having left the departments in question but still being listed on their websites 886 mails were returned with a delivery failure notice. From the remaining 12,670 individuals, 2270 responded to the survey. The response rate was therefore 17.9%, but we still achieved our target of at least 2000 responses.

The response rate may have varied according to a number of reasons, and in order to correct for self-selection bias the data from the sample was weighted using post-stratification survey weights. Appendix B gives details of how weights were estimated to make our sample of 2270 respondents representative of the whole population of 62,637 individuals employed as academic and research staff at all 24 Russell Group universities in 2012, following the methodology proposed in [41,42].

4. Model

We use an ordered logit model to explore the variables that may be associated with the probability of a member of academic staff being appointed at a certain level. A member of staff's appointment is characterized as being separated into five ordered levels, which we call grade 6, grade 7, grade 8, grade 9, and grade 10, with different terms of contract (open-ended, on probation and fixed-term for grades 6, 7, and 8, and open-ended and fixed-term for grades 9 and 10). Grade 6, for example, is typically the entry level for a tenure-track academic member of staff, but it is also the level at which a postdoc on a fixed-term contract may be hired. Grade 10, at the highest end of the spectrum, is that of full professor. Most appointments at grades 9 or 10 are open-ended, although occasionally some are fixed-term. Very rarely, however, do they involve a probation period, and we only had two observations of grade 9 and two of grade 10 on probation, which we merged with those on open-ended contracts. This is not controversial because at UK universities those on probation are typically confirmed on open-ended contracts. The grading system across UK universities is fairly similar, as is the associated salary scale. Because each grade has an associated salary scale, grade and salary are virtually interchangeable at most departments and universities. The actual number given to a certain grade (6, 7, etc.) does not matter in itself as long as it is clearly defined.

In the survey we did not ask what grade respondents were appointed at, but rather, we asked for the title of their posts, so that these could be linked to a consistent grade scale which we defined as shown on Table 1.

Table 1. Grades.

Grade	Posts
6	Assistant Lecturer, Junior Lecturer, Research Assistant, Researcher, Research Fellow, Teaching Fellow
7	Researcher, Lecturer, Clinical Lecturer
8	Senior Lecturer, Senior Researcher
9	Reader, Associate Professor, Senior Researcher
10	Professor

Depending on personal preferences, an academic may prefer to be appointed at grade 9 on a fixed-term contract rather than at grade 7 on an open-ended contract, or vice versa. In other words, when grade and type of contract are combined, it is not possible to order all the possible combinations. Thus, an order can be established for:

(a) Grades 6 to 10 on probation and open-ended (i.e., excluding all fixed-term contracts);
(b) Grades 6 to 10 on fixed-term contracts (i.e., excluding all probation and open-ended contracts);
(c) Within each grade, fixed-term, probation and open-ended contracts.

Furthermore, fixed-term appointments, by definition, almost never lead to appointments at the professorial level. Thus, given that the aim of this study is to examine the association between gender and academic rank, which we also call grade, we exclude respondents on fixed-term contracts, which represent 26% of our sample, and focus on those either on probation or on open-ended contracts.

Having excluded the fixed-term contract cases, our dependent variable is grade, which ranges from grade 6 to grade 10, taking values 1 to 5 correspondingly. The type of contract can be either probation or open-ended and these two are not discriminated within this categorical variable.

We consider a number of independent variables detailed in Section 5 and use an ordered logistic model:

$$Grade^{*} = X' \times \beta + \varepsilon$$

where X is the column vector of individual characteristics and β is the column vector of coefficients to be estimated by the ordered logistic regression, with ε assumed to follow a logistic distribution.

5. Results and Discussion

All our results were computed with STATA. Tables 2 and 3 present all the variables we used and their descriptive statistics.

Table 2. Categorical variables and their descriptive statistics (unweighted sample).

Categorical Variables		Description	Frequency
Grade	1	Grade 6	50
	2	Grade 7	538
	3	Grade 8	428
	4	Grade 9	153
	5	Grade 10	477
		Missing values	624
Gender	0	Male	1210
	1	Female	1060
Marital status (defined as Dummies)		Partner (Married or Living with partner)	1736
		No partner (Separated, Widowed, Single or Other)	534
Household chores	1	Respondent does most of them	767
	2	Respondent shares them equally with someone else	1115
	3	Someone else does most of them	372
		Missing values	16
Area of research (defined as dummies)		Area 1: Science (Mathematical, Physical and Computer Sciences, Engineering, and Chemistry)	489
		Area 2: Medicine and Life Sciences (Medical Sciences, Other allied to medicine, and Life Sciences)	674
		Area 3: Social Sciences (Social Sciences, Economics and Econometrics, Law, Business and Management Studies, Architecture and the Built Environment, Education, Geography, Environmental Studies and Archaeology, Sport and Exercise Sciences, Leisure and Tourism)	626
		Area 4: Arts and Humanities (Arts and Humanities)	405
		Missing values	76
Maternity timing was influenced by promotion, tenure and/or job permanency concerns (This variable was only used to run models using two separate samples).		Yes	595
		No	936
		Not applicable	739

All the regressions we report were estimated with weights, which were computed as explained in Appendix B.

Table 3. Numerical variables and their descriptive statistics (unweighted sample).

Numerical Variables	Minimum	Maximum	Mean	Std Dev	Percentiles
Respondent's year of birth	1931	1989	1969.55	10.7198	10%: 1954 25%: 1962 50%: 1971 75%: 1978 90%: 1982
Number of children under 18	0	6	0.67797	0.02007	10%: 0 25%: 0 50%: 0 75%: 1 90%: 2
PhD	0	2	0.82026	0.3965	10%: 0 25%: 0 50%: 1 75%: 1 90%: 1
Percentage of working time spent on teaching and teaching-related activities	0	100	32.6522	24.0227	10%: 0 25%: 10 50%: 30 75%: 50 90%: 65
Journal papers (number of papers published in peer-reviewed journals in the last five years)	0	500	11.3824	22.8158	10%: 1 25%: 3 50%: 6 75%: 13 90%: 25
Conference papers (number of papers published in conference proceedings in the last five years)	0	125	4.91454	10.3027	10%: 0 25%: 0 50%: 1 75%: 5 90%: 14
Number of grants obtained in the last five years	0	6	1.5493	1.8455	10%: 0 25%: 0 50%: 1 75%: 3 90%: 5

5.1. Baseline Model

Our baseline model includes gender, year of birth, number of children under the age of 18 years, and responsibility for the household chores (cooking, shopping, cleaning, washing/ironing). As it can be seen from the column reporting the results of the baseline model in Table 4, being a woman has a negative and significant association with academic rank. This is not worrying because we are not controlling for research productivity at this stage.

We also find the usual and expected result that the younger a person is, the less likely he/she is to be high up on the academic ladder, an intuitive result in line with [12,13,17].

The number of children under the age of 18 years has a positive and significant association with grade. This result holds for the whole sample but also for the subsample of men and the subsample of women separately, although for brevity, the subsample results are not reported here. Previous research found that having children is positively associated with the academic rank of men, but found that either it has a negative association with the academic rank of women [10], or the association with the academic rank of women is not statistically significant [12,13,15].

Ours is therefore an interesting result. The problem with observational data is that it is not easy to determine causality. From an intuitive point of view, it is unlikely that having children under the age of 18 years has a positive impact on academic rank and it is more likely that academics wait to have their children until they have reached a certain grade. We further investigate this issue below.

Table 4. Ordered logistic regression of grade on alternative model specifications.

	Baseline Model	**With PhD and Research Productivity Variables**	**With PhD, Research Productivity Variables and a Teaching-Related Variable**
Gender	−0.573 ***	−0.500 ***	−0.474 ***
	(0.126)	(0.135)	(0.133)
Respondent's year of birth	−0.121 ***	−0.131 ***	−0.135 ***
	(0.008)	(0.008)	(0.008)
Number of children under 18	0.305 ***	0.216 ***	0.225 ***
	(0.063)	(0.064)	(0.065)
Household chores	0.130	0.124	0.080
	(0.097)	(0.096)	(0.096)
PhD		0.306 *	0.320 *
		(0.159)	(0.165)
Journal papers		0.020	0.016
		(0.016)	(0.015)
Conference papers		0.003	0.003
		(0.008)	(0.007)
Grants		0.276 ***	0.277 ***
		(0.045)	(0.043)
Share time on teaching			−0.018 ***
			(0.004)
Area 1 (Science) *Reference*			
Area 2 (Medicine and Life Sciences)		−0.028	−0.178
		(0.178)	(0.178)
Area 3 (Social Sciences)		0.517 ***	0.550 ***
		(0.173)	(0.173)
Area 4 (Arts and Humanities)		0.301	0.376 *
		(0.215)	(0.212)
Log pseudolikelihood	−41504.04	−39233.87	−38719.46
Number of obs	1280	1280	1280
Wald chi2	301.29	399.12	417.05
Prob > chi2	0.0000	0.0000	0.0000
Pseudo R2	0.14	0.19	0.20

Note: Standard errors are in parenthesis. * (**) (***) indicate statistical significance at the 10 (5) (1) % levels.

The variable household chores has the correct sign but it is not significant. We also included a number of other variables, such as ethnicity, childcare responsibilities, and responsibility for looking after a disabled, sick or elderly friend or relative, none of which were statistically significant. On similar lines, another study finds that neither care of an elderly parent or relative nor time spent on household or childcare duties has a significant association with research productivity of faculty men or women (pp. 434–435 [30]).

We also tried marital status, but this was also non-significant, in line with (p. 400 [12]) and (p. 51 [13]). On the other hand, one study finds that having a spouse or partner employed at the same institution is unrelated to tenure and rank amongst women faculty but being married is positively associated with both tenure and rank for men faculty (p. 301 [15]), and another study finds a positive association between being married or living with a partner and salary [16].

5.2. PhD, Publications, Grants and Area of Research

Papers published in peer reviewed journals, papers published in conference proceedings, and number of grants obtained are typically seen as important for career progression in academia, and thus we included those variables in our model. We also included the variable PhD (no PhD degree, one PhD degree, two PhD degrees). In addition, we included research area in order to control for differences across different fields of knowledge. The results are reported on Table 4, under the column entitled PhD and research productivity variables. As in the baseline model, gender has a negative coefficient and is statistically significant. Given that we are controlling for research productivity, this result is very worrying and may be an indicator of discrimination against women. Being a woman per se has a negative association with grade. This is in line with findings in [10–13,15,17,19,40]. On similar lines, a study on faculty salaries, finds a negative association between being a woman and salary (p. 595 [16]).

The variables year of birth and number of children under 18 have the same sign as before and are significant. Again, the variable household chores is not significant.

Having a PhD, as expected, has a positive association with grade, although the variable is only significant at 10% in this specification. Another intuitive result, similar to that found in [18], is the positive association between the number of grants obtained in the last five years and academic rank. The reason that neither the number of papers published in peer-reviewed journals nor the number of papers published in conference proceedings in the last five years is statistically significant, even though both coefficients have the expected positive sign, is that these two variables are correlated between themselves and with the number of grants, as could have been reasonably expected. Importantly, all three variables are significant at least at a 5% level when they are included alone in the model. Another study finds that the number of publications is important for academic progression, but grants obtained are not [20], probably due to the two variables being correlated, although it does not consider this as a possible explanation for this counterintuitive result.

The reference (research) area in this and all specifications in this study is area 1 (Science). This is an arbitrary choice as any area could have been used as reference area.

The results show that for the models on Table 4 that take into account research area, relative to area 1 (Science), there are no significant differences, except for area 3 (Social Sciences), i.e., academics working in Social Sciences are likely to hold a higher rank, everything else being equal.

We also tried models which included marital status and ethnicity but none of these variables proved to be statistically significant.

In addition, we estimated a number of OLS regressions with journal publications, conference proceedings, and grants as dependent variables, and gender, area, grade, and number of children under 18 as independent variables. The results are presented in Table A6 of Appendix C. The coefficient for gender was negative and significant, albeit at 10%, for journal publications, i.e., women publish less, in line with [14,17,21–27]. For conference proceedings and for grants, the coefficient for gender was not significant. The coefficient for grade was positive and significant in all three regressions. A higher grade may "provide the level of resources and job security that serve to bolster one's level of productivity" (p. 436 [30]) or academics with higher grades may be simply more experienced and therefore more productive. The coefficient for the number of children under the age of 18 years was not significant in the journal publications or the conference proceedings regressions, in line with [27,29–31]. One study finds a positive relationship between having children and journal publications for female economists but no relationship for male economists [32]. Our coefficient for the number of children under 18, however, remained not significant even when we ran separate regressions for men and for women, although for brevity, these are not reported. The coefficient for the number of children under 18 was positive and significant in the grants regression.

5.3. Percentage of Time Spent on Teaching and Teaching-Related Activities

The percentage of working time allocated to different activities during the working day can have an impact on academic rank. Thus, we specified a model which includes the percentage of time spent

on teaching and teaching-related activities, as reported by respondents. The last column of Table 4 shows the results. Gender, year of birth, and number of children all have the same signs as before and are statistically significant. The variable household chores continues to be not significant and having a PhD has the same sign as before and continues to be significant at a 10% level. The variables on research productivity have the same signs and significance as before. For the area of research, relative to area 1 (Science), there are positive differences for area 3 (Social Sciences), at a 1% level, and for area 4 (Arts and Humanities), at a 10% level, i.e., academics working in Social Sciences or in Arts and Humanities are likely to hold a higher rank than academics working in Science, with everything else constant.

The coefficient for percentage of time spent on teaching and teaching-related activities is negative and statistically significant, in line with [18]. On similar lines, another study finds that "involvement in teaching negatively affects salary" (p. 886 [43]). Either teaching does not help career progression or those in lower academic ranks are given a heavier teaching workload, or both, potentially making this a vicious circle.

We also estimated the OLS regressions of Table A6 again, adding the percentage of time spent on teaching and teaching related activities as an independent variable. The results are reported in Table A7 of Appendix C. The coefficient for gender ceased to be significant in the journal publications regression, remained not significant in the conference proceedings regression, and was positive and significant, albeit at 10%, in the number of grants regression. This is a key result because it reveals that once we control for the share of time spent on teaching, women publish as many journal papers as men and get more grants than men.

The coefficient for grade continued to be positive and significant in all three regressions. The coefficient for the number of children under the age of 18 years continued to be not significant in the journal publications and in the conference proceedings regressions, and positive and significant in the grants regression.

Crucially, the coefficient for percentage of time spent on teaching and teaching related activities was negative and significant at a 1% level in the journal publications regression. It was also negative and significant, albeit at a 10% level, in the conference proceedings and grants regressions. Although we cannot establish causality this is a very important result.

In order to understand whether the percentage of time spent on teaching affects the academic rank of women and men differently, we estimated the same model for men only and for women only, but this time we dropped the variable household chores, which was consistently not significant in Table 4. Table 5 shows the results. The variables year of birth and number of grants have the same sign as before and are significant. Number of children under 18 also has the same sign as before and is significant, but only at a 5% level for women. The coefficients for journal and conference publications continue to be positive and not significant, except for journal publications in the case of women, which is now significant. PhD is not significant any longer in the case of women. For areas of research, relative to area 1 (Science), there are no significant differences, except for area 3 (Social Sciences) in the case of men. Percentage of time spent on teaching and teaching-related activities is still negative and statistically significant in both cases but with a slightly lower coefficient for men.

In order to understand how correlated teaching is to gender, as well as to area of research and academic rank we estimated an OLS regression. Table 6 shows the results.

As it can be seen on Table 6, the coefficient for area 2 (Medicine and Life Sciences) is negative and significant and the coefficients for area 3 (Social Sciences) and 4 (Arts and Humanities) are positive and significant, implying that the percentage of time spent by faculty on teaching is lower in Medicine and Life Sciences relative to Sciences, and higher in Social Sciences and Arts and Humanities, relative to Science. Although counterintuitive at first sight, many teaching contact-hours in courses falling under the remit of Medicine, Life Sciences, and Science tend to rely on lab and class work, usually led by teaching assistants, demonstrators, and PhD students, who are on casual and fixed-term contracts,

rather than on faculty. Faculty in the Arts and Humanities and in the Social Sciences, on the other hand, tend to bear most of the contact-hours with students, and hence the difference in coefficients.

Table 5. Ordered logistic regression of grade for men and women subsamples.

	Men Only	**Women Only**
Respondent's year of birth	−0.146 ***	−0.114 ***
	(0.010)	(0.012)
Number of children under 18	0.267 ***	0.198 **
	(0.084)	(0.094)
PhD	0.510 **	0.049
	(0.223)	(0.244)
Journal papers	0.010	0.043 ***
	(0.013)	(0.010)
Conference papers	0.001	0.007
	(0.008)	(0.017)
Grants	0.301 ***	0.250 ***
	(0.054)	(0.050)
Share time on teaching	−0.016 ***	−0.019 ***
	(0.005)	(0.004)
Area 1 (Science) *Reference*		
Area 2 (Medicine and Life Sciences)	−0.200	−0.290
	(0.216)	(0.295)
Area 3 (Social Sciences)	0.752 ***	0.264
	(0.215)	(0.294)
Area 4 (Arts and Humanities)	0.302	0.435
	(0.259)	(0.342)
Log pseudolikelihood	−25619.11	−12969.67
Number of obs	730	556
Wald chi2	241.30	182.72
Prob > chi2	0.0000	0.0000
Pseudo R2	0.20	0.18

Note: Standard errors are in parenthesis. * (**) (***) indicate statistical significance at the 10 (5) (1) % levels.

Importantly, the coefficient for gender is positive and significant. According to these results, the women in our sample tend to spend a higher percentage of their working time on teaching and teaching-related activities than their male counterparts. This result is in line with findings in [25,27,44].

We also find that the lower the academic rank, the higher the percentage of time spent on teaching. Since women tend to have lower academic ranks than men, the two effects may have some synergy and become an obstacle for academic progression. With that in mind, we present the results of a second regression, where a statistical interaction term, gender × grade, is also included as an explanatory variable. The coefficient of the interaction term is the difference in the effect of grade between men and women. The fact that the interaction is significant, albeit at a 5% level, indicates that the effect of grade is different for men and for women. It should be noted, however, that the variable grade is now not statistically significant, which is not a problem because adding an interaction term drastically changes the interpretation of all the coefficients, i.e., the effect of grade is now conditional on the value of gender (and vice-versa). The effect of grade is now −0.896 for men and −3.061 for women. This is obtained as $-0.896 - 2.165 \times 0 = -0.896$ and $-0.896 - 2.165 \times 1 = -3.061$, respectively. Put more simply, going up one grade (say from lecturer to senior lecturer or from senior lecturer to reader) reduces the percentage of time spent on teaching by a factor of 0.896 for men and by a factor of 3.061 for women. Women going up the academic ladder see the percentage of time they spend on teaching and teaching-related activities decrease more than men going up the academic ladder, everything else being equal.

Table 6. Linear regression of percentage of time spent on teaching and teaching-related activities on gender, area of research, grade, and gender × grade.

	Without Interaction Term	With Interaction Term
Gender	3.408 ***	9.799 ***
	(1.271)	(3.311)
Area 1 (Science) *Reference*		
Area 2 (Medicine and Life Sciences)	−7.962 ***	−7.938 ***
	(1.643)	(1.644)
Area 3 (Social Sciences)	3.864 ***	3.776 ***
	(1.450)	(1.450)
Area 4 (Arts and Humanities)	8.712 ***	8.668 ***
	(1.563)	(1.560)
Grade	−3.680 ***	−0.896
	(.484)	(1.407)
Gender × Grade		−2.165 **
		(0.928)
Constant	44.634 ***	36.200 ***
	(2.698)	(5.214)
Number of obs	1597	1597
F	F (5, 1591) = 48.71	F (6, 1590) = 45.22
Prob > F	0.0000	0.0000
R-squared	0.1469	0.1499
Root MSE	19.416	19.389

Note: Standard errors are in parenthesis. * (**) (***) indicate statistical significance at the 10 (5) (1) % levels.

The effect of gender is now 9.799 − 2.165 × grade, with grade taking values between 1 and 5. It is easy to check that this effect decreases as grade increases, and becomes negative for the highest grade, 5, which is that of professor.

To summarize, the results from the second regression on Table 6 indicate that, for any given research area, 1, 2, 3 or 4, the percentage of working time spent on teaching and teaching-related activities is higher for women than for men at all grades, except for that of professor, when it is finally slightly lower, thanks to the more rapid decrease they experience, relative to men, as they progress on the academic ladder.

A higher percentage of working time spent on teaching and teaching-related activities may be an indicator of a heavier teaching load. Since we did not ask any question about the total number of hours effectively worked per year (rather than contracted), we cannot discard the possibility that men and/or those in higher academic ranks work many more hours than women and/or those in lower academic ranks, in which case the percentage of working time spent on teaching and teaching-related activities could potentially be lower even if the actual teaching load (measured for example by contact hours and number of students) were the same or higher.

Heavier teaching loads on women could be the result of subtle, probably unintentional, discrimination, which arguably, becomes less obvious as women progress academically and the percentage of time they spend on teaching and teaching-related activities decreases more than that of their male counterparts, for each grade they progress.

5.4. Timing of Children

The most puzzling result in this study is that the variable number of children under the age of 18 years has a positive association with the academic rank for both men and women, and not just for men, as previously found in [10,12–15]. Our results are more in line with [11], which finds that although young children (under the age of 6 years) reduce the chances of women getting a tenure-track job, older children (aged 6 to 17 years) have a positive association with women getting a tenure-track job and with both men and women getting tenure. Interestingly, in contrast with us, the authors find no effect of children, young or old, on men or women being promoted to full professor [11]. They argue

that the need to provide for their children motivates academics to get tenure-track jobs and tenure, but once tenure is secured there is no motivation to get a full professorship on economic grounds as they have already ensured that their children will be provided for [11].

The answer to the puzzle of this positive association between the number of children under the age of 18 years and academic rank in our results seems to be linked to the timing of children. One of the questions in the survey asked if the respondent's timing with regard to having a child had been influenced by promotion/tenure/job permanency concerns. Therefore, we estimated two regressions, one for those whose timing was influenced by career concerns and one for those whose timing was not. Table 7 shows the results.

Table 7. Ordered logistic regression of grade for those who timed their children with career considerations in mind and those who did not.

	Subsample that Timed Children with Career Considerations	**Subsample that Did not Time Children with Career Considerations**
Gender	−0.305	−0.733 ***
	(0.282)	(0.182)
Respondent's year of birth	−0.213 ***	−0.127 ***
	(0.022)	(0.012)
Number of children under 18	0.457 ***	0.100
	(0.149)	(0.089)
PhD	0.054	0.204
	(0.358)	(0.228)
Journal papers	0.046 ***	0.015
	(0.009)	(0.021)
Conference papers	−0.026 *	0.002
	(0.015)	(0.011)
Grants	0.425 ***	0.161 ***
	(0.075)	(0.058)
Share time on teaching	−0.010	−0.022 ***
	(0.009)	(0.005)
Area 1 (Science) *Reference*		
Area 2 (Medicine and Life Sciences)	0.462	−0.436 *
	(0.371)	(0.253)
Area 3 (Social Sciences)	1.113 ***	0.399 *
	(0.380)	(0.234)
Area 4 (Arts and Humanities)	1.497 ***	0.057
	(0.450)	(0.301)
Log pseudolikelihood	−6911.27	−19625.55
Number of obs	307	617
Wald chi2	166.26	164.60
Prob > chi2	0.0000	0.000
Pseudo R2	0.34	0.16

Note: Standard errors are in parenthesis. * (**) (***) indicate statistical significance at the 10 (5) (1) % levels.

The coefficient for year of birth in Table 7 continues to be negative and significant. Having a PhD is not significant any longer. Journal and conference publications have the expected sign and are now significant for the subsample of respondents who timed their children with career considerations but are still not significant for the subsample of those who did not. The coefficient for number of grants continues to be positive and significant. The percentage of time spent on teaching and teaching-related activities continues to be negative but is now not significant for the subsample of respondents who timed their children with career considerations.

For the subsample of respondents who timed parenthood, the results for area of research are as follows. Relative to area 1 (Science), there are positive differences for area 3 (Social Sciences) and for area 4 (Arts and Humanities), both at a 1% level. For the subsample of respondents who did not time

parenthood, relative to area 1 (Science), there are negative differences for area 2 (Medicine and Life Sciences) and positive differences for area 3 (Social Sciences), albeit both only significant at a 10% level.

Moving on to the variables gender and number of children under 18, both of which have been consistently significant in all our models, Table 7 shows what could be regarded as the most important findings in this study. The coefficient for the variable number of children under the age of 18 years, which was positive in all our previous regressions, remains positive and significant when only those whose timing was influenced by career considerations are included in the sample. However, when only those whose timing was not influenced are included in the sample, the coefficient for the variable number of children under 18 becomes not significant. Another interesting result is that the coefficient for gender, which was consistently negative and significant in all our models, becomes not significant for those who timed their babies with career considerations, and we discuss this further below.

A caveat that needs to be highlighted is that the samples are rather small in both cases because: (a) 54% of all those on open-ended contracts and 71% of those on probation did not have children under the age of 18 years at the time of the survey, (b) the already small group of respondents who did have children under the age of 18 years was split into those who timed and those who did not time parenthood with career considerations, and (c) the sample of those who timed their children would have been 27% larger and the sample of those who did not time their children would have been 22% larger if all respondents with children under the age of 18 years had disclosed their age. Dropping the variable year of birth would make the samples larger but an important control variable, significant in all our models, would be lost in that case.

The association between number of children under the age of 18 years and higher grade does not equal causality. Given that the variable number of children under 18 is significant for the sample who timed their children with career considerations in mind but not significant for the sample who did not, there would appear to be some evidence to suspect that rather than children having a positive impact, children arrived after a certain grade had been secured.

The fact that the variable gender, which was negative and significant in all our models, becomes not significant for the sample who timed their babies, could also be seen as evidence that women who timed their children secured a certain grade first, thus protecting themselves from discrimination, or at least discrimination after having children.

Timing seems to be key. This important finding implies that women may find the decision of when to have a baby excruciating because postponing motherhood could cost them not ever having children at all, as fertility declines with age. There is evidence that "women are more successful in obtaining academic careers if they delay or forsake marriage and children" (p. 401 [11]) and that academics who did not have children often regret the decision later in life when it is too late, as do those who wish they had had more children (p. 69 [10]). A qualitative study also finds that "women academics have been tailoring their personal lives to fit their professional lives" (p. 223 [45]).

The fact that men and women may need to time their reproduction per se reflects that academia is not women friendly. Furthermore, it is worth highlighting that although 50% of our (unweighted) sample of respondents were of childbearing age (42 years old or younger) at the time of the survey (i.e., 2013), 60.7% did not have any children under the age of 18 years. In England and Wales, about 20% of women are childless at the age of 45 years [46], compared to 53% in our sample. Furthermore, 15.9% reported that their decision on whether to have or not to have children had been based on career considerations, and 57% from those whose decision on whether to have children or not had been based on career considerations did not have children of any age.

For comparison purposes, 66% of the surveyed academic women in [3] did not have children under the age of 18 years even though 80% of them were 50 years old or younger, 53% of academic women in the sample in [27] did not have any children, and 42% of academic women with tenure in the sample in [10] did not have any children. In our sample 48% of women on open-ended contracts did not have children of any age.

Figure 1 shows the percentage of respondents in our sample who did not have children of any age at the time of the survey by gender and type of contract.

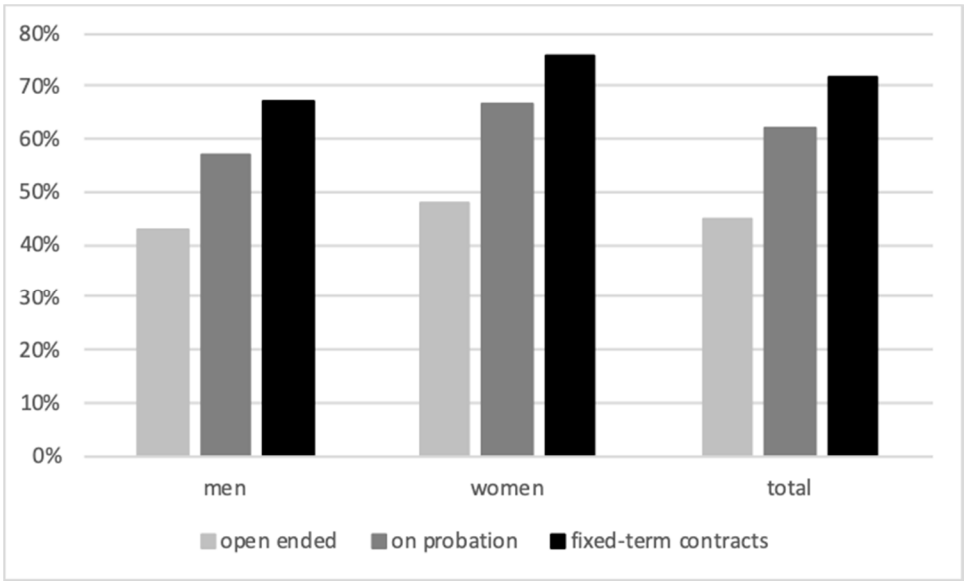

Figure 1. Percentage of respondents who do not have any children by gender and type of contract. Source: Unweighted survey responses.

Figure 1 supports our finding about timing of children with career considerations, and is in line with [45], who finds that academic women tend to time having babies for after they have secured permanency. In our sample, this conclusion also applies to men. However, for every type of contract, the percentage of men who do not have any children is lower than the percentage of women who do not have any children. For the whole sample the difference (50% versus 59%) is statistically significant at 1%.

Figure 1 also shows that the percentage of respondents that do not have any children decreases as the terms of their employment become more secure. This can be explained by two logical, intuitive reasons. One reason could be simply responsible parenthood, which concerns the consideration of the factors that have a bearing on whether to start a family and also, on family size. Potential parents may decide that in order to provide for the basic and also other needs of their children they would rather have a permanent job, or at least, be on the track to one. Another reason could be simply that the average age of all respondents on open-ended contracts at the time of the survey was 48 years, and so most of those respondents wanting to have children would have already had them. This age-related explanation, however, does not seem to apply fully to our sample because the average age of those on probation was 35 years, three years younger than the average age of those on fixed contracts. Despite those on fixed contracts being older, on average, than those on probation, the percentage of those with no children was higher.

Despite the caveat of "responsible parenthood" the statistics from Figure 1 are somewhat worrying and tell a story of the kind of working environment that academia is, or at least is perceived to be. This is surprising given that all universities have written policies on work-life balance, which at least on paper, support family life. Clearly, perceptions need to be changed, so that structural change can be brought about. We discuss some policy recommendations regarding this issue in the last section.

5.5. Other Variables

It is worth noting that we estimated many alternative specifications of the model, including a number of other variables. For example, as well as papers in peer-reviewed journals and papers in conference proceedings included in some of our tables, we also tried guest-edited journal volumes,

chapters in books, authored books, and edited books. None of these variables was significant. We also tried variables on availability of flexible working arrangements, part-time opportunities, good career guidance, influential role models and/or mentors, support from senior colleagues, support from other colleagues, knowing the "right people" within the respondent's institution and/or outside, availability of good childcare, and support from partner/spouse. In addition, we tried variables on academic activities which respondents had to reduce involvement in and/or attendance to because they were pregnant/expecting a child and/or had preschool age children, such as committees/boards memberships, refereeing and peer reviewing, guest-editing journal volumes, being main editor of a journal, being on Editorial Boards of academic journals, invitations to present keynote speeches, lectures or chair sessions at conferences, presenting other papers at conferences, amongst others.

The variables that consistently proved to be significant in our regressions were gender, number of children under 18, percentage of time spent on teaching and teaching-related activities, and number of grants obtained.

6. Policy Recommendations

The 24 Russell Group universities have a number of policies in place already to support work-life balance and family life, including flexible working arrangements and part-time opportunities. In the UK, all employers also offer unpaid parental leave schemes to care for children under the age of 18 years. In addition, the biological father or the mother's partner (regardless of gender or marital status) is typically entitled to one or two weeks of paternity leave following the birth or adoption of a child, with at least statutory pay, and in some cases, full pay. Most Russell Group universities also offer generous maternity leave packages, with new mothers being entitled to up to 52 weeks of maternity/adoption leave, with at least the first 18 weeks being paid at 90% of their salary. Some universities have even more generous packages. In 2015, the UK government also introduced shared parental leave, which allows parents to share up to 50 weeks of leave and 37 weeks of statutory pay after their child is born. All 24 universities offer this. The uptake of shared parental leave in the UK has been low mainly due to workplace culture as well as parents' views, which see the mother as the primary caregiver, especially in the first year, and the complexity of the shared parental leave policy [47]. Another factor for the low uptake may also be financial, as in many cases the combined income is lower with shared parental leave than with the traditional maternity leave.

Many of the Russell Group universities offer subsidized childcare within campus, others offer subsidies for childcare off campus, and the UK government also offers tax-free childcare, albeit with a cap. In addition, most universities offer career guidance through appraisal schemes for men and women, and in some cases, through workshops designed by and for women specifically. As explained in Section 5.4, we tested all of these variables but they were not statistically significant, which does not necessarily imply that these policies and benefits are not important. If they were not in place, the gender gap would probably be wider. Despite all these policies and benefits, our results show that women tend to hold lower grades than men. In order to achieve structural change at the institutional level and facilitate the advancement of women in academia, we propose the following two policies, following up from the variables that were found to have an association with academic rank: transparent workload models and promotion on the basis of clear and transparent criteria.

Universities should have systems in place to allow a fair and equitable distribution of teaching (and administrative) loads amongst faculty as well as continuous monitoring of such distribution. This could be actioned through, for example, a transparent workload model where everyone can see everybody else's teaching loads, including number of courses taught, contact hours, number of students, marking, dissertation supervision, etc. Some British universities, including some in the Russell Group, have already adopted or are in the process of adopting workload models. Some are university-wide workload models and others are designed within Schools or Departments. The tariffs used vary across institutions, and sometimes, across Schools or Departments within the same institution, and are at present the subject of much debate. The tariffs of any workload model meant

for academics should be set by academics, as academics know the time it takes to prepare a lecture, mark an exam, supervise a student project, write a journal paper, prepare a research proposal, etc. In addition, promotion should be based on clear and transparent criteria. Although there are typically three criteria by which candidates for promotion are judged (research, teaching, and administration), these criteria are not equally weighted (p. 2 [7]), (p. 47 [22]). The decisive factor for promotion is research, i.e., if a candidate's research is deemed inadequate, no amount of teaching or administration will compensate for this (p. 48 [22]). If this is the path that the Russell Group Universities want to stick to then this should be made crystal clear and no claims of the possibility of promotion on the basis of teaching (or administration) excellence should be made. Guidelines should be communicated to all staff so that everyone is clear that the most important criterion for promotion is research. However, if universities are going to continue with their current (written) policies for promotion, many of which include excellence in teaching, then, these policies should be implemented in practice. Excellence in teaching, however, is difficult to demonstrate. Student evaluation, for example, could be one of the metrics, although this is frequently positively correlated with faculty evaluation (higher grades on average) of students and small class sizes [22]. Peer and other evaluations may also be controversial, so careful thought would need to be given to how excellence in teaching can be established.

Adopting these two policies will help reduce the discriminatory teaching loads on women, which is a contributor to their lack of progression, and will make promotions fairer and more transparent, with a probable outcome of having more women climbing up the academic ladder.

7. Conclusions

Using an ordered logit model and the results of a survey, which we conducted in 2013, with 2270 observations of academics of both genders at all levels in all fields of knowledge at the 24 Russell Group universities in the UK, we have examined the association between gender and academic rank, controlling for a number of variables, including but not limited to, respondent's year of birth, number of children, responsibility for household chores, academic degrees, number of publications, grants, percentage of working time spent on teaching and teaching-related activities, and main area of research.

One caveat that should be highlighted is that this study only finds associations with models that use observational data. Causal relationships cannot be identified with the current dataset. Still, the associations found are very important and can guide policy.

Our findings can be summarized as follows.

A negative association between being a woman and academic rank is indeed observed in all our models but one, when run for a small subsample of male and female academics who timed their children with career considerations in mind. In general, however, women are less likely to hold a higher academic rank even after controlling for individual characteristics using variables like respondent's year of birth, marital status, responsibility for the household chores, area of research, number of children under 18, holding a PhD or not, percentage of working time spent on teaching and teaching-related activities, and a number of research productivity variables. This result is in line with [10–15,17,19,40], all of whom also find that women tend to progress at a lower rate than men, even after accounting for variables that would capture family formation and/or academic/research achievements. We call this the gender effect. Put simply, two people who have similar, or even identical credentials and personal circumstances except for one being a man and the other being a woman, are likely to have different academic ranks, with the man having a higher rank than the woman. One explanation for this phenomenon may be discrimination against women.

Another important finding is that the percentage of time spent on teaching and teaching-related activities has a negative and statistically significant association with academic rank, in line with [18]. On similar lines, another study finds a negative association between teaching and salary [43]. Furthermore, our results show that women spend a higher percentage of their working time on teaching and teaching-related activities than men at all academic grades, except for that of professor. This is in line with [25,27,44], which also find that women tend to spend either more time or a higher

percentage of their working time on teaching and teaching-related activities, but in contrast with [3,7], which do not find differences between the genders related to absolute or relative time spent on teaching and teaching-related activities.

In addition, we find that going up one grade (say from lecturer to senior lecturer or from senior lecturer to reader) reduces the percentage of time spent on teaching more for women than for men, and so eventually, female professors spend a lower percentage of their working time on teaching and teaching-related activities than male professors.

If a higher percentage of working time spent on teaching and teaching-related activities is to be taken as an indicator of a heavier teaching load, then we can conclude that women at all ranks, except for that of professor, are being discriminated against. At the same time, relative to men, women experience a higher reduction in the percentage of time spent on teaching and teaching-related activities by going up one grade.

Another important result, which is new and has not been quantified before for the UK, is a positive and significant association between number of children under the age of 18 years and the academic rank of both men and women, as long as babies were timed with career considerations in mind. In line with [11], the reason for this is very unlikely to be that children have a positive impact on academic rank, other than triggering their parents' eagerness to achieve a certain level of job stability and income in order to provide for them. What this result is probably showing is that children arrived after a certain rank (for example, an open-ended contract) had been secured. Importantly, for the subsample of academics who timed their children, the variable gender ceases to be significant.

These findings pose a dilemma for women because the 30 s is the decade when they have two competing goals in their lives: establishing themselves in their careers having finished their doctorates, and having children. Delaying pregnancy can mean that these women are left childless as fertility declines with age, especially after the age of 35 years. Some further inspection of our data confirms our finding about timing of children with career considerations: the percentage of respondents that do not have children (of any age) decreases as the terms of their employment become more secure. This state of affairs is especially biased against women.

Author Contributions: Conceptualization: G.S., S.D.V.P., Methodology: G.S., S.D.V.P., Acquisition and analysis of data: G.S., S.D.V.P., Writing: G.S., S.D.V.P., Reviewing and editing: G.S.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

In this Appendix we include the survey that was conducted in 2013, which provided the data for this study.

Survey: Gender and Academic Progression

WELCOME

My name is Georgina Santos and I am a lecturer at Cardiff University.

I am undertaking a piece of research to assess and understand whether there are any problems linked to Gender and Academic Progression. In 2010/11 44.2% of all the academic staff employed at UK Higher Education Institutions were female, yet only 19.8% of Professors were women (Higher Education Statistics Agency, 2012).

I would be very grateful if you could complete this questionnaire, which is essentially the same questionnaire that was conducted in 1999–2000 by the National Centre for Social Research (Blake, M. and I. La Valle, 2000, "Who applies for research funding", report published by the Wellcome Trust), although the aims and objectives of that piece of research were different from mine.

Higher Education Statistics Agency (2012), Staff at higher education institutions in the United Kingdom 2010/11. https://www.hesa.ac.uk/news/19-01-2012/sfr170-staff.

Blake, M. and I. La Valle (2000), Who Applies for Research Funding? Key factors shaping funding application behaviour among women and men in British higher education institutions, An independent summary report prepared for the Biotechnology and Biological Sciences Research Council (BBSRC), the Economic and Social Research Council (ESRC), the Engineering and Physical Sciences Research Council (EPSRC), the Medical Research Council (MRC), the Natural Environment Research Council (NERC), the Particle and Physics Research Council (PPARC) and The Wellcome Trust, London: The Wellcome Trust. https://wellcome.ac.uk/sites/default/files/wtd003209_0.pdf.

DATA PROTECTION

For the purposes of this survey Cardiff University is the data controller. All data collected in this survey will be held securely by the survey software provider (University of Bristol) under contract and then retained by the research team working on the project "Gender and Academic Progression' at Cardiff University in accordance with the Data Protection Act (1998). Data from the survey, including answers to questions where personal details are requested, will only be used by the research team for research purposes and will not be shared with anyone outside the research team.

Participation in the survey is completely voluntary and you may withdraw at any point. You may also complete part of it and save it to complete it later.

Cookies, personal data stored by your Web browser, are not used in this survey.

Background & Demographic Information

1. What is your gender?

   Male
   Female

2. What is your date of birth?
   DD-MM-YYYY (Optional)

3. What is your marital status?

   Married
   Living with a partner
   Separated
   Widowed
   Single
   Other

a. What is your partner/spouse's main activity? *Please tick one only. (for married)*
   Working full-time (30 or more hours per week)
   Working part-time (less than 30 hours per week)
   Unemployed and looking for work
   Looking after the home and family
   In full-time education
   Permanently sick or disabled
   Retired
   Other

b. What is your partner/spouse's main activity? *Please tick one only*. (for living with partner)
Working full-time (30 or more hours per week)
Working part-time (less than 30 hours per week)
Unemployed and looking for work
Looking after the home and family
In full-time education
Permanently sick or disabled
Retired
Other

c. In what year did you get married?
… … … … … … … … … …

4. Do you have any children aged 18 years or younger (including adopted and fostered children)?
Yes
No

a. Please, state number of children (including adopted and fostered children) and their ages.

b. In your family, who is mainly responsible for childcare (excluding any paid childcare you may have)? *Please tick one only.*
Myself
My partner/spouse
Someone else
Myself and partner/spouse equally
Myself and someone else equally
Partner/spouse and someone else equally

5. If you don't have children aged 18 years or under, please tick 'Not applicable' on all the options in the following table.
If you have children aged 18 years or under, please tick Yes, No or Not applicable.
Which of the following have you used while in your current job? *Please tick one column in each row.*

	Used in my Current Job:		
	Yes	**No**	**Not Applicable**
a. Term-time contract			
b. Paid leave when child(ren) are ill			
c. Unpaid leave when child(ren) are ill			
d. Maternity leave longer than statutory (14 weeks)			
e. Paid paternity leave			
f. Unpaid paternity leave			
g. Career breaks for domestic/family reasons			
h. A workplace based crèche			
i. Employer pays some or all childcare costs			
j. Employer is with a childcare vouchers scheme (max. £243 per month)			
k. Employer offers additional tax breaks on childcare costs on top of the £243 per month offered by the government			
l. Working from home			

6. Do you have responsibility for looking after a disabled, sick or elderly friend or relative? *(Optional)*
Yes
No
Partially

7. Who does the household chores (i.e.: cooking, shopping, cleaning, washing/ironing) in your family? *Please tick one only. (Optional)*
   I do most of them
   My partner/spouse does most of them
   Someone else does most of them
   I share them equally with my partner/spouse or someone else

8. Which of the following groups best describes your ethnic origin? *Please tick one only. (Optional)*
   White
   Black-Caribbean
   Black-African
   Black-Other
   Indian
   Pakistani
   Bangladeshi
   Chinese
   Other

Please note that the following questions apply whether you are a man or a woman.

9. Please select the options(s) that best describe your situation(s). *(Select all that apply)*
   Are or were expecting a child before earning tenure/getting an open-ended contract/being confirmed on post until retiring age.
   Have or had pre-school age children to care for before earning tenure/getting an open-ended contract/being confirmed on post until retiring age.
   Are or were expecting a child after earning tenure/getting an open-ended contract/being confirmed on post until retiring age but prior to promotion to full professor.
   Have or had pre-school age children to care for after earning tenure/getting an open-ended contract/being confirmed on post until retiring age but prior to promotion to full professor.
   None of the above

10. Please tick one box in each row.

	Academic activities which you had to reduce involvement in/attendance to because you were pregnant/expecting a child and/or had pre-school age children.				
	Yes, considerably	**Yes, moderately**	**Yes, slightly**	**No**	**Not applicable**
a. Membership of external research & professional committees/boards (e.g.: research council selection boards or committees, committees of professional societies)					
b. Refereeing and peer reviewing (e.g.: peer reviewing applicants for Research Councils, peer reviewing articles for journals & conference papers)					
c. Guest-editing journal volumes					

d. Being main editor of a journal (Editor-in-Chief, Associate Editor, etc.)					
e. Being on Editorial Boards of academic journals					
f. Invitations to present keynote speeches, lectures or chair sessions at conferences					
g. Presenting other papers at conferences					
h. Attending conferences without presenting papers					
i. External examiner at other HE institutions					
j. Assessor for RAE or REF					
k. Assessor for Teaching Quality Assessment					
l. Technology transfer/liaison with industry/industrial secondment					
m. Joint research/consultancy with other organisations (e.g.: government, charities)					
n. Visiting/exchange with other HE institutions (for a term or longer)					

Note: RAE: Research Assessment Exercise, REF: Research Excellence Framework.

11. Is or was your decision on whether to have children influenced by promotion/tenure/job permanency concerns?
    Yes
    No
    Not applicable

12. Is or was your timing regarding having children influenced by promotion/tenure/job permanency concerns?
    Yes
    No
    Not applicable

13. What is your grade of employment? *Please tick one only.*
    Professor/Head of Department
    Reader
    Principal lecturer/Senior lecturer
    Clinical lecturer
    University lecturer
    Assistant lecturer
    Departmental lecturer
    Senior Researcher
    Researcher
    Research assistant
    Teaching fellow
    Senior teaching fellow

Other (please specify):
Please state the precise year when you obtained the previously reported grade:

14. Are you a member of the University and College Union? *(Optional)*
Yes
No

15. Are you on an open-ended contract (i.e., appointed to the retiring age), on probation (on track to an open-ended contract) or on a fixed term contract? *Please tick one only.*
Open-ended contract (i.e., appointed to the retiring age)
On probation (on track to an open-ended contract)
Fixed term contract

16. Is your contract full-time (30 h a week or more) or part-time (less than 30 h a week)? (Please include job share as part-time) *Please tick one only.*
Full-time (throughout the year)
Full-time (term-time only)
Part-time (throughout the year)
Part-time (term-time only)

17. What have been your main areas of research in the last five years (i.e.: since January 2008)? Please code up to three subjects, the one on which you have spent the most time first, using the list of subject codes provided below. Note that this question refers to your own areas of research, not the main research area of the department in which you are based. If you have not conducted research at all in the last 5 years please put NA.

	CODE ***(please use the list of subject codes provided below)***
a. Most important area of research in last 5 years:	
b. Second most important area of research in last 5 years:	
c. Third most important area of research in last 5 years:	

Units of Assessment **The REF has 36 units of assessment, as follows:**		
Main Panel	**Unit of Assessment**	
A	1	Clinical Medicine
	2	Public Health, Health Services and Primary Care
	3	Allied Health Professions, Dentistry, Nursing and Pharmacy
	4	Psychology, Psychiatry and Neuroscience
	5	Biological Sciences
	6	Agriculture, Veterinary and Food Science
B	7	Earth Systems and Environmental Sciences
	8	Chemistrye
	9	Physics
	10	Mathematical Sciences
	11	Computer Science and Informatics
	12	Aeronautical, Mechanical, Chemical and Manufacturing Engineering
	13	Electrical and Electronic Engineering, Metallurgy and Materials
	14	Civil and Construction Engineering
	15	General Engineering

C	16	Architecture, Built Environment and Planning
	17	Geography, Environmental Studies and Archaeology
	18	Economics and Econometrics
	19	Business and Management Studies
	20	Law
	21	Politics and International Studies
	22	Social Work and Social Policy
	23	Sociology
	24	Anthropology and Development Studies
	25	Education
	26	Sport and Exercise Sciences, Leisure and Tourism
D	27	Area Studies
	28	Modern Languages and Linguistics
	29	English Language and Literature
	30	History
	31	Classics
	32	Philosophy
	33	Theology and Religious Studies
	34	Art and Design: History, Practice and Theory
	35	Music, Drama, Dance and Performing Arts
	36	Communication, Cultural and Media Studies, Library and Information Management

Current employment conditions and workload

If you have more than one job, please answer the questions in this section for the academic/research job on which you spend most time. If you spend equal time on two jobs, answer for the one which you have held for longest.

18. Which of the following are available in your current job (whether formally or informally)? *Tick yes, if they would be available to you if you had children or you were expecting a child. We would like to hear from all respondents, even if the benefits are not applicable to you or you don't k now if they are available. Please tick one column in each row.*

	Available in your current job whether formally or informally		
	Yes, available	**No, not available**	**I don't know**
a. Term-time contract			
b. Paid leave when child(ren) are ill			
c. Unpaid leave when child(ren) are ill			
d. Maternity leave longer than statutory (14 weeks)			
e. Paid paternity leave			
f. Unpaid paternity leave			
g. Career breaks for domestic/family reasons			
h. A workplace-based crèche			
i. Employer pays some or all childcare costs			
j. Employer is with a childcare vouchers scheme (max. £243 per month)			
k. Employer offers additional tax breaks on top of the typical £243 per month			
l. Working from home			
m. Other family friendly working arrangements			

19. Approximately what percentage of your time do you spend on the tasks below in an average week:

(a) during term-time (excluding exam periods)
(b) during the vacation (when undergraduate students are away)?

Please record the percentage of time you actually spend on the tasks rather than contracted time. If the time for any of the tasks is none, please enter "0". If you have two jobs, please provide the detailed information only for your main job as a percentage of your total hours in that job.

	Percentage of time spent on each area of work during a week in (a) Term-time (in %)	**Percentage of time spent on each area of work during a week in (b) Vacation (in %)**
a. Teaching (include contact hours, preparation, tutoring, marking essays/exams, supervision of postgraduate students)		
b. Administration and management (include personal admin., committee work and organisation, course admin., staff and other meetings, management of research projects and staff, etc.)		
c. Research (include lab. work, library research, field work, etc. and applying for grants and fellowships, include joint research with outside bodies)		
d. Training and conferences (attending courses, workshops and conferences)		
e. Clinical work		
f. Other		
g. TOTAL (should be 100%)		

Career and education history

20. Please indicate which was your main activity in each of the last 10 academic years. Your main activity is that which you were engaged in for the longest period of time in that year. Please read all columns before ticking any. If more than one applies, please tick the one closest to the left of the grid. Please enter a tick on each row. Include years during which you were in full-time education.

Please indicate which was your main activity in each of the last 10 academic years. *If more than one applies, please tick the one closest to the left of the grid.*

Academic Year	Full-Time Permanent Post in Higher Education (Academic/Academic Related)	Part-Time Permanent Post in Higher Education (Academic/Academic related)	Full-Time Fixed Term Contract in Higher Education (Academic/Academic Related)	Part-Time Fixed Term Contract in Higher Education (Academic/Academic related)	Research Job Outside Higher Education	Other Type of Employment Outside Academia/Research	PhD (Full Time or Part Time)	Looking After the Home or Family	Unemployed	Full-Time Education/Retraining
a. 2012–2011										
b. 2011–2010										
c. 2010–2009										
d. 2009–2008										
e. 2008–2007										
f. 2007–2006										
g. 2006–2005										
h. 2005–2004										
i. 2004–2003										
j. 2003–2002										

Academic qualifications

21. Please list all your academic qualifications. For pending awards (exams taken or thesis submitted but not yet awarded), please enter "pending" in the "Year of award" column. Please give all the information requested in the column headings.

	Qualification (i.e., BA Hons, MSc, PhD, etc.	**Year of Award**	**Institution**
a. 1st degree/qualification			
b. 2nd degree/qualification			
c. 3rd degree/qualification			
d. 4th degree/qualification			
e. 5th degree/qualification			
f. 6th degree/qualification			

Publication record

22. How many of the following have you had published in the last five years (i.e.: since January 2008)? Please include joint and single author publications, publications through consortia, articles "in press" and those available online but not on paper yet and "online only" as well. *If the answer for any category is none, please enter "0".*

	Number in the Last 5 Years
a. Articles in peer-reviewed journals:	
b. Conference proceedings:	
c. Guest-edited journal volumes:	
d. Chapters in books (if several chapters in one book record as 1):	
e. Entire books:	
f. Edited books:	

Other academic activities

23. Have you been involved in any of the following in the last five years (i.e.: since January 2008)? *Please tick one box in each row.*

	Involvement in the Last Five Years (i.e.: Since January 2008)	
	Yes	**No**
a. Membership of external research & professional committees/boards (e.g.: research council selection boards or committees, committees of professional societies)		
b. Refereeing and peer reviewing (e.g.: peer reviewing applicants for Research Councils, peer reviewing articles for journals & conference papers)		
c. Guest-editing journal volumes		
d. Being main editor of a journal (Editor-in-Chief, Associate Editor, etc.)		
e. Being on Editorial Boards of academic journals		
f. Invitations to present keynote speeches, lectures or chair sessions at conferences		
g. Presenting other papers at conferences		
h. Attending conferences without presenting papers		

i. External examiner at other HE institutions		
j. Assessor for RAE or REF		
k. Assessor for Teaching Quality Assessment		
l. Technology transfer/liaison with industry/industrial secondment		
m. Joint research/consultancy with other organisations (e.g.: government, charities)		
n. Visiting/exchange with other HE institutions (for a term or longer)		

24. Were you included in your department's 2008 Research Assessment Exercise (RAE)? *Please tick one only. (Optional)*
    Yes
    No
    Not applicable (e.g., not in the department at the time)
    I don't know

25. Will you be included in your department's 2014 Research Excellence Framework (REF)? *Please tick one only. (Optional)*
    Yes, definitely
    Yes, probably
    No
    Not applicable (e.g., not in the department at the time)
    I don't know

Attitudes

26. Regardless of your gender and whether you have children or not, please answer the following question. Which of the following have been available to you in your academic or research career to date? If any of these are not relevant to you, please tick the 'Not applicable' box. *Please tick one box in each row.*

	Available to Me in My Academic or Research Career to Date		
	Yes, Available	**No, not Available**	**Not Applicable**
a. Flexible working arrangements (formally or informally)			
b. Part-time opportunities			
c. Good career guidance			
d. Influential role models and/or mentors			
e. Support from senior colleagues			
f. Support from other colleagues			
g. Knowing the 'right people' within my institution and/or outside			
h. Availability of good childcare			
i. Support from partner/spouse			

27. At this stage in your career, in order to gain promotion in your institution, how important is your performance in the following areas? *If any of these are not relevant, please tick the 'Not applicable' box.*

	To gain Promotion in Your Institution				
	Not Applicable	**Very Important**	**Fairly Important**	**Not very Important**	**Not at All Important**
a. Research					
b. Teaching					
c. Supervising postgraduate students					
d. Pastoral care/tutoring					
e. Student satisfaction/feedback from courses					
f. General administration					
g. Internal committee work					
h. Management of people					
i. Strategic and policy management (i.e.: contributing to the formulation and implementation of departmental/institutional policies)					
j. Publication record					
k. Presenting papers at conferences					
l. Income generating activities (winning research grants/links with industry & government departments)					
m. Interdisciplinary research					
n. External activities/representing the institution (e.g., on external committees, examining boards, in the media)					

Grants and commissioned research

28. Have you obtained any commissioned research contracts from industry, government departments, charities, etc. in the last five years (i.e.: since January 2008)?
    Yes
    No
    How many such research contracts have you obtained in the last five years (i.e.: since January 2008)? Please write in the number.

    Number obtained: … … … …

29. Have you been awarded any grants in the last five years, i.e., since January 2008? If Yes, please fill in the table but do not include commissioned research or contracts which were covered in the previous question. Please include the last six grants on which you were named as an applicant, even if you were not named as the principal applicant.

	Year of Award	Funding Body/Bodies	I Was			Duration of Funding	Duration of Funding					Level of Funding (Over Entire Duration of Award)			
			Principal Applicant/Investigator	Co-Applicant/investigator	Co-Author/Recognised Researcher	Other type of employment outside academia/research	1 Year or Less	More than 1, up to 2 Years	More than 2, up to 3 Years	More than 3, up to 5 Years	More than 5 Years	<£15,000	£15,000–£29,999	£30,000–£99,999	>£100,000
a. 1st "most recent"															
b. 2nd															
c. 3rd															
d. 4th															
e. 5th															
f. 6th "least recent"															

30. Thank you very much for taking time to complete this survey. If you would like to add any comments about the issues raised in the questionnaire please do so below, on the understanding that we may anonymously quote part or all of what you write.

Appendix B

In this Appendix we explain why weights were needed to make our sample representative of the whole population, and how they were estimated.

Weights

The population of the study was all academic and research staff employed at the 24 Russell Group universities. Any member of the population belonging to a department linked to one of the 36 REF areas had the same probability of being invited to respond to the survey. The response rate may have varied according to a number of reasons, some of which were reported by the respondents themselves, such as for example, lack of time or concerns over privacy issues. There are no data on "lack of time" of the population, let alone "lack of time" during the weeks when the survey was live online, or how different individuals feel about disclosing personal information. Other reasons for non-response, and for which there are no population data either, include personal circumstances such as having or not having children under the age of 18 years (which may carry an inherent interest in the research in question but may also reduce the time a member of staff can afford to fill surveys in), personal tastes (i.e., liking or not liking surveys), altruism or selfishness (being prepared to collaborate with a researcher or not), etc.

The characteristics that could also influence response rates and for which there are some data, or at least proxies, on the population are gender, research area, and seniority. Needless to say, in order to correct for the potentially different response rates data on the population is essential. Thus, data for the whole population (academic and research staff at the 24 Russell Group universities) on gender, research area, and seniority was provided by the Higher Education Statistics Agency (HESA) on request, as explained below.

HESA Data on Gender

The HESA holds data on the legal sex of staff members, as opposed to the gender with which they identify [48].

HESA Data on Research Area

The HESA does not hold data on the area of research being carried out by each member of the population. However, it does hold data on "cost centers" and "staff members' qualifications". The cost centers tend to have similar cost structures for teaching and research, similar patterns for capital expenditure, academic coherence in terms of the academic disciplines of staff, and similar rates of funding for research grants and contracts. However, given the interdisciplinary characteristics of many departments across the 24 Russell Group universities, it is not unusual to see economists working in Geography departments or Schools of Business, and carrying out research in Economics, or Chemists working in Biology departments and carrying out research in Chemistry, or Physicists working in Chemistry departments and carrying out research in Physics, to name a few examples. For this reason, we decided to use the data on "staff members' qualifications", rather than the data on the number of staff associated to different cost centers. The HESA uses "academic discipline" to designate "the subject or subjects appropriate to that staff member's academic qualification", which although may "not necessarily be the academic subject in which that staff member may currently be teaching or researching" [48], has a much higher chance of being closely related to it than "cost centers".

HESA Data on Seniority

The HESA does not hold data on the grade at which each member of staff is employed (professor, reader, lecturer, etc.) but holds data on professorial role, i.e., professor or non-professor.

We grouped the 36 REF areas and the 146 different academic disciplines from the HESA in 16 areas. Table A1 shows the mapping. Table A2 shows the number of individuals in the sample and in the population in each of the 16 areas, also classified by gender and by whether they hold a professorial role or not.

Table A1. Our classification mapped against REF and HESA classifications.

Our Classification	REF Classification		HESA Classification	
Medical Sciences	1	Clinical Medicine	(A3)	Clinical medicine
	2	Public Health, Health Services and Primary Care	(A1)	Pre-clinical medicine
	3	Allied Health Professions, Dentistry, Nursing and Pharmacy	(A2)	Pre-clinical dentistry
	4	Psychology, Psychiatry and Neuroscience	(A4)	Clinical dentistry
			(A9)	Others in medicine & dentistry
			(B1)	Anatomy, physiology & pathology
			(B2)	Pharmacology, toxicology & pharmacy
			(B3)	Complementary medicine
			(B4)	Nutrition
			(B5)	Ophthalmics
			(B6)	Aural & oral sciences
			(B7)	Nursing
			(B8)	Medical technology
			(B9)	Others in subjects allied to medicine
			(C8)	Psychology
	5	Biological Sciences	(C1)	Biology
	6	Agriculture, Veterinary and Food Science	(C2)	Botany
	7	Earth Systems and Environmental Sciences	(C3)	Zoology
			(C4)	Genetics
			(C5)	Microbiology
			(C7)	Molecular biology, biophysics & biochemist
			(C9)	Others in biological sciences
			(D1)	Pre-clinical veterinary medicine
			(D2)	Clinical veterinary medicine & dentistry
			(D3)	Animal science
			(D4)	Agriculture
			(D5)	Forestry

Table A1. *Cont.*

Our Classification	REF Classification		HESA Classification	
			(D6)	Food & beverage studies
			(D7)	Agricultural sciences
			(D9)	Others in veterinary sciences, agriculture
			(F6)	Geology
			(F7)	Science of aquatic and terrestrial environments
	9	Physics	(F3)	Physics
	10	Mathematical Sciences	(F5)	Astronomy
	11	Computer Science and Informatics	(F9)	Others in physical sciences
			(G01)	Broadly based programmes in mathematical science
			(G02)	Broadly based programmes in computer science
			(G1)	Mathematics
			(G2)	Operational research
			(G3)	Statistics
			(G4)	Computer science
			(G5)	Information systems
			(G7)	Artificial intelligence
			(G91)	Others in mathematical sciences
			(G92)	Others in computer sciences
	21	Politics and International Studies	(L2)	Politics
	22	Social Work and Social Policy	(L3)	Sociology
	23	Sociology	(L4)	Social policy
	24	Anthropology and Development Studies	(L5)	Social work
	27	Area Studies	(L6)	Anthropology
			(L9)	Others in social studies
Humanities	28	Modern Languages and Linguistics	(P1)	Information services
	29	English Language and Literature	(P2)	Publicity studies
	30	History	(P3)	Media studies

Table A1. *Cont.*

Our Classification	REF Classification		HESA Classification	
	31	Classics	(P4)	Publishing
	32	Philosophy	(P5)	Journalism
	33	Theology and Religious Studies	(P9)	Others in mass communications & documentation
	36	Communication, Cultural and Media Studies, Library and Information Management	(Q1)	Linguistics
			(Q2)	Comparative literary studies
			(Q3)	English studies
			(Q4)	Ancient language studies
			(Q5)	Celtic studies
			(Q6)	Latin studies
			(Q7)	Classical Greek studies
			(Q8)	Classical studies
			(Q9)	Others in linguistics, classics & related subjects
			(R1)	French studies
			(R2)	German studies
			(R3)	Italian studies
			(R4)	Spanish studies
			(R5)	Portuguese studies
			(R6)	Scandinavian studies
			(R7)	Russian & East European studies
			(R8)	European Studies
			(R9)	Others in European languages, literature & related subjects
			(T1)	Chinese studies
			(T2)	Japanese studies
			(T3)	South Asian studies
			(T4)	Other Asian studies
			(T5)	African studies
			(T6)	Modern Middle Eastern studies
			(T7)	American studies
			(T8)	Australasian studies

Table A1. *Cont.*

Our Classification	REF Classification		HESA Classification	
			(T9)	Others in Eastern, Asiatic, African, American & Australasian languages, literature & related subjects
			(V1)	History by period
			(V2)	History by area
			(V3)	History by topic
			(V5)	Philosophy
			(V6)	Theology & religious studies
			(V9)	Others in historical & philosophical studies
	12	Aeronautical, Mechanical, Chemical and Manufacturing Engineering	(F2)	Materials science
	13	Electrical and Electronic Engineering, Metallurgy and Materials	(G6)	Software engineering
	14	Civil and Construction Engineering	(H0)	Broadly-based programmes within engineering & technology
	15	General Engineering	(H1)	General engineering
			(H2)	Civil engineering
			(H3)	Mechanical engineering
			(H4)	Aerospace engineering
			(H5)	Naval architecture
			(H6)	Electronic & electrical engineering
			(H7)	Production & manufacturing engineering
			(H8)	Chemical, process & energy engineering
			(H9)	Others in engineering
			(J1)	Minerals technology
			(J2)	Metallurgy
			(J3)	Ceramics & glasses
			(J4)	Polymers & textiles
			(J5)	Materials technology not otherwise specified
			(J6)	Maritime technology
			(J7)	Biotechnology

Table A1. *Cont.*

Our Classification	REF Classification		HESA Classification	
			(J9)	Others in technology
Economics and Econometrics	18	Economics and Econometrics	(L1)	Economics
	20	Law	(M1)	Law by area
			(M2)	Law by topic
			(M9)	Others in law
	19	Business and Management Studies	(N1)	Business studies
			(N2)	Management studies
			(N3)	Finance
			(N4)	Accounting
			(N5)	Marketing
			(N6)	Human resource management
			(N7)	Office skills
			(N9)	Others in business & administrative studies
	16	Architecture, Built Environment and Planning	(K1)	Architecture
			(K2)	Building
			(K3)	Landscape design
			(K4)	Planning (urban, rural & regional)
			(K9)	Others in architecture, building & planning
	34	Art and Design: History, Practice and Theory	(W1)	Fine art
	35	Music, Drama, Dance and Performing Arts	(W2)	Design studies
			(W3)	Music
			(W4)	Drama
			(W5)	Dance
			(W6)	Cinematics & photography
			(W7)	Crafts
			(W8)	Imaginative writing
			(W9)	Others in creative arts & design

Table A1. *Cont.*

Our Classification	REF Classification	HESA Classification		
Chemistry	8	Chemistry	(F1)	Chemistry
	25	Education	(X1)	Training teachers
			(X2)	Research & study skills in education
			(X3)	Academic studies in education
			(X9)	Others in education
Geography,	17	Geography, Environmental Studies and Archaeology	(F4)	Forensic & archaeological science
			(F8)	Physical geographical sciences
			(L7)	Human & social geography
			(V4)	Archaeology
Sport and Exercise Sciences, Leisure and	26	Sport and Exercise Sciences, Leisure and Tourism	(C6)	Sports science
			(N8)	Hospitality, leisure, tourism and transport

Source: REF website (https://www.ref.ac.uk/2014/panels/unitsofassessment/) and data provided by HESA on request.

Table A2. Populations and sample individuals classified by area of research, gender, and professorial role.

Field	HESA DATA					SURVEY DATA				
	Prof + M	**Prof + F**	**Non-Prof + M**	**Non-Prof + F**	**Total**	**Prof + M**	**Prof + F**	**Non-Prof + M**	**Non-Prof + F**	**Total**
Medical Sciences	696	126	1396	1016	3234	4	4	8	11	27
Other Allied to Medicine	949	340	3889	5756	10934	23	26	78	201	328
Life Sciences	1128	264	5176	5027	11595	39	14	140	126	319
Mathematical, Physical Sciences and Computer Sciences	1458	159	5311	1503	8431	82	8	162	57	309
Social Sciences	416	192	1360	1665	3633	15	11	54	72	152
Humanities	871	323	2882	3153	7229	49	33	131	161	374
Engineering	729	37	3686	952	5404	17	3	89	26	135
Economics and Econometrics	393	61	857	485	1796	28	4	35	17	84
Law	249	104	511	498	1362	24	18	27	49	118
Business and Management Studies	215	49	677	571	1512	15	0	17	25	57
Architecture and the Built Environment	63	22	334	201	620	7	5	17	16	45
Arts	94	24	391	351	860	5	5	11	9	30
Chemistry	410	47	1687	709	2853	9	4	24	8	45
Education	58	41	397	821	1317	7	9	9	35	60
Geography, Environmental Studies and Archaeology	250	61	779	578	1668	16	9	29	44	98
Sport and Exercise Sciences, Leisure and Tourism	15	2	91	81	189	0	1	2	8	11
Total	7994	1852	29424	23367	62637	340	154	833	865	2192

Source: Responses from our survey and data provided by HESA on request. Note: "M" denotes male, "F" denotes female, "Prof" denotes professorial status, "Non-Prof" denotes non-professorial status.

As it can be seen from Table A2 the shares (not actually shown since we show the actual numbers) differ between the sample and the population. The reasons for this may be linked to the likelihood of different individuals to respond to the survey. This likelihood may vary with the three characteristics in question, gender, research area, and seniority. Non-response repartition is hardly the result of a random phenomenon. Some types of individual have been over-sampled, and some have been under-sampled, and as a consequence, the distribution of these three characteristics across the sample is different from that of the population. This would introduce bias in any estimate.

In order to correct for survey non-response and reduce any potential bias in the estimates we used weights. The method essentially consists of increasing the weight of the sample respondents to take into account the population of non-respondents. The method chosen is based on the mechanism of homogeneous response within subpopulations. Therefore, the Russell Group population is assumed to be homogeneous concerning non-response within well-chosen subpopulations.

The data from the sample was thus weighted using post-stratification survey weights so that the sample would reflect the distribution of academics in the 24 Russell Group universities according to gender, professorial role (or not) and area of research.

Before applying any weights, we tested whether these were indeed needed. Using the population data provided by HESA, we created a database of 62,637 individuals representing the whole Russell Group population, and therefore containing the three characteristics (gender, area of research, and professorial role). Once we had this database we created a dummy variable Y and assigned a "1" to our survey respondents (contained in the population) and a "0" to everyone else in the population (not included in our sample). The following step was to regress the zero-one response indicator on the three variables (gender, area of research, and professor marker). We used logistic regression for this, following [41,42].

Table A3 shows the results of a logistic regression run for gender, professor marker, and area of research. Table A4 shows the results of the same logistic regression run excluding the gender variable.

Table A3. Logistic regression of response indicator on gender, professor marker and area of research.

Variable	Coefficient	*P*-Value
Gender	0.375 (0.045)	0.000
Professor marker	0.559 (0.054)	0.000
Area of research	0.044 (0.005)	0.000
Constant	−4.208 (0.081)	0.000
Log likelihood	−9403.38	
Number of obs	62637	
LR chi2	197.17	
Prob > chi2	0.0000	
Pseudo R2	0.0104	

Note: Standard errors in parenthesis. Gender denotes gender (male or female), professor marker denotes professorial role (either a professor or a non-professor) and area of research denotes one of our 16 areas of research. The independent variable is a dummy variable, which is the response-non-response indicator.

The results show that all three variables were significant in determining whether an individual responded to the questionnaire or not. As we can see, gender seems to have a significant impact on the probability of response to the survey, as when we break by gender, other variables have less explanatory power. The coefficient for the gender variable (coded 0 for man and 1 for woman) is positive and statistically significant, showing that women were more likely to respond to the survey. The log likelihood and pseudo-R squared are also higher when gender is included.

The conclusion from Tables A3 and A4 was therefore that non-response adjustments according to gender, area of research, and professorial role were required and for that we used weights.

Table A4. Logistic regression of response indicator on professor, marker, and area of research.

Variable	Coefficient	*P*-Value
Professor marker	0.459 (0.052)	0.000
Area of research	0.042 (0.005)	0.000
Constant	−3.641 (0.041)	0.000
Log likelihood	−9437.73	
Number of obs	62637	
LR chi2	128.46	
Prob > chi2	0.0000	
Pseudo R2	0.0068	

Note: Standard errors in parenthesis. The variables are defined as in Table A3.

Once the subpopulations were defined, the probability of response of all members of that subpopulation was assumed to be the same, i.e., constant within the subpopulation, in line with the mechanism of homogeneous response within subpopulations, as already highlighted above. In addition, this probability was assumed to be independent from the probabilities of response of all the other subpopulations.

When the size of each subpopulation is known there is no need to estimate the probabilities to respond using a logistic regression, as post-stratification estimators are better [42]. The method based on estimated probabilities of response does not allow any control over the dispersion of values. Indeed, the estimator can become very unsteady because of very under-represented types of respondents, which have high weights assigned to them. As argued in [42], the construction of homogeneous groups of respondents conveys more robustness, especially when the model of regression is not accurate.

The weights in our case can therefore be simply estimated by the ratio:

$$w_h = \frac{N_h}{r_r}$$

where $h = 1 \ldots 64$ and h denotes the 64 different strata, i.e., the 64 possible combinations of characteristics an individual can have (male, female; professor, non-professor, and one of 16 different research areas), r_r is the number of respondents of subpopulation h (i.e., that were included in the sample), N_h is the size of subpopulation h.

The problem we have (and we would still have even if we were to use a logistic regression to estimate probabilities of response) is that, as Table A2 clearly shows, in two cases we have zero respondents in our sample (i.e., $r_r = 0$. The two subpopulations in question are female professors in Business and Management Studies and male professors in Sport and Exercise Sciences, Leisure and Tourism. Division by zero does not exist and therefore $w_h = \frac{N_h}{r_r}$ cannot be computed. As a solution, we merged Business and Management Studies with Economics and Econometrics and Education with Sport and Exercise Sciences, Leisure and Tourism. The rationale behind the first merge was that many economists work in Business and Management Studies Schools and also academics doing research in Business and Management Studies and academics doing research in Economics and Econometrics share some similarities regarding training. They tend to hold first degrees, masters, and PhDs and often these are gained from departments that have both Economics and Business. The rationale behind the second merge was that the years and type of training tend to be similar. Many academics in those areas do not actually hold PhDs, but they hold postgraduate diplomas and certificates, often requiring about one year of full-time equivalent study/training.

As underlined in [42], the number of subpopulations is the result of a problematic trade-off between increasing the number of strata (ensuring great homogeneity within each stratus) and lowering the number of strata (ensuring a lower variance of the estimator). Once the problematic cells with zeros, which made the calculation of ratios impossible, disappeared, the ratios were computed.

Table A5 shows the weights computed as the ratios of the size of the subpopulation with characteristics h to the size of the subsample with characteristics h.

Table A5. Weights computed as ratios.

	Prof + M	Prof + F	No Prof + M	No Prof + F
Medical Sciences	174	31.5	174.5	92.36
Other Allied to Medicine	41.26	13.08	49.86	28.64
Life Sciences	28.92	18.86	36.97	39.9
Mathematical, Physical Sciences and Computer Sciences	17.78	19.88	32.78	26.37
Social Sciences	27.73	17.45	25.19	23.13
Humanities	17.78	9.79	22	19.58
Engineering	42.88	12.33	41.42	36.62
Law	10.38	5.78	18.93	10.16
Economics and Econometrics. Business and Management Studies	14.14	27.5	29.5	25.14
Architecture and the Built Environment	9	4.4	19.65	12.56
Arts	18.8	4.8	35.55	39
Chemistry	45.56	11.75	70.29	88.63
Education. Sport and Exercise Sciences. Leisure and Tourism	10.43	4.3	44.36	20.98
Geography, Environmental Studies and Archaeology	15.63	6.78	26.86	13.14

Source: Table A2.

The weight coefficients for professor and for non-professor are higher for females than for males in all research areas, except for Medical Sciences. This shows that women had been over-represented among the respondent population. Given the subject (and the results of the logistic regressions shown on Tables A3 and A4), it is not a surprise that women were more prone to respond to our survey than men.

We also note that the difference of weight coefficients between the professor and non-professor subpopulations is much stronger in the female subpopulation than in the male subpopulation. Hence, a women professor is the subpopulation most over-represented in our survey respondents.

The weights computed in Table A5 were used in all our models to make our sample representative of the population.

Appendix C

In this Appendix we present the results of the linear regressions of the research productivity variables, discussed in Sections 5.2 and 5.3.

Table A6. Linear regressions of research productivity variables on gender, area of research, grade and number of children under 18.

	Number of Journal Publications	Number of Conference Proceedings	Number of Grants
Gender	−2.241 *	−0.197	0.199
	(1.172)	(0.721)	(0.125)
Area 1 (Science) *Reference*			
Area 2 (Medicine and Life Sciences)	−1.849	−4.584 ***	−0.065
	(2.365)	(1.235)	(0.182)
Area 3 (Social Sciences)	−12.653 ***	−7.613 ***	−0.938 ***
	(2.227)	(1.028)	(0.154)
Area 4 (Arts and Humanities)	−15.064 ***	−9.092 ***	−1.122 ***
	(2.315)	(1.067)	(0.155)
Grade	4.490 ***	1.391 ***	0.429 ***
	(0.660)	(0.343)	(0.050)
Number of children under 18	0.567	−0.090	0.213 ***
	(0.616)	(0.406)	(0.062)
Constant	9.259 **	7.144 ***	0.495 *
	(3.942)	(1.624)	(0.253)
Number of obs	1380	1380	1380
F	F (6, 1373) = 40.03	F (6, 1373) = 17.63	F (6, 1373) = 29.47
Prob > F	0.0000	0.0000	0.0000
R-squared	0.1026	0.0912	0.1408
Root MSE	25.847	11.94	1.839

Note: Standard errors are in parenthesis. * (**) (***) indicate statistical significance at the 10 (5) (1) % levels.

Table A7. Linear regressions of research productivity variables on gender, area of research, grade, number of children under 18 and percentage of time spent on teaching and teaching-related activities.

	Number of Journal Publications	Number of Conference Proceedings	Number of Grants
Gender	−1.724	−0.053	0.220 *
	(1.156)	(0.722)	(0.124)
Area 1 (Science) *Reference*			
Area 2 (Medicine and Life Sciences)	−2.821	−4.854 ***	−0.105
	(2.431)	(1.229)	(0.180)
Area 3 (Social Sciences)	−12.253 ***	−7.501 ***	−0.921 ***
	(2.175)	(1.030)	(0.155)
Area 4 (Arts and Humanities)	−13.973 ***	−8.789 ***	−1.077 ***
	(2.206)	(1.083)	(0.159)
Grade	4.023 ***	1.262 ***	0.410 ***
	(0.663)	(0.354)	(0.051)
Number of children under 18	0.566	−0.090	0.213 ***
	(0.605)	(0.406)	(0.062)
Share time on teaching	−0.128 ***	−0.036 *	−0.005 *
	(0.028)	(0.018)	(0.003)
Constant	14.860 ***	8.702 ***	0.727 ***
	(4.490)	(1.814)	(0.280)
Number of obs	1380	1380	1380
F	F (7, 1372) = 35.83	F (7, 1372) = 15.81	F (7, 1372) = 25.74
Prob > F	0.0000	0.0000	0.0000
R-squared	0.1110	0.0943	0.1435
Root MSE	25.735	11.924	1.8367

Note: Standard errors are in parenthesis. * (**) (***) indicate statistical significance at the 10 (5) (1) % levels.

References and Note

1. Higher Education Statistics Agency. Staff at Higher Education Institutions in the United Kingdom 2011/12. 2013. Available online: https://www.hesa.ac.uk/news/17-01-2013/sfr185-staff (accessed on 15 May 2019).
2. Higher Education Statistics Agency. Data provided by the Higher Education Statistics Agency containing the number of academic staff at Russell group universities in 2011/12, by academic employment function (teaching/research/both/neither), along with the number of professors, plus age, gender and academic discipline for everyone. 2013.
3. Blake, M.; La Valle, I. *Who Applies for Research Funding? Key Factors Shaping Funding Application Behaviour among Women and Men in British Higher Education Institutions*; An Independent Summary Report Prepared for the Biotechnology and Biological Sciences Research Council (BBSRC), the Economic and Social Research Council (ESRC), the Engineering and Physical Sciences Research Council (EPSRC), the Medical Research Council (MRC), the Natural Environment Research Council (NERC), the Particle and Physics Research Council (PPARC) and The Wellcome Trust; The Wellcome Trust: London, UK, 2000; Available online: https://wellcome.ac.uk/sites/default/files/wtd003209_0.pdf (accessed on 30 April 2013).
4. Becker, G. Human Capital, Effort, and the Sexual Division of Labor. *J. Labor Econ.* **1985**, *3*, S33–S38. [CrossRef]
5. Browne, K.R. *Biology at Work: Rethinking Sexual Equality*; Rutgers University Press: Piscataway, NJ, USA, 2002.
6. Summers, L.H.; Transcript of "Remarks at NBER Conference on Diversifying the Science & Engineering Workforce". Cambridge, MA, USA, 14 January 2005. Available online: https://web.archive.org/web/20080130023006/http://www.president.harvard.edu/speeches/2005/nber.html (accessed on 15 May 2013).
7. Hancock, K.J.; Baum, M.; Breuning, M. Women and Pre-Tenure Scholarly Productivity in International Studies: An Investigation into the Leaky Career Pipeline. *Int. Stud. Perspect.* **2013**, *14*, 1–21. [CrossRef]
8. MIT Council for Faculty Diversity. Reports of the Committees on the Status of Women Faculty. 2002. Available online: https://facultygovernance.mit.edu/sites/default/files/reports/2002-03_Status_of_Women_Faculty-All_Reports.pdf (accessed on 15 May 2013).
9. European Commission. *Structural Change in Research Institutions: Enhancing Excellence, Gender Equality and Efficiency in Research and Innovation*; Report EUR 24905 EN, European Commission: Directorate-General for Research; Office for Official Publications of the European Communities: Luxembourg, 2012; Available online: http://ec.europa.eu/research/science-society/document_library/pdf_06/structural-changes-final-report_en.pdf (accessed on 15 July 2013).
10. Mason, M.A.; Wolfinger, N.H.; Goulden, M. *Do Babies Matter?: Gender and Family in the Ivory Tower (Families in Focus)*; Rutgers University Press: New Brunswick, NJ, USA, 2013.
11. Wolfinger, N.H.; Mason, M.A.; Goulden, M. Problems in the Pipeline: Gender, Marriage, and Fertility in the Ivory Tower. *J. High. Educ.* **2008**, *79*, 388–405. [CrossRef]
12. Ginther, D.K.; Hayes, K.J. Gender differences in salary and promotion in the humanities. *Am. Econ. Rev.* **1999**, *89*, 397–402. [CrossRef]
13. Ginther, D.K.; Hayes, K.J. Gender differences in salary and promotion for faculty in the humanities 1977-95. *J. Hum. Resour.* **2003**, *38*, 34–73. [CrossRef]
14. Ginther, D.K.; Kahn, S. Women in economics: moving up or falling off the academic career ladder? *J. Econ. Perspect.* **2004**, *18*, 193–214. [CrossRef]
15. Perna, L. Sex Differences in Faculty Tenure and Promotion: The Contribution of Family Ties. *Res. High. Educ.* **2005**, *46*, 277–307. [CrossRef]
16. Toutkoushian, R.K.; Bellas, M.L.; Moore, J.V. The Interaction Effects of Gender, Race, and Marital Status on Faculty Salaries. *J. High. Educ.* **2007**, *78*, 572–601. [CrossRef]
17. Dunkin, M.J. Determinants of Academic Career Advancement at an Australian University. *High. Educ. Res. Dev.* **1991**, *10*, 115–131. [CrossRef]
18. Over, R. Correlates of Career Advancement in Australian Universities. *High. Educ.* **1993**, *26*, 313–329. [CrossRef]
19. Ash, A.S.; Carr, P.L.; Goldstein, R.; Friedman, R.H. Compensation and advancement of women in academic medicine: Is there equity? *Ann. Intern. Med.* **2004**, *141*, 205–212. [CrossRef]
20. Dobele, A.R.; Rundle-Theile, S. Progression through Academic Ranks: A Longitudinal Examination of Internal Promotion Drivers. *High. Educ. Q.* **2015**, *69*, 410–429. [CrossRef]

21. Dunkin, M.J. Stability and Change in Determinants of Academic Career Advancement. *High. Educ. Res. Dev.* **1992**, *11*, 191–201. [CrossRef]
22. Park, S.M. Research, teaching and service—Why shouldn't women's work count? *J. High. Educ.* **1996**, *67*, 46–84. [CrossRef]
23. Symonds, M.R.; Gemmell, N.J.; Braisher, T.L.; Gorringe, K.L.; Elgar, M.A. Gender Differences in Publication Output: Towards an Unbiased Metric of Research Performance. *PLoS ONE* **2006**, *1*. [CrossRef]
24. Fox, M.F.; Mohapatra, S. Social-Organizational Characteristics of Work and Publication Productivity among Academic Scientists in Doctoral-Granting Departments. *J. High. Educ.* **2007**, *78*, 542–571. [CrossRef]
25. Abramo, G.; D'Angelo, C.A.; Caprasecca, A. Gender differences in research productivity: A bibliometric analysis of the Italian academic system. *Scientometrics* **2009**, *79*, 517–539. [CrossRef]
26. Bird, K. Do women publish fewer journal articles than men? Sex differences in publication productivity in the social sciences. *Br. J. Sociol. Educ.* **2011**, *32*, 921–937. [CrossRef]
27. Aiston, S.J. Leading the academy or being led? Hong Kong women academics. *High. Educ. Res. Dev.* **2014**, *33*, 59–72. [CrossRef]
28. Krapf, M.; Ursprung, H.W.; Zimmermann, C. Parenthood and productivity of highly skilled labor: Evidence from the groves of academe. *J. Econ. Behav. Organ.* **2017**, *140*, 147–175. [CrossRef]
29. European Commission. Meta-Analysis of Gender and Science Research, Synthesis Report, European Commission, Directorate-General for Research and Innovation, Directorate B—European Research Area. 2011. Available online: http://ec.europa.eu/research/science-society/document_library/pdf_06/meta-analysis-of-gender-and-science-research-synthesis-report.pdf (accessed on 16 July 2013).
30. Sax, L.; Serra Hagedorn, L.; Arredondo, M.; Dicrisi, F.A., III. Faculty Research Productivity: Exploring the Role of Gender and Family-Related Factors. *Res. High. Educ.* **2002**, *43*, 423–446. [CrossRef]
31. Eagan, M.K., Jr.; Garvey, J.C. Stressing Out: Connecting Race, Gender, and Stress with Faculty Productivity. *J. High. Educ.* **2015**, *86*, 923–954. [CrossRef]
32. Joecks, J.; Pull, K.; Backes-Gellner, U. Childbearing and (female) research productivity: A personnel economics perspective on the leaky pipeline. *J. Bus. Econ.* **2014**, *84*, 517–530. [CrossRef]
33. Marsh, H.; Bornmann, L.; Mutz, R.; Daniel, H.-D.; O'Mara, A. Gender Effects in the Peer Reviews of Grant Proposals: A Comprehensive Meta-Analysis Comparing Traditional and Multilevel Approaches. *Rev. Educ. Res.* **2009**, *79*, 1290–1326. [CrossRef]
34. Marsh, H.; Jayasinghe, U.; Bond, N. Gender Differences in Peer Reviews of Grant Applications: A Substantive-Methodological Synergy in Support of the Null Hypothesis Model. *J. Informetr.* **2011**, *5*, 167–180. [CrossRef]
35. Mutz, R.; Bornmann, L.; Hans-Dieter, D. Does Gender Matter in Grant Peer Review? An Empirical Investigation Using the Example of the Austrian Science Fund. *Zeitschrift Fur Psychologie J. Psychol.* **2012**, *220*, 121–129.
36. Wennerås, C.; Wold, A. Nepotism and sexism in peer-review. *Nature* **1997**, *387*, 341–343. [CrossRef]
37. Bornmann, L.; Mutz, R.; Daniel, H.-D. Gender Differences in Grant Peer review: A Meta-Analysis. *J. Informetr.* **2007**, *1*, 226–238. [CrossRef]
38. Tamblyn, R.; Girard, N.; Qian, C.J.; Hanley, J. Assessment of potential bias in research grant peer review in Canada. *Can. Med. Assoc. J.* **2018**, *190*, E489–E499. [CrossRef]
39. Witteman, H.O.; Hendricks, M.; Tannenbaum, C. Are gender gaps due to evaluations of the applicant or the science? A natural experiment at a national funding agency. *Lancet* **2019**, *393*, 531–540. [CrossRef]
40. Wright, A.L.; Schwindt, L.A.; Bassford, T.L.; Reyna, V.F.; Shisslak, C.M.; St Germain, P.A.; Reed, K.L. Gender differences in academic advancement: Patterns, causes, and potential solutions in one US college of medicine. *Acad. Med.* **2003**, *78*, 500–508. [CrossRef]
41. Iannacchione, V.G.; Milne, J.G.; Folsom, R.E. Response Probability Weight Adjustments Using Logistic Regression. In *Proceedings of the American Statistical Association*; Section on Survey Methods; 1991; pp. 637–642. Available online: http://www.asasrms.org/Proceedings/papers/1991_109.pdf (accessed on 31 May 2013).
42. Caron, N. *La correction de la non-réponse par repondération et par imputation*; Série des Documents de Travail de la Direction des Statistiques Demographiques et sociales, N°M0502; Institut National de la Statistique et des Etudes Economiques: Paris, France, 2005; Available online: https://www.epsilon.insee.fr/jspui/handle/1/95475 (accessed on 31 May 2013).

43. Kelly, K.; Grant, L. Penalties and premiums: The impact of gender, marriage, and parenthood on faculty salaries in science, engineering and mathematics (SEM) and non-SEM fields. *Soc. Stud. Sci.* **2012**, *42*, 869–896. [CrossRef]
44. Bozeman, B.; Gaughan, M. Job Satisfaction among University Faculty: Individual, Work, and Institutional Determinants. *J. High. Educ.* **2011**, *82*, 154–186. [CrossRef]
45. Armenti, C. May Babies and Posttenure Babies: Maternal Decisions of Women Professors. *Rev. High. Educ.* **2004**, *27*, 211–231. [CrossRef]
46. Office for National Statistics. Around one Fifth of Women are Childless at Age 45', Part of Cohort Fertility, England and Wales, 2012, Released on 5 December 2013. Available online: http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/rel/fertility-analysis/cohort-fertility--england-and-wales/2012/sty-cohert-fertility.html (accessed on 1 August 2016).
47. Birkett, H.; Forbes, S. Where's dad? Exploring the low take-up of inclusive parenting policies in the UK. *Policy Stud.* **2019**, *40*, 205–224. [CrossRef]
48. Higher Education Statistics Agency. Definitions: Staff. Available online: https://www.hesa.ac.uk/content/view/2881 (accessed on 23 August 2018).

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Assessment of Sustainable Development of the Performance of Higher Education Credentials in the Transitive Labor Market

Aftab Ahmed Memon and Zhimin Liu *

College of Public Administration, Nanjing Agricultural University, Nanjing 210095, China; aftabahmed32@gmail.com

* Correspondence: liuzhimin@njau.edu.cn

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Abstract: Given the transitive challenges in the labor market, education can provide a sustainable developmental map for worldwide economic prosperity. Deep understanding of the dynamics of human capital, reflecting earnings aspirations in the labor market, indicates the need for policy makers to monitor and modify pedagogical curricula to meet the supply/demand of markets based on scientific evidence. In this study, we propose a methodology based on a household integrated economic survey (HIES) and, using different models, assess the impact of attained education and returns on the practical utility of skills within the context of a transitive labor market. We observe that effort levels are snowballing and rejection rates are declining for people with higher education (HE), whereas wage offers decline for people with low education (LE). Our results reveal significant differences in the supply/demand factors of both the public and private markets' one-shot and continual affiliations. We conclude the impact of sheepskin effects and the implication of our findings.

Keywords: wage discrimination; sustainable development; sheepskin effects; supply/demand transition in labor market; higher education

1. Introduction

Over the past six decades, education has received considerable attention in the literature. School produces cognitive, human capital (knowledge)-based skills [1–3], which is captured in the phrase, "plant a seed and reap a hundred harvests". Contemporary scholars have a similar mindset [4], reporting the importance of educational investment. Similarly, investing in years of education, like investing in the accumulation of productive skills, improves people's abilities as demanded by the labor market [5]. Economists consider that resources should be expended on physical capital, as investment that yields a future return, rather than on consumption; expenditure on human capital must be considered analogous to physical capital [6,7]. The government of Pakistan consistently emphasized human capital development as a potential engine for developing a knowledge-based economy [8]. Budgetary allocations for human capital development in the educational sector has increased every fiscal year, and a sum of RS 20.5 billion or 21% was allocated in the 2015–2016 budget for the Higher Education Commission (HEC) of Pakistan.

The affiliation between the labor market earnings of individuals and their completed level of education has been adequately established [9]. Human capital schooling is the standardized practice for promoting this affiliation, considering the correlation of "labor market experience with earmark controls" as being consistent with their view that high earnings improve worker productivity due to the intensification of each subsequent schooling level [10]. However, individuals with higher education (HE) are comparatively associated with professional designations in the labor market [11].

Similarly, ecumenical education is considered to play an imperative role in the prospect of employment, where more educated candidates are not exclusively more disposed to procure employment than less educated candidates, but they are more likely to acquire employment of a superior quality [12].

Consulting economic theory, workers are compensated according to their marginal productivity. This is called anticipatory wage—the mechanism associated with people's education and skill-based productivity [13]. However, workers' authentic productivity is laborious to observe, and employers often rely on surrogates when making decisions about wages. For instance, from the perspective of screening, one of the most visible indicators of productivity is the curriculum vitae [14,15] and human capital [16,17], and studies indicate that individuals accumulate skills and knowledge while at school, where their productivity improves. Empirical studies have shown positive and significant returns from education [18,19].

Educational institutions are positively correlated with labor markets, and a well-trained workforce that possess supplementary education is generally understood as a significant precondition for economic development. However, all workers with HEs do not inevitably induce high economic growth. Although the productive value of education is not only dependent on the level of education, but also on the quality of the pedagogy and the knowledge and skills imparted to students [20]. So to answering the questions, what is the demand of education in transitive labor market and how it is supplied from the institute's side? What is the tendency of individual's education?

The structure of this paper is as follows. Section 2 provides a literature review. Section 3 provides the background of the supply/demand transition in the labor market. Section 4 offers research-related details on the relationships between the data and the scope of the study and outlines the empirical methodology. Section 5 provides the results in centile groupings. Finally, Section 6 provides a discussion and conclusions.

2. Literature Review

The sheepskin effect is an applied economic theory related to people's academic degree, which is offered by institutions after completing a schooling period. According to previous studies, returns from education are associated with certificates of qualification and sheepskin effects, which are less clear [21]. Likewise, most of the analyses related to the earnings function have been affected by the nonexistence of the diploma or sheepskin effect [22,23]. Dissimilar from previous studies, including in Pakistan [24], scholars calculated the educational returns by using Pakistan Social and Living Standard Measurement Survey (PSLM) data from 1979, though it was old fashioned and inappropriate data. In the literature, gender-based inequality in employment remains in the focus area [25–27], and we think that the labor market seeks committed productivity and the distribution of individuals' incomes into specific grade levels, neither of which vary according to gender-based returns [28]. Although it is very difficult to judge the ability of an employee, the sheepskin "certificate or acquisition of a receipt after the completion of schooling" is a helpful tool for screening, based on a projection of the future production of the employee.

Being globally focused on personal investment into education and its outputs, we also focused on the variation in outcomes associated with different education levels and, related to the duality theory, the input of the supplied education and the demand in the market. The trend of the supply/demand factor in the transitive labor market has seldom been studied [29]. For instance, the sustainable development of any country relies on the Gross Enrolment Index (GEI), or Gross Enrolment Ratio (GER), of educational enrolments in school at different levels, along with a qualification from those particular grade levels. The GER can exceed 100% equal to the entire population of a whole country and would indicate the eradication of poverty.

The findings of this study contribute to the expansion of our understanding in two ways. First, we synchronize the tendency of educational returns at certain levels of completed qualified certificates to the education sectors from 2005/2006 to 2010/2011. Second, we investigated the trend in the educational supply/demand factor in the economic sectors, which requires careful consideration because

this has not been adequately addressed in the literature to date. This study provides hypothetical information for policymakers regarding the efficiency of different types of qualifications and ascertains the supply of labor and demand conditions in Pakistan's labor market. Because the supply/demand of skills contrasts across all economic sectors, this suggests that the frequency of educational levels may differ a lot across rural/urban over time. We are using city data from 27 cities in Pakistan, which shall help to fill the gap of educational weakness, like the existing studies for Pakistan [30], Hong Kong, USA [31], and Taiwan [32].

3. Supply/Demand Transition in the Labor Market

Several countries have accountable modification pauses for the protection of certain workers from contrary effects. Educating the population requires investment in human capital, such as educational amenities, alongside updated technology-related pedagogical curricula, which must be monitored. Particularly in the case of Pakistan's culture and damaged labor markets, previous studies [33–35] reported numerous factors that increase the likelihood of instantaneous consequences related to an increase in the number of graduate contestants in the labor market, for instance, an increase in unemployment along with a lack of productive skills and increasing age over that required by employment standards. Tables 1 and 2 present our findings regarding youth attainment of education and labor market transition, respectively.

Table 1. Educational attainment of youth cumulative (%).

Series Years	Primary 25+ Years	SSc 25+ Years	HSc 25+ Years	BA 25+ Years	BS/BE, 25+ Years	MS/ME, 25+ Years
2005	30.3	21.4	6.7	3.9	-	-
2006	45.9	32.4	23.3	6.2	-	-
2007	-	-	-	-	-	-
2008	43.3	31.2	22.5	5.9	-	-
2009	44.9	32.2	23.2	6.6	-	-
2010	46.2	33.3	23.8	6.9	-	-
2011	48.3	33.2	24.1	7.3	-	-
2012	47.6	34.9	25.6	7.5	7.5	1.6
2013	48.5	35.4	26.0	7.9	7.9	1.7
2014	49.8	37.3	27.7	8.7	8.7	1.8

Source (2019): World Bank data indicator.; Description code: SSc: Secondary School; HSc: Higher Secondary School; BA: Bachelor of Arts; BS/BE: Bachelor of Science/Bachelor of Engineering; MS/ME: Master of Science/Master of Engineering.

Every level of education has an increasing enrolment ratio in rural and urban areas. Over the last three years, a significant increment was found in enrolment, averaging 8% at BS/BE and 1.7% at MS/ME levels. This is a significantly diminished ratio of enrolment compared to the first baseline levels. Table 2 displays the trend of individuals to transition from agricultural professions to industry services employment. The abundant availability of graduates and oversupply of nonprofessional skills prepares them for careers other than administrative careers and decreases their employability. Gradually, many modifications appeared depending on several aspects of sustainable job search, including funds, information about the degree, the job that the candidates seek and employers possess, graduates' wage expectations, and how the labor market may alter in the short- and long-term. In competitive labor markets, overall schooling involves new practices alongside the development of cognitive skills.

Table 2. Transitive labor market cumulative (%).

		Total Cumulative %				National Estimate
Series Years	**Employers**	**Employment in Agriculture**	**Employment in Industry**	**Employment in Services**	**Employment to Population Ratio**	**Employment to Population Ratio, 15+, Total (%)**
2005	0.89	43.06	20.31	36.61	48.56	
2006	0.90	43.38	20.73	35.88	50.36	49.74
2007	0.84	43.63	20.98	35.38	50.57	49.84
2008	0.95	44.69	20.11	35.18	50.48	49.87
2009	1.32	44.62	20.16	35.21	50.78	50.26
2010	1.34	43.38	21.41	35.19	51.22	50.66
2011	1.51	43.49	21.76	34.73	51.15	50.37
2012	1.35	42.05	22.78	35.16	50.96	
2013	1.32	42.23	22.92	34.84	50.74	49.93
2014	1.13	42.23	22.87	34.89	51.21	50.06

Source (2019): World Bank data indicator.

The above considerations provide a loose theoretical framework that suggests a testable hypothesis, for the analysis of largest increasing HE effects from the Pakistan's labor market. Figure 1 presents the chain of educational inputs. Individuals complete their schooling and obtain knowledge, earn skills after the completion of schooling, and, in the end, institutes offer them degrees. It is the degree (sheepskin effect) that functions as a signaling device for entering into the labor market for employment, which implies that the employer needs to provide production skills and make wage discriminations.

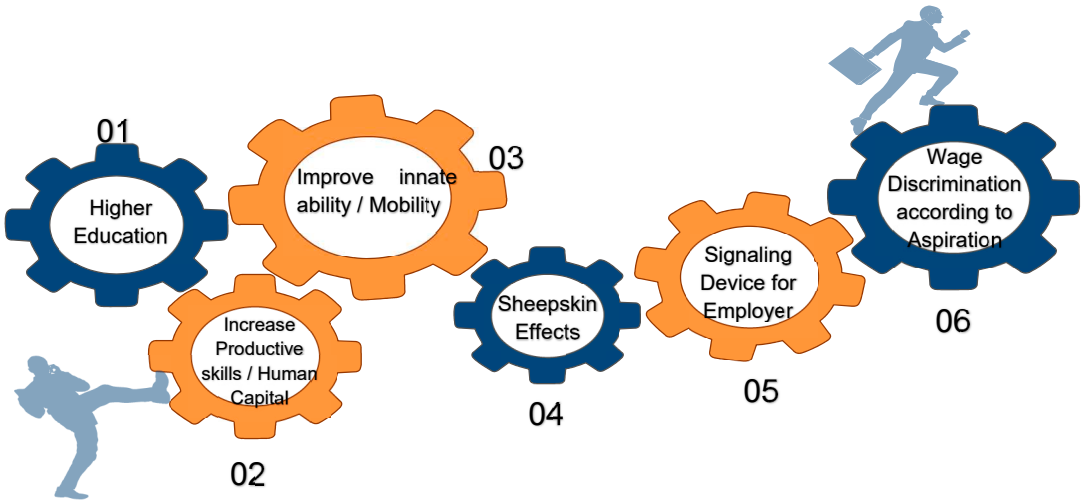

Figure 1. Sustainable developmental key factors indication toward educational relation to aspire wage discrimination.

4. Materials and Methods

4.1. Data Resources

We used Pakistan's administrative annual household integrated economic survey (HIES) dataset to estimate the variation over 4 years of sample data from 2004/2005 to 2010/2011, connected with information regarding the current condition of the rapid secular transition supply/demand for educated workforce in public and private markets. Every year the Pakistan Bureau of Statistics (PBS) conducts the HIES survey, which is one of the most all-encompassing studies of the earnings equilibrium of individuals in Pakistan. It was an appropriate source of data for the study, since it enables an analysis of the characteristics of the educational tendency and transition of supply/demand in the labor market. The transition could be seen in the next five years (2024) as a result of the implementation of the skilled

development project. Thus, this will not only be beneficial for supposed individuals' selection who rely on their level of qualifications, but also for other individuals in Pakistan's economy. The latest HIES also provides the government with valuable information for assessing the efficiency of public investment into education, especially in relation to solving the problem of educational mismatches (over- or undereducation) in the Pakistan labor market. Both aspects may redirect inadequacies in the allocation of resources.

Certain features are considered for the data sample selection. From 2004/2005 to 2010/2011, 106,008 respondents from households were randomly selected for the HIES survey. First, employee respondents had to be between the ages of 15 and 64 years. Second, individuals were excluded if they had not attended school (either they had not completed education (dropouts) or had no formal education), as well as those who are currently undertaking education alongside their job and are self-employed, which is consistent with the process followed in the literature. Those who were currently enrolled in school were migrant workers or had qualifications that were not recognized by the educational system of Pakistan's Ministry of Education (MoE) were also excluded. The reason for the exclusion of self-employed people is that it is difficult to measure their income. Similarly, workers who work without salary, pensioners, unpaid family members, and housewives were excluded. Unpaid family workers may also qualify as self-employed. The selection standard was based on 46,008 respondents and the individuals with the highest level of education certificates were chosen as mentioned in Table 3.

Table 3. Descriptive statistics.

Variables	2004/05	2005/06	2007/08	2010/11
	Mean (Std. Dev)	Mean (Std. Dev)	Mean (Std. Dev)	Mean (Std. Dev)
Wage	7.020 (3.307)	7.267 (3.333)	7.910 (3.018)	7.907 (3.015)
S	4.300 (2.124)	4.291 (2.148)	4.276 (2.050)	4.257 (2.051)
D & M	0.105 (0.306)	0.118 (0.323)	0.122 (0.328)	0.120 (0.325)
P & L	0.110 (0.301)	0.112 (0.315)	0.113 (0.317)	0.112 (0.315)
AP & APT	0.099 (0.298)	0.112 (0.316)	0.096 (0.295)	0.095 (0.294)
A & F	0.106 (0.308)	0.101 (0.302)	0.110 (0.313)	0.109 (0.311)
Supervisors	0.102 (0.303)	0.116 (0.321)	0.113 (0.317)	0.110 (0.313)
F & RB	0.099 (0.299)	0.097 (0.297)	0.105 (0.306)	0.102 (0.303)
PMO	0.101 (0.301)	0.102 (0.303)	0.109 (0.312)	0.107 (0.310)
OC	0.149 (0.356)	0.130 (0.336)	0.107 (0.310)	0.119 (0.324)
EO	0.144 (0.351)	0.125 (0.331)	0.129 (0.336)	0.127 (0.333)
Exp	12.654 (6.911)	12.876 (7.004)	13.117 (6.301)	13.13 (6.203)

Description of short codes: wage(Pakistan rupee); S: School; D&M: Director and Manager; P&L: Professionals and Legislators; AP & APT: Associated and Professional Teachers; A & F: Agriculture and Fisheries; F & RB: Finance and related Business; PMO: Plant Machine Operators; OC: Office Clerks; EO: Elementary Office.

4.2. Research Method

This section outlines the practical methodology used for testing our hypothesis using the random effects model, fixed effects model, Hausman test, and the stretched Jacob Mincer [36] to investigate the returns on education in Pakistan's public and private sectors. This describes the sheepskin effect influencing earnings, apart from education, experience, and years of schooling. We use the model in Equation (1) to test the hypothesis:

$$\ln \omega_{ITK} = \alpha + \beta_0 \sum_{H} \sum Edu_{ITK} + \beta_1 \sum exp_{ITK} + \beta_2 \sum {exp_{ITK}}^2 + \lambda_{ITK} + \varepsilon_{ITK} \quad (1)$$

where α is a constant term, I is the index of individuals ($I = 1, \ldots, N$), T is the period of indexes (T = 2004/2005, 2005/2006, 2007/2008, or 2010/2011), K represents the direction of the occupation-related services sector, and $\ln\omega$ is the place holder for the natural log of individuals' yearly earnings. Education is considered the attainment of a specified level of education from a school, college,

or university. The criteria are university-based certificates (postgraduate, graduate), college certificates (diploma, HSc: Higher secondary certificate; school certificates, SSc: Secondary school certificate; middle, primary), or primary school certificates. A chain of dummy variables is included in the expressive education types (levels). The primary level is used to classify the group captured in the finding of the demand and supply of educational skills among the occupation-related services sectors and the variations in returns on education for other certificates. The alteration of educational returns for other certificates of qualification was compared to primary school education, and EXP is the potential experience (age − schooling years − 5), following the specification supplied by Psacharopoulos [37]. The assumption is that children commence schooling at 5 years of age and are employed promptly after the completion of schooling. This aligns with the compulsory schooling policy for children of six years of age in Pakistan. Exp^2 is the quadratic of experience, measuring the capture concavity of an experience–earnings profile. λ is a predictor variable for estimating the earning effects among the occupations. A series of dummy (binary form) variables are included to represent the types of professions. There are nine occupational groups, as stated in the HIES.

Our study indicates the occupational variables as control variables, since the professions are associated with acquired skills and different levels of qualification may have different rates of returns from education. By including industrial controls, the performance of overeducated workers can be determined [38]. Likewise, in the present study, earnings are significantly affected, but small. The standard practice in the literature is to determine the private average rates of return to education (r_i) to measure each low and high level of qualification for comparison [39]. These are calculated using the estimated coefficients: $r_I = (\beta_I - \beta_{I\text{-}1})/(ES_I - ES_{I\text{-}1})$, where H is the highest certificate obtained. For instance, the rates of return to qualification are designed as r (Higher Degree) = $(\beta_{MS\text{-}degree} - \beta_{BS\text{-}degree})/(S_{18} - S_{16})$. In the present study, we used log-linear regressions to analyze the rates of return from high levels to low levels of qualification in the public and private labor markets. With the robust option, the point estimate of the coefficients is exactly the same as in the ordinary least squares (OLS), but the standard errors consider issues concerning heterogeneity and the lack of normality, as well as observations within districts being dependent. Robust standard errors easily deal with the heteroscedasticity problem because we usually do not know the structure of heteroscedasticity (especially in our case where the sample size is large), as suggested by White [40]. The application of the log-linear regression estimations also aids in the interpretation of the results of this study by using dummy variables to analyze the curvature of educational returns between 2004/2005 and 2010/2011. This methodology analysis provides a preliminary picture of the various educational standards in the Pakistan labor market.

5. Results

5.1. Educational Tendency

The results are shown in Table 4. First, we assumed that the workers who completed additional years of education received a premium over the nondiscriminatory wage structure, the exception being that this monotonic increase in HEs applies to those who acquire a postgraduate degree, associated with a cohort that terminates studies after obtaining a university degree. Second, shifting attention to control variable results revealed that higher earnings are related to employees who possess higher qualified degrees and better cognitive skills, and who expected that wage discrimination increases with experience. For instance, from the analysis, we found that those people who attained HE had high-ranking occupations, whereas those who possessed less education due to a lack of resources, with an orientation toward the accomplishment of skills, remained unemployed, self-employed, or made compromises with their nondiscrimination wage. However, human capital and the sheepskin effect were found to influence the distribution of wages among the occupations. For instance, the top four professions enjoy a higher premium in each sector because they require the possession of higher qualifications along with an abundance of years of experience, and the remaining professions are considered to have low wage distribution according to their level of educational status and skills. However, wage

was constant in each occupation, whether in the public or private sector. Many elementary educated occupants were found to have had a similar experience to directors and managers, but they failed to earn higher wages because of the difference in their educational qualifications.

Table 4. Estimated results in the education investment and labor market wage discriminations.

Variables	2004/2005	2005/2006	2007/2008	2010/2011
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
Intercept	3.244 (0.045) **	3.442 (0.037) **	4.921 (0.033) ***	6.09 (0.026) ***
Primary	0.004 (0.014) **	0.019 (0.012) *	0.049 (0.006) ***	0.05 (0.004) **
Middle	0.049 (−0.018)	0.032 (0.016) **	0.018 (0.009) **	0.014 (−0.007)
SSc	0.066 (0.019) ***	0.054 (0.016) ***	0.082 (−0.015)	0.068 (0.011) **
HSc	0.069 (0.017) ***	0.07 (0.014) **	0.113 (0.014) **	0.096 (0.010) **
Diploma	0.119 (0.013) ***	0.144 (0.011) *	0.116 (0.009) **	0.112 (0.007) ***
Graduation	0.154 (0.017) **	0.189 (0.015) ***	0.176 (0.010) **	0.167 (0.007) **
Postgraduation	0.195 (0.014) **	0.269 (0.013) ***	0.182 (0.012) ***	0.177 (0.008) ***
EXP	0.045 (0.013) ***	0.056 (0.011) ***	0.033 (−0.009)	0.059 (0.006) *
EXP^2	0.002 (0.003) ***	0.003 (−0.001)	0.001 (0.0001) ***	0.003 (0.017) **
D & M	0.482 (0.021) **	0.388 (0.019) ***	0.617 (0.020) *	0.582 (−0.016)
P&L	0.421 (−0.02) *	0.386 (0.018) ***	0.519 (0.020) ***	0.508 (0.015) **
AP & APT	0.357 (0.020) ***	0.381 (0.016) ***	0.428 (0.020) **	0.386 (0.016) *
A & F	0.321 (0.021) **	0.273 (0.018) **	0.424 (0.019) ***	0.404 (0.015) *
Supervisors	0.302 (0.021) *	0.264 (0.019) *	0.147 (0.019) **	0.169 (−0.015)
F & RB	0.259 (0.021) ***	0.245 (−0.018) **	0.289 (0.019) *	0.288 (−0.016) *
PMO	0.11 (0.023) ***	−0.088 (0.02) **	−0.257 (0.019) ***	0.258 (0.015) *
OC	−0.138 (0.020) *	−0.099 (0.017) *	−0.168 (0.018) **	−0.155 (0.014) ***
EO	−0.15 (0.008) **	0.117 (0.010) *	−0.215 (0.09) **	−0.189 (0.005) ***
R^2	69.41	70.12	72.46	71.02
Observation	2929	3514	5811	11815

This study uses robust standard errors * $p < 0.05$, ** $p < 0.1$, *** $p < 0.001$. Primary: Middle, SSc: Secondary school certificate, HSc: Higher school certificate, vocational and SE: Standard error.

Table 4 shows that the expected mean value of Y, when all X = 0, with each column showing that the counterfactual thinking related to increasing earnings including additional levels of schooling and credentials does not mean that a greater ability related with human capital is conferred only by finishing school. Globally, the sheepskin effect is the first tool that helps people enter into the market by helping them successfully navigate recruitment and employer screening of their intellectual capability, as well as meet the firm's expected productivity.

University dropouts can gain an advantage over the low-level education (LLE) by attainment of more schooling years, which deprive the rights of LLE obtained people. Our results reveal that lower educational skills are negatively related with wage. Table 5 presents the marginal earning difference between each level of schooling.

Table 5. Total and the average rate of returns to the level of education (%).

Level of Qualification	2004/05	2005/06	2007/08	2010/11	Total	% Changes, 2004/05 to 2010/11
Primary	0.0581	0.0248	0.0062	0.0027	0.0919	−5.54%
Middle	0.0325	0.0387	0.1063	0.0172	0.1947	−1.53%
SSc	0.0886	0.0506	0.0558	0.083	0.2781	−0.56%
HSc	0.1285	0.1308	0.154	0.1629	0.5763	3.44%
Vocational	0.2629	0.2578	0.2861	0.2917	1.0986	2.88%
Graduate	0.2925	0.2904	0.378	0.3924	1.3532	9.99%
Post graduate	0.2908	0.2914	0.431	0.4217	1.4349	13.09%

Author's calculation: Containing all levels of qualification and description of each year ratio with change: as referencing year 2004/05 minus 2010/11.

In short, the trend in wage disparity among the distinct levels of educational attainment is considered the baseline column 5, subtracted from column 2, obtaining results that support the change

in the economic value of sheepskins. First, the primary-level–SSc-level enrolment ratio increased with the implementation of government policies that provide free of cost primary to HSc education, regardless of whether or not the policy is sufficient to support work-places with respect to standard designations. As Table 5 presents, people with the last three education ranks enjoy higher wages because they invest more years in education. Our estimated results support the human capital theory, a higher productivity and higher salary belong to people with HEs, along with sheepskins [41–43].

Figure 2 shows that the reforms had a complex effect on educational enrolment, and in terms of the impact of reform on the educational trend, there was a consistently diminishing ratio of enrolment in education from the low to the high level. At the primary to the higher secondary school levels, gross enrolment rates are higher every year. The most surprising aspect in the analysis was that the vocational education ratio was continuously weak and that the BS level recovered its attention. Hence, we think that a greater investment into years of schooling and then university is responsible for the refinement of the skills of individuals and their accreditation. The experiential learning obtained from this education is required for entering into the labor market, and this is directly related to the supply/demand factor. For example, instead of having only an HSc-level schooling job in the labor market and spending more years to gain experience to wait for a wage increase, the wage will not be equal to the university level schooling wage discrimination [44]. The acquisition of skills and knowledge is an investment in human capital, which is similar to physical capital resources, as an investment that yields a future return rather than consumption. We think that most of the impressive increases in the wages of the workforce were found in developed countries, owing to their investment in tertiary education for the growth of the economy, and this indicates a limiting factor in the advance of poor developing countries, such as Pakistan.

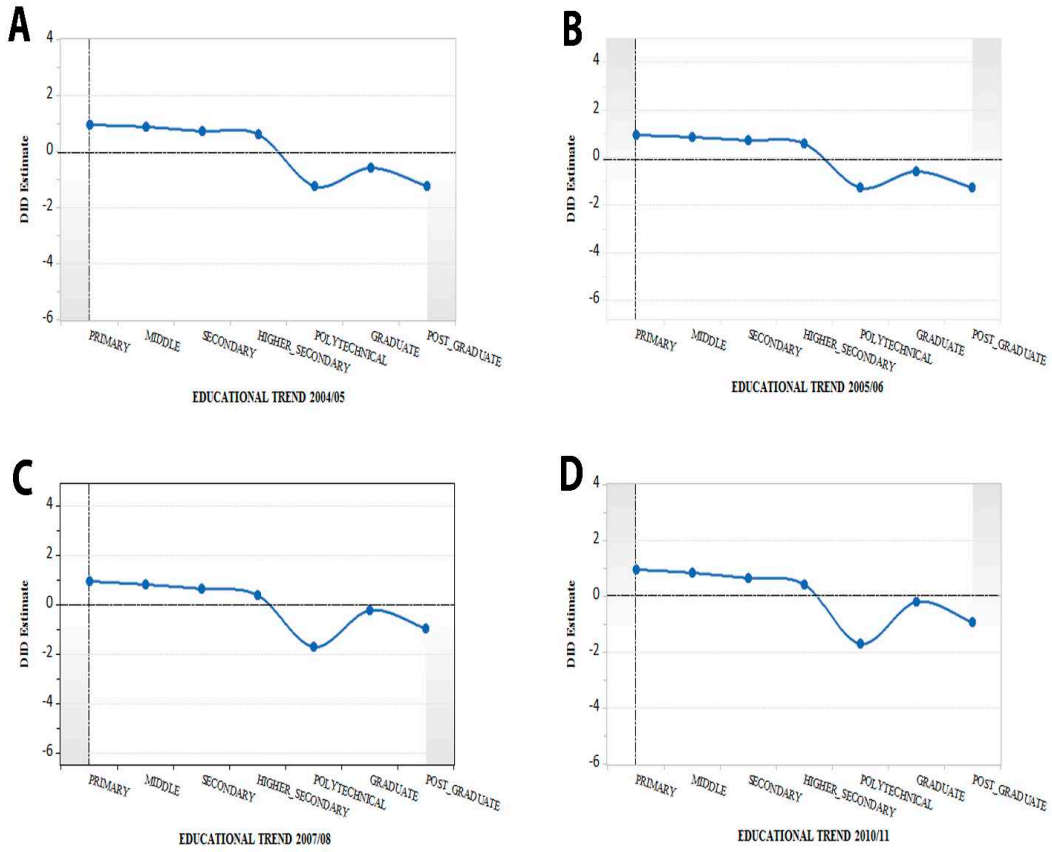

Figure 2. Data source: Pakistan Bureau of Statistics (PBS). Educational enrolment trend of each year difference in difference estimates, the vertical line targets low-level (primary) to high-level standards (postgraduate).

In Figure 3, the zigzag blue line represents the trend in the occupational ratio of the low-level grade jobs, which are related to low-level investment into education on the right-hand side, crossing over the horizontal baseline, whereas the higher-wage occupations require tertiary education. On average, the high-ranking enrolment ratio increased in the labor market, as low-level education tended toward tertiary education but lacked financial support, still remaining behind the ratios in developed nations. Sheepskins and human capital together played a uniform role that is directly related to wage discrimination.

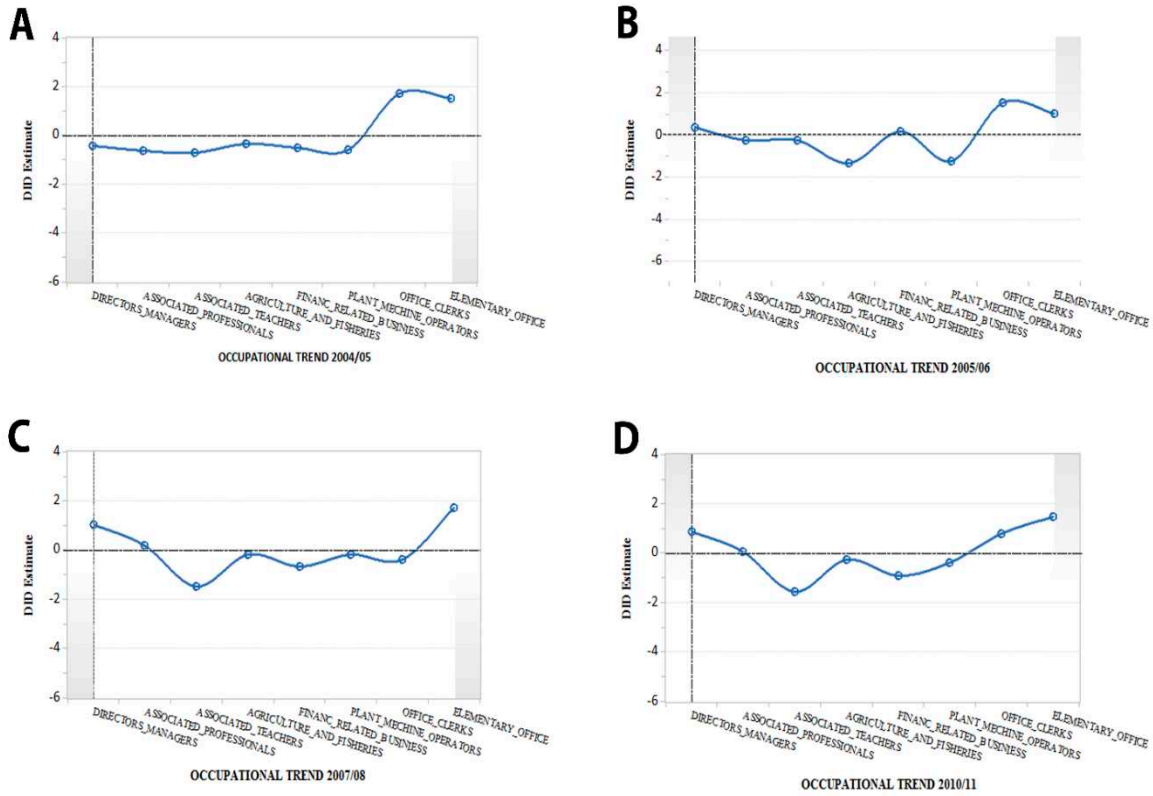

Figure 3. Data source: PBS. Occupational trend of each year difference in difference estimates, the vertical line targets high rank job (director and manager) to low level standards (elementary office).

5.2. Labor Market Specification

A range of political and economic factors have had opposite effects on Pakistan's economy in recent years, including low levels of investment and a deteriorating quality of education. Assuming high illiteracy rates, strategies emphasizing increasing access to education and evolutional studies related to educational fields in developing countries focused on entrance, particularly into primary and secondary education [45,46].

A straightforward but comparatively new tactic concerning the pathway toward the advancement of education among economic sectors over time involves comparing the rates of returns in these clusters to the inclusivity of the labor market [47]. The youth face more disadvantages, including limited job search expertise, a mismatch of educational skills and jobs, a lack of mobility, along with the high aspirations and expectations of employers. Unpredictably, some scholars [43,48–50] reported that higher earnings are exclusively due to HE. In the economic sector, employers screen employees by the sheepskin effect as an indicator of productivity for the firm, and decide rewards according to the level of education.

Different regions have different features regarding wage discrimination and the supply compared to the demand for levels of schooling in labor markets. To better understand wage disparities, we grouped all 27 cities by acummulated years of data, as presented in Table 6. We assumed that

all the cities have the same wage, and we applied other methods, such as random effects and fixed effects models, allowing for heterogeneity among cities. The results suggest that investment in each level of schooling has a positive relationship in every location. Comparing the results of both models, the coefficients in the model are different than zero and another thing, there R^2 are quite resemble. We applied hausman test to be more clear that which model is an appropriate. We found that null hypothesis rejected, means that wage has relationship with education.

Table 6. Estimated results in the education investment and labor market wage discriminations.

All Variables	Random Effects Model	Fixed Effects Model	Hausman Test
	Coefficient (SE)	**Coefficient (SE)**	**Fe-Re (SE)**
Intercept	1.207 (0.133) ***	1.272 (0.168) ***	
Primary	−0.247 (0.309)	−0.360 (0.342)	−0.1129 (0.1462)
iddle	0.219 (0.267)	0.167 (0.316)	−0.0520 (0.1688)
SSc	0.043 (0.051)	0.136 (0.072)	0.0932 (0.0501)
HSc	0.122 (0.072)	0.155 (0.085)	0.0331 (0.0446)
Diploma	0.186 (0.074) **	0.170 (0.085) *	−0.0150 (0.0421)
Graduation	0.209 (0.066) ***	0.196 (0.078) **	−0.0121 (0.0407)
Postgraduation	0.276 (0.084) ***	0.286 (0.094) ***	0.0104 90.0422)
EXP	0.020 (0.008) **	0.018 (0.009) **	−0.0022 (0.0042)
EXP^2	−0.0005 (0.0004)	−0.0003 (0.0005) **	0.0001 (0.0002)
D & M	0.432 (0.080) ***	0.402 (0.102) ***	−0.0303 (0.0642)
P&L	0.387 (0.096) ***	0.316 (0.111) ***	−0.0708 (0.0549)
AP & APT	0.341 (0.084) ***	0.343 (0.107) ***	0.0013 (0.0664)
A & F	0.327 (0.081) ***	0.302 (0.096) ***	−0.0247 (0.0525)
Supervisors	0.246 (0.078) ***	0.210 (0.100) **	−0.0011 (0.0534)
F & RB	0.212 (0.085) **	0.237 (0.086) ***	−0.0085 (0.0378)
PMO	0.151 (0.096)	0.134 (0.105)	−0.0165 (0.0430)
OC	0.042 (0.086)	0.106 (0.099)	0.0635 (0.0481)
EO	−0.094 (0.087)	−0.054 (0.105)	0.0408 (0.0596)
R^2	84.68	83.40	

Note: Estimated coefficients are significantly different from zero at *at 10% level; ** at 5% level and ***at 1% level. Standard errors are reported in the parenthesis. Ho = Random effects model; Ha = Fixed effects model.

Table 7 presents the estimated coefficient results from the randomly sampled Pakistan Bureau of Statistics (PBS), demonstrating the difference between the public and private sectors corresponding to all the reporting wage earning relationships and the supply of educational skills. Controlling for the length of experience and development along with increasing log wages seems to provide some support for the strong sheepskin hypothesis. A number of results are worth reviewing from Table 7. First, the f-statistics are more flexible and are superior in terms of fit over the prototypical mincer model regarding all specifications. Second, we found that the rate of returns on education are correlated with the level of schooling, for instance, a 3.4% increase in wages in the public or private sector. Third, larger and significant sheepskin effects appeared for extra years in tertiary education, when observing that plant machine operators in elementary jobs possess insufficient education. Earnings are constant but inversely proportional to wage discrimination, whether from top-ranking positions, directors, managers, or supervisors who possess positive and higher sheepskins. This is why they enjoy high wages in both the public and private sectors.

Table 7. Estimates the occupational coefficient wage differences in public and private markets.

Variables	Public Coefficient (SE)	Private Coefficient (SE)
Intercept	1.0386(0.1900) ***	1.0466 (0.1129) ***
Gender	0.0640 (0.0177) ***	0.0617(0.0176) ***
S	0.0342 (0.0084) ***	0.0350(0.0084) **
D & M	0.5488 (0.0794) **	0.5256 (0.0935) ***
P & L	0.4627 (0.0829) **	0.4336 (0.0989) ***
AP & APT	0.5812 (0.0833) ***	0.5505 (0.0991) ***
A & F	0.2733 (0.0807) **	0.2464 (0.0953) **
Supervisors	0.2926 (0.0826)	0.2683 (0.0992) *
F & RB	0.2976 (0.0832)	0.2727 (0.0986) **
PMO	−0.1808 (0.0829)	−0.2164 (0.0996) **
OC	−0.1917 (0.0847) *	−0.2239 (0.1031) **
EO	−0.3162 (0.0862) **	−0.3452 (0.1060) ***
Exp	0.0445 (0.0052) ***	0.0478 (0.0051) *
Exp^2	−0.0009 (0.0001) ***	−0.0011 (0.0001) ***
R^2	0.529	0.533
F-Statistics	457.01	477.248
N	5291	5437

Note: Estimated coefficients are significantly different from zero at *at 10% level; ** at 5% level and ***at 1% level. Standard Errors are reported in the parenthesis.

By interpreting the occupational differences between the public and private sectors as indicative of discrimination, our results suggest that the public sector is better paid compared to the private sector considering the difference in endowments. The sheepskins are almost the same for each public and private sector job, and more experience is required in the private sector. However, job security and other incentives, for example, learning during working in the shape of training and promotions, due to a scarcity of resources, requires more time to obtain more experience until the fixed age of retirement and pensioning provided by the public sector. Regarding screening theory, the private sector prioritizes highly experienced employees with HE and negotiates regarding the fixation of wages and policies. We also found from the survey of the data that many over-aged (retired from the public sector) employees are found in the private sector only because they have experience. This is why education cannot be presumed nor can it end. More investment into education, with an increased budget, alongside monitoring the maintenance of the pedagogical system with updated technology, are the nation's key assets for future development.

6. Discussion and Conclusions

The aim of this study was to evaluate the context of the higher education in Pakistan and its relationship with labor markets regarding the supply/demand by applying the fixed effects method and the mincer model with respect to wage discrimination using the PBS survey from 2004/2005 to 2010/2011. First, the results suggest that little variation occurred in R^2, although we used different methods. Second, the results for the predictor variables illustrate that higher returns exist with white collar jobs due to the accumulation of HE (postgraduate). These people easily find employment compared to blue-collar individuals who possess LE, which causes difficulty in job searches according to their expected wage. However, the oversupply of higher secondary level schooling and graduates with nonprofessional skills prepares them for little more than administrative careers and reduces their employability. The dearth of career counseling services at schools and universities leads to students choosing professions based on limited knowledge about career options. A degree's weak link to the labor market is a factor in the lack of the career acquisition of skills. The results indicate that more investment after graduate over postgraduate education is helpful for meeting the demand for standard jobs. LE is losing its strength to even ensure low-wage jobs in the public or private labor markets. Education is not only associated with the personal benefits of individuals, although it has a

strong relationship with socioeconomic and national developments. As a consequence of the growing population rate and global ineconomic rate, the demand for a highly skilled workforce in the market has created a competitive environment. Educational institutions, with the cooperation of market job skills, boost candidates to acquire more education and make them assets to national development. This could be possible to minimize the litracy rate all over the world, if the teachers in educational institutes, take a part to enhance the mobility among students for future high earnings, with updated technology based syllabus as applied in the transitive labor market.

Our study has various limitations. Our analysis is not based on a specific representative area of Pakistan. The Householed Integrated Economic Survey (HIES) conducted every year in all over the Pakistan. Our data selection samples was based on 27 renowned cities of Pakistan, who were enjoying their premium with the respect of high-skills and obtained more education. We cannot rule out the social impact on high education, which may reveal different results. This can be achieved with future research in this area.

Policy Recommendations

The government needs to pay attention to the growth in public expenditure on the education sector and the burgeoning well-organized budget in relation to the source of productivity to upgrade the pedagogical curriculum for the maintenance of a quality assurance framework of HE, with the collaboration of global market development. Pakistan's government should attempt to become a learning center for educational excellence and, to address the deteriorating rates of return to workforce from LE to HE upgrade policies, provide merit-based scholarships, and update learning tools related to markets. Further study is required to evaluate the effects of the innovative potential objective clusters of entrants with HE and to enrich the discussion about the methods and mechanisms of governance, especially in a country like Pakistan, where education stems from a privilege to a factually successful life and employment. This research will be continually updated in accordance with the census providing new HE data.

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References

1. Castelló, A.; Doménech, R. Human capital inequality and economic growth: Some new evidence. *Econ. J.* **2002**, *112*, C187–C200. [CrossRef]
2. Hanushek, E.A.; Woessmann, L. *Schooling, Cognitive Skills, and the Latin American Growth Puzzle*; National Bureau of Economic Research: New York, NY, USA, 2009.
3. Hanushek, E.A.; Woessmann, L. *The High Cost of Low Educational Performance: The Long-Run Economic Impact of Improving PISA Outcomes*; Organization for Economic Cooperation and Development: Paris, France, 2010.
4. Schultz, T.W. Capital formation by education. *J. Polit. Econ.* **1960**, *68*, 571–583. [CrossRef]
5. Busemeyer, M.R.; Garritzmann, J.L.; Neimanns, E.; Nezi, R. Investing in education in Europe: Evidence from a new survey of public opinion. *J. Eur. Soc. Policy* **2018**, *28*, 34–54. [CrossRef]
6. Storey, V.A.; Gill, M.G. Investing in the Future: Developing Education Lifelong Learning Tracks. In *Advocacy in Academia and the Role of Teacher Preparation Programs*; IGI Global: Hershey, PA, USA, 2018; pp. 288–301.
7. Burgess, M. Investing in the future of farmworkers' children. *Farmer's Wkly.* **2018**, *2018*, 30–32.
8. Butt, B.Z.; ur Rehman, K. A study examining the students satisfaction in higher education. *Procedia Soc. Behav. Sci.* **2010**, *2*, 5446–5450. [CrossRef]
9. Verwiebe, R.; Reinprecht, C.; Haindorfer, R.; Wiesboeck, L. How to succeed in a transnational labor market: Job search and wages among Hungarian, Slovak, and Czech commuters in Austria. *Int. Migr. Rev.* **2017**, *51*, 251–286. [CrossRef]

10. Chevalier, A.; Harmon, C.; Walker, I.; Zhu, Y. Does education raise productivity, or just reflect it? *Econ. J.* **2004**, *114*, F499–F517. [CrossRef]
11. Beblavy, M.; Teteryatnikova, M.; Thum, A.E. Expansion of Higher Education and Declining Quality of Degrees. *SSRN Electron. J.* **2013**. [CrossRef]
12. Cellini, S.R.; Chaudhary, L. The labor market returns to a for-profit college education. *Econ. Educ. Rev.* **2014**, *43*, 125–140. [CrossRef]
13. Kelly, E.; McGuinness, S. *A Study of Sub-Minimum Wage Rates for Young People*; ESRI and the Low Pay Commission: Dublin, Germany, 2017.
14. Arrow, K. The theory of discrimination. *Discrim. Labor Mark.* **1973**, *3*, 3–33.
15. Spence, A.M. *Market Signaling: Informational Transfer in Hiring and Related Screening Processes*; Harvard University Press: Cambridge, MA, USA, 1974.
16. Becker, G.S. *Human Capital Theory*; Columbia: New York, NY, USA, 1964.
17. Mincer, J.; Polachek, S. Family investments in human capital: Earnings of women. *J. Political Econ.* **1974**, *82*, S76–S108. [CrossRef]
18. Psacharopoulos, G.; Patrinos, H.A. Returns to investment in education: A further update. *Educ. Econ.* **2004**, *12*, 111–134. [CrossRef]
19. Peet, R.; Hartwick, E. *Theories of Development: Contentions, Arguments, Alternatives*; Guilford Press: New York, NY, USA, 2015.
20. Becker, G.S.; Chiswick, B.R. Education and the Distribution of Earnings. *Am. Econ. Rev.* **1966**, *56*, 358–369.
21. Trostel, P.A. Nonlinearity in the return to education. *J. Appl. Econ.* **2005**, *8*, 191–202. [CrossRef]
22. Park, J.H. Estimation of sheepskin effects using the old and the new measures of educational attainment in the Current Population Survey. *Econ. Lett.* **1999**, *62*, 237–240. [CrossRef]
23. Antelius, J. *Sheepskin Effects in the Returns to Education: Evidence on Swedish Data*; Working Paper Series 158; Trade Union Institute for Economic Research: Stockholm, Sweden, 2000.
24. Shabbir, T. Sheepskin effects in the returns to education in a developing country. *Pak. Dev. Rev.* **1991**, *30*, 1–19. [CrossRef]
25. Gao, Y.; He, Q.; Liu, Y.; Zhang, L.; Wang, H.; Cai, E. Imbalance in spatial accessibility to primary and secondary schools in china: Guidance for education sustainability. *Sustainability* **2016**, *8*, 1236. [CrossRef]
26. Scarborough, W.J.; Lambouths, D., III; Holbrook, A.L. Support of workplace diversity policies: The role of race, gender, and beliefs about inequality. *Soc. Sci. Res.* **2019**, *79*, 194–210. [CrossRef]
27. Abukhait, R.M.; Bani-Melhem, S.; Zeffane, R. Empowerment, Knowledge Sharing And Innovative Behaviours: Exploring Gender Differences. *Int. J. Innov. Manag.* **2019**, *23*, 1950006. [CrossRef]
28. Oreopoulos, P. The compelling effects of compulsory schooling: Evidence from Canada. *Can. J. Econ./Rev. Can. Écon.* **2006**, *39*, 22–52. [CrossRef]
29. Muehlemann, S.; Pfann, G.A.; Pfeifer, H.; Dietrich, H.W. *The Effects of Supply Shocks in the Market for Apprenticeships: Evidence from a German High School Reform*; IZA—Institute of Labor Economics: Bonn, Germany, 2018.
30. Abbas, Q. Over-education and under-education and their effects on earnings: Evidence from Pakistan, 1998–2004. *Saarc J. Hum. Resour. Dev.* **2008**, *4*, 109–125.
31. Cohn, E.; Johnson, E.; Chu Ng, Y. The incidence of overschooling and underschooling and its effect on earnings in the United States and Hong Kong. In *Research in Labor Economics*; Emerald Group Publishing Limited: Bingley, UK, 2000; pp. 29–61.
32. Hung, C.-Y. Overeducation and undereducation in Taiwan. *J. Asian Econ.* **2008**, *19*, 125–137. [CrossRef]
33. Liu, Y. Labor market matching and unemployment in urban China. *China Econ. Rev.* **2013**, *24*, 108–128. [CrossRef]
34. Knight, J.; Song, L. China's emerging urban wage structure, 1995–2002. *Inequal. Public Policy China* **2008**, 221–242. [CrossRef]
35. Knight, J.; Deng, Q.; Li, S. China's expansion of higher education: The labour market consequences of a supply shock. *China Econ. Rev.* **2017**, *43*, 127–141. [CrossRef]
36. Mincer, J. *Schooling, Experience, and Earnings*; National Bureau of Economic Research, Inc.: New York, NY, USA, 1974.
37. Psacharopoulos, G.; Layard, R. Human capital and earnings: British evidence and a critique. *Rev. Econ. Stud.* **1979**, *46*, 485–503. [CrossRef]

38. Reece, I.; Walker, S. *Teaching, Training and Learning: A Practical Guide*; Business Education Publishers Ltd.: Sunderland, UK, 2016.
39. Kenayathulla, H.B. Higher levels of education for higher private returns: New evidence from Malaysia. *Int. J. Educ. Dev.* **2013**, *33*, 380–393. [CrossRef]
40. White, H. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econom. J. Econom. Soc.* **1980**, *48*, 817–838. [CrossRef]
41. Becker, G.S. Front matter, human capital: A theoretical and empirical analysis, with special reference to education. In *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, 2nd ed.; NBER: New York, NY, USA, 1975.
42. Pyatt, G. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*; JSTOR: New York, NY, USA, 1966.
43. Stanley, B.G. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*; University of Chicago Press: Chicago, IL, USA, 1983.
44. Cherkesova, E.Y.; Breusova, E.A.; Savchishkina, E.P.; Demidova, N.E. Competitiveness of the human capital as strategic resource of innovational economy functioning. *J. Adv. Res. Law Econ.* **2016**, *7*, 1662–1667.
45. Bertrand, M.; Duflo, E.; Mullainathan, S. How much should we trust differences-in-differences estimates? *Q. J. Econ.* **2004**, *119*, 249–275. [CrossRef]
46. Sutherland, D.; Price, R.; Joumard, I.; Nicq, C. *Performance Indicators for Public Spending Efficiency in Primary and Secondary Education*; OECD Publishing: Paris, France, 2007.
47. Boccanfuso, D.; Larouche, A.; Trandafir, M. Quality of higher education and the labor market in developing countries: Evidence from an education reform in Senegal. *World Dev.* **2015**, *74*, 412–424. [CrossRef]
48. Bacolod, M.P.; Tobias, J.L. Schools, school quality and achievement growth: Evidence from the Philippines. *Econ. Educ. Rev.* **2006**, *25*, 619–632. [CrossRef]
49. Hannum, E.; Behrman, J.; Wang, M.; Liu, J. Education in the reform era. *China's Great Econ. Transform.* **2008**, 215–249. Available online: http://kczx.xhu.edu.cn/G2S/eWebEditor/uploadfile/20120427135908_684449439144.pdf (accessed on 6 May 2019).
50. Handa, S.; Simler, K.R. Quality or Quantity? The Supply-side Determinants of Primary Schooling in a Poor Rural Economy. *J. Afr. Econ.* **2006**, *15*, 59–90. [CrossRef]

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Effects of Higher Education Levels on Total Factor Productivity Growth

Jie Liu [1] and Chao Bi [2,*]

[1] School of Humanities, Economics and Laws, Northwestern Polytechnical University, Xi'an 710072, China; liujie01@nwpu.edu.cn
[2] International Business School, Shaanxi Normal University, Xi'an 710119, China
* Correspondence: xabichao@126.com

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Abstract: China is facing challenges to sustainable economic growth. Higher education of Chinese residents can affect total factor productivity (TFP) growth and hence has an influence on economic sustainability. However, currently, there is limited literature on the nexus between higher education and TFP in China. Therefore, this paper empirically analyzes the heterogeneous and spatial effect of higher education on the regional TFP growth using a dynamic spatial econometric model with provincial panel data from 2003 to 2016. The results indicate that different levels of higher education have significant effects on TFP growth and are mainly reflected in the spatial spillover effect. Bachelor and doctoral education (particularly doctoral education) demonstrated significant positive effects, whereas the technical school and master education had significant negative effects. When decomposing this effect into technical efficiency and technical progress to explore the mechanism of influences, the latter plays the major role. Therefore, the Chinese government can promote TFP growth and economic sustainability by expanding the scale of bachelor and doctoral education and improving the quality of technical and master education.

Keywords: education heterogeneity; spatial spillover effects; total factor productivity growth; dynamic spatial SLX model

1. Introduction

Although China's economy has experienced a long period of double-digit growth since the 1990s, China is facing numerous challenges to sustainable economic growth. One of the prominent characteristics of the high-speed growth in China is that it relies heavily on resources input (e.g., natural resources, human resources, financial resources, environmental resources, etc.), which is not sustainable [1]. Improving total factor productivity (TFP), which is a measurement of the output efficiency of all production factors, can solve the sustainability question for the reason that TFP growth can promote economic growth continuously and steadily without additional resources input [2,3]. Higher education, which provides training of critical thinking, technological skills, and literacy, would cultivate educated workers to implement tasks more efficiently and hence improve a country's TFP and sustainable economic growth [4]. However, based on the current literature, there are limited studies that explore the relationship between higher education and TFP growth in China. Therefore, exploring the nexus between higher education and TFP growth deserves more attention. Undoubtedly, it is not only an important area of research, but also a matter of considerable interest to policymakers.

Although much research has examined the relationship between higher education and TFP, in general, the literature has not yet reached a definitive conclusion. From the theoretical perspective, Lucas indicated that average human capital can theoretically improve TFP [5]. Then, Romer extended this model with the idea that increasing the number of innovative talents also aids the economy [6].

Empirically, Hua indicated that higher education, rather than primary education, significantly affects TFP [7]. Gu et al. (2017) contended that graduate education can improve the economy through its spillover effects [8]. In agreement, Bloom noted that this effect is particularly prominent in developing countries [9]. Adversely, a few pieces of literature indicate that higher education does not have a significant influence on economic productivity. Using a sample of countries belonging to the Organization for Economic Co-operation and Development, Wolff (2001) revealed that the number of higher education graduates does not significantly affect economic productivity [10]. Vedder (2004) found that states with greater public expenditures on higher education did not obtain more economic growth in the US [11]. Guo and Jia (2009) constructed a two-step human capital accumulation model and observed that compared to primary education, the effect of higher education on economic productivity is ambiguous [12].

There are three reasons to explain why these conclusions above are inconsistent. First, higher education could increase employment and improve the safety of society, and any results that do not consider these points are biased [13]. Second, according to Hanushek (2016), extending the years of education without improving human capital does not influence economic productivity [14]. Lastly, Di and Sun (2014) revealed that different types of higher education have distinct impacts on economic efficiency and growth [15]. Overall, the overwhelming majority of the literature has discussed education in general, but few studies have distinguished among various higher education levels.

This paper explores the effect of higher education on TFP growth using a dynamic spatial econometric method with panel data from 2003 to 2016 in China. The main contributions of the paper are as follows. First, this paper takes the heterogeneity of higher education into consideration and divides higher education into four different levels (e.g., technical education, bachelor education, master education, and doctoral education), which makes it possible to explore the impact of different levels of higher education on TFP growth. Second, this paper takes the inter-provinces mobility of higher education graduates into consideration by using a spatial econometrics approach, which makes it possible to estimate the spillover effect of higher education on TFP growth. This method can help assess the effect of higher education on TFP growth more accurately since the number of higher education graduates of the specific province is inconsistent with the net recipient of new human capital into this province. The paper is structured as follows: Section 2 displays assumptions; Section 3 details the methodology and variables selection; Section 4 summarizes the benchmark estimations and main results; and Section 5 provides conclusions and policy implications.

2. Assumptions

2.1. Heterogeneous Human Capital and Regional TFP Growth

Becker posited that differences in income can reflect human capital inconsistency [16]. High-level education can promote technical skills and thereby increase TFP growth [17]. In addition, different education levels have distinct targets. For example, the purpose of a technical school is to provide minimum necessary training to begin working in the chosen career field. Bachelor's education aims to provide basic knowledge in a particular area. Master's education trains students with a certain degree of research ability, while doctoral education equips students with skills that encourage innovation based on research ability. Therefore, diverse, target-oriented education influences economic efficiency and growth in different ways. According to Spence's signal theory, graduates with a higher level of education have higher productivity [18]. Many of these graduates probably had a naturally productive mindset before pursuing education, with the diploma attesting to their high human capital potential. The first hypothesis is that discrepant education levels affect regional TFP differently.

2.2. Graduates' Mobility and TFP Growth

The development of the economy is unbalanced, and education resources are distributed unevenly; this causes graduates to move across provinces. According to the Chinese Education Statistical

Yearbook and China Labor Statistical Yearbook, data can be used to calculate the net mobility of higher educated labor. Table 1 displays the accumulated net flow of three levels of the graduates in each province from 2003 to 2016. We find that there are 15 provinces where technical school students had a net flow in, 17 provinces where bachelor students had a net flow in, and 17 provinces where postgraduate students had a net flow in. The quantities of net flow graduates are 5270 thousand, 4720 thousand, and 800 thousand, respectively. Furthermore, we captured the characteristics of mobility among graduates and the three influential channels: neighboring provinces, state of birth, and developed provinces (In China, developed provinces include Beijing, Tianjin, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, and Guangdong, which have a relatively high GDP per capita. Most of them are distributed along the eastern coast) [19]. These three patterns of mobility, in fact, represent two reasons for graduates to flow. The first one is that graduates like to work in developed provinces, which means more opportunity and a higher salary. The second is that graduates prefer neighboring provinces and states of birth which they can easily get used to. These data indicate that higher education not only affects the local economy, but also spreads to other provinces [17]. Thus, we present the second assumption that higher education affects the economy through spatial spillover effects.

Table 1. Net Flow of Three Levels of Graduates 2003–2016.

Province	Technical School	Bachelor	Master & PhD	Province	Technical School	Bachelor	Master & PhD
Beijing	63.29	33.91	−16.07	Henan	−37.98	−34.91	7.68
Tianjin	1.26	13.59	0.81	Hubei	−71.20	−81.38	−4.91
Hebei	−41.05	−14.76	6.42	Hunan	−36.12	−9.89	1.03
Shanxi	−3.30	15.86	2.66	Guangdong	114.58	41.02	−1.02
Inner Mongolia	18.20	15.24	2.28	Guangxi	−2.46	10.96	2.60
Liaoning	−14.27	−44.05	−11.52	Hainan	−1.69	2.22	−0.04
Jilin	−19.68	−59.20	−11.33	Chongqing	30.89	−11.03	−1.33
Heilongjiang	−16.21	−34.26	−4.69	Sichuan	−10.81	−49.32	−12.44
Shanghai	38.21	75.61	16.89	Guizhou	−27.50	−2.24	−0.18
Jiangsu	75.49	33.87	−0.02	Yunnan	3.94	6.31	2.58
Zhejiang	80.29	108.34	13.83	Shaanxi	−43.25	−66.38	−13.63
Anhui	20.62	16.72	3.13	Gansu	−5.92	−4.06	−2.61
Fujian	42.30	44.93	3.48	Qinghai	11.96	7.82	−0.31
Jiangxi	−76.80	−38.71	0.89	Ningxia	5.12	7.73	0.82
Shandong	−119.17	−22.22	10.08	Xinjiang	14.31	33.93	4.62

Note: unit of measurement: 10 thousand.

2.3. Human Capital and TFP Decomposition

To disentangle the sources of the total factor productivity growth, the decomposition analysis of the TFP index is conducted. In summary, technical progress change and technical efficiency change are two of the most important components driving TFP growth. The technical progress component captures the effects of a shift in the production possibility frontier on productivity (PPF) [20]. The PPF changes its position in response to various shocks arising from technological advances. Human capital embodies knowledge and skills, which play a role in technological advances. On the other hand, the technical efficiency component measures the effects of deviations from the PPF on productivity. This deviation mainly comes from variations in the input utilization efficiency. Higher education could improve the efficiency of input utilization.

Using the Data Envelopment Analysis (DEA) method, the production possibility frontier (PPF) can be obtained. Technical progress is signified by the expansion of PPF; conversely, retreating of PPF represents technical regression [21]. Technical efficiency indicates a movement towards the production possibility frontier. If movement towards PPF is less than the PPF expansion, technical efficiency decreases, or vice versa. The third assumption is that either technical progress change or technical efficiency change could be channels for human capital impacting TFP growth.

3. Methodology and Selections of Variables

3.1. Empirical Model

Spatial econometric models often focus on spillover effects, such as whether a change to the level of higher education in a particular province affects the TFP growth in neighboring provinces. Comparisons of point estimates from those derived from non-spatial models, with the findings of spatial econometric models, may lead to erroneous conclusions. The objective of this study is to establish a rationale for the different spatial lags and spatial weight matrices, which best fit the data, and provide a clearer understanding of the impact of neighboring provinces on human capital. To deal with spatial interactions among geographical units, spatial lags that are co-determinants in the dependent variable, the explanatory variables, and the error term from neighboring or other provinces should be used following the spatial econometrics literature [22]. Two crucial issues involved in specifying a spatial econometric model are the choice of the type of spatial lags and the choice of a weight matrix. The objective of this study is to establish a rationale for identifying which types of spatial lags in combination with which type of spatial weight matrix best fit the data. Accordingly, this study considers seven spatial econometric models' specifications and three potential specifications of the spatial weight matrix in an empirical analysis. These combinations are tested within a common framework.

The spatial econometric model is a linear regression model (to estimate the effects of four education levels of human capital on TFP growth, we assumed a linear relationship, which is based on Abbas et al. (2000) [23]. They estimate the standard growth accounting model with human capital as a factor production, that is, Cobb-Douglas production function extension. After taking the log of the model, the linear relationship between education level and economic growth exists.) extended to include spatial lags in the dependent variable, the explanatory variables, or some combination thereof. Including all spatial lags yields a so-called general spatial nesting model. In addition to a static model, Goldsmith (2007) considers a dynamic model that contains the temporal lag of the variables to control for persistence [24]. This extension is known as the dynamic general spatial nesting model [25]:

$$y_t = ay_{t-1} + \rho W_1 y_t + g_{t-1}\beta + W_2 g_{t-1}\theta + W_3 g_{t-1} v + V_t \gamma + \varepsilon_t \quad (1)$$

where y_t denotes an $N \times 1$ vector of the TFP growth for every province in the sample during time period t; g_{t-1} is an $N \times 4$ matrix of exogenous explanatory variables, which denote one period lag for four higher education levels of graduates; V_t represents the control variable, in the $N \times K$ matrix, where k denotes the number of control variables; α, ρ, β, θ, γ, and v measure the strength of these spatial lags; and finally, ε_t is the stochastic error term.

Basically, there are three main types of spatial lags that can be used to explain provincial TFP growth [26]. First, an endogenous spatial lag measures whether the TFP growth of province i depends on the TFP growth of other province j, or vice versa, resulting in the spatial autoregressive (SAR) model. $W_1 y_t$ in the right hand can represent it and this y_t denotes TFP growth in other provinces j. W_1 is the spatial weight matrix in endogenous spatial lag. Second, exogenous spatial lags can measure whether the TFP growth of country i depends on the explanatory variables of other provinces j. Models containing these lags are the spatial lag of X models (SLX). $W_2 g_{t-1}$ in the right hand represents exogenous spatial lags. W_2 is the spatial weight matrix in exogenous spatial lag. Third, a spatial lag among the error term might be pertinent if countries share similar unobserved characteristics or face similar unobserved institutional environments. Models that rely on this lag are known as spatial error models (SEM).

The spatial weight matrix can model mutual relationships among provinces, which is another crucial issue for determining which set of provinces might affect the local province. Generally, spatial weight matrix elements can depend on geographical and economic distances between provinces. W is an $N \times N$ non-negative spatial weight matrix, whose diagonal elements are 0 because a province

cannot be its own relatives [22]. For this study, we use two principles to construct three spatial weights. (1) A province may respond to other provinces of even more distant provinces because of economic factors. Graduates in developing provinces are more likely to flow to developed provinces. Therefore, we construct a matrix in which these provinces' economic activities interact, and then combine it using economic distance, W_1 and W_2, $w_{i,j} = PGDP_j/PGDP_i$ [27]. It denotes the effect of GDP per capita in province j on GDP per capita in province i to reflect the spillover effect. (2) Sharing a common land or maritime border [24,28] implies the binary (0/1) contiguity matrix, W_3.

Another one of the biggest problems in empirical spatial econometric research is choosing among different model specifications. Too many studies only consider one type of spatial lag, resulting in just an SAR, SEM, or SLX model, whereas we test the model specifications against one another later.

3.2. Variable Selection

3.2.1. Dependent Variables

TFP growth (tfpch) is the dependent variable. Comparing the advantages and disadvantages of TFP calculation methods, we selected the DEA-Malmquist productivity index to estimate TFP growth [29]. Data drawn from the provincial statistical yearbook included GDP, labor, and capital per province [30].

3.2.2. Independent Variables

Independent variables were the number of graduates for the four education levels, namely technical schools, bachelor's, master's, and doctoral education.

3.2.3. Control Variables

Based on a literature review of factors influencing TFP growth [31], we used capital per capita (capital) by using the capital-labor ratio, which can improve technical progress and openness (trade) by using the total import-export of GDP ratio. More openness indicates that the province has a higher possibility of improving its efficiency. We calculated the total demand fluctuation (demand) by using total retail sales of consumer goods in the whole society of GDP ratio; in general, an increase in demand encourages an enterprise to increase investment in production, rather than R&D. We also calculated the labor input scale (inscale) to control the influence of factor input scale change on TFP growth.

A summary of the variables is presented in Table 2. Considering enlarged enrollment policy, we selected a sample span of the years 2003–2016. Based on the standard error and average value, it is easy to find that TFP growth, its decomposition, and graduates obviously differ among provinces. According to the average TFP growth of each province, Beijing (0.302), Tianjin (2.845), Shanghai (3.478), Jiangsu (2.195), Zhejiang (0.311), and Guangdong (−0.601), which are all distributed in eastern of; whereas Anhui (−2.764), Henan (−5.667), Guangxi (−6.227), Xizang (−6.858), which belong to Middle and Western part. It is obvious that TFP growth differs among provinces and eastern provincial TFP growth is larger than in the middle and western provinces. As for higher educated graduates, taking undergraduates, for instance, there are 10 provinces exceeding 100 thousand, which are Beijing (102,075), Hebei (107,860), Jiangsu (181,985), Shandong (166,083), Henan (134,396), Hubei (148,525), Hunan (106,582), Guangdong (137,745), Shaanxi (112,089), and Sichuan (124,420); on the contrary, Xizang, Qinghai, and Ningxia only have 3487, 5424, and 9369 undergraduates, respectively.

Table 2. Summary of variables.

Variables	Average	Standard Error	Min	Max
tfpgrowth	−2.622	3.616	−15.808	9.650
technical progress	−1.450	4.403	−18.430	11.563
technical efficiency	−1.084	3.900	−9.783	21.431
technical school	84.193	68.071	1.144	293.593
undergraduate	79.250	57.645	0.491	245.900
master	10.585	11.024	0.014	71.661
doctor	1.398	2.342	0.000	16.968
capital per capita	1.326	0.898	−4.009	4.880
trade	−0.005	0.078	−0.414	0.312
demand	0.006	0.017	−0.031	0.157
labor input scale	0.359	0.502	−2.417	3.411

4. Empirical Results

4.1. The Spillover Effect of Heterogeneous Human Capital on Regional TFP Growth

To compare each nest relationship, we can simultaneously identify the most likely spatial econometric model and the most likely spatial weight matrix. To ensure the rationality of empirical models, we estimated models (1)–(7) and used the Likelihood Ratio (LR) test, the Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC) rules. We also display static and dynamic versions of the model specifications; the latter includes the TFP growth indicator lagged in time. Table 3 contains the different models in combination with three proposed spatial weight matrices. The first column represents the results of the dynamic panel model (DPM). The second and third columns signify the dynamic spatial lagged independent variables. Columns 4, 5, 6, and 7 represent the dynamic spatial autoregression (DSAR) model, dynamic spatial errors model (DSEM), dynamic spatial Durbin model (DSDM), and dynamic spatial Durbin errors model (DSDEM), respectively. The dependent variable is regional TFP growth. After applying the LR test and the Hausman test, we chose the fixed effect model and used the quasi-maximum-likelihood method to make the estimation.

Table 3 reports the estimation results, where LR1 is the likelihood ratio of dynamic models to static models. The results show that regardless of the matter panel model or the spatial econometric model, we should choose the dynamic form. The last two columns of LR2 significantly rejected the hypothesis that exogenous interaction item $W_2 g_{t-1}$ is zero. It means that model DSDM is better than DSAR and model DSDEM is better than DSEM. In other words, regional TFP growth had a spatial lag because of independent variables. Although model DSLX also contains an exogenous interaction item, it does not include endogenous spatial interaction items $W_1 y_t$ and $W_1 u_t$. According to the LR3, insignificant results indicate that compared to DSDM and DSDEM, DSLX is better off. Furthermore, the difference between Model DSLX1 and DSLX2 is that the latter contains spatial weight matrix W_3. W_3 is an adjacency matrix, representing spillover effects from neighboring provinces. Whether to include this part in the model depends on the third column of LR2. Results significantly reject the hypothesis that adjacency matrices /are zero. Therefore, DSLX2 is identified as the most likely spatial econometric model. AIC and BIC rules verify this as well and we finally chose the model DSLX2.

According to the estimation results from model DSLX2, we found that the coefficient of the one-period lag TFP growth is highly significant (1% level). In addition, the coefficients of the control variables are all consistent with expectations. Specifically, the effect of capital density was not significant, but a negative sign reflected that the return of capital is decreasing, as is TFP growth. The coefficient of openness was significantly positive. Demand fluctuation and input factor scale were significantly negative. These results are consistent with the literature [32].

Table 3. Estimation results from basic models.

y:tfpch	DPM	DSLX1	DSLX2	DSAR	DSEM	DSDM	DSDEM
lag_tfpgrowth	0.5573 ***	0.5752 ***	0.5360 ***	0.5627 ***	0.5681 ***	0.5752 ***	0.5766 ***
	(13.02)	(13.57)	(12.41)	(13.24)	(13.24)	(13.57)	(13.56)
lag_techschool	−0.0062	−0.0018	−0.0055	−0.0031	−0.0033	−0.0017	−0.0018
	(−0.94)	(−0.24)	(−0.69)	(−0.47)	(−0.47)	(−0.23)	(−0.24)
lag_undergraduate	0.0029	−0.0022	0.0024	0.0008	−0.0007	−0.0023	−0.0021
	(0.28)	(−0.19)	(0.21)	(0.07)	(−0.06)	(−0.20)	(−0.18)
lag_master	0.0602	0.0489	−0.0038	0.0662	0.0616	0.0496	0.0487
	(0.89)	(0.70)	(−0.05)	(0.99)	(0.90)	(0.71)	(0.70)
lag_doctor	−0.3131	−0.1359	0.0529	−0.3075	−0.3119	−0.1409	−0.1372
	(−0.99)	(−0.42)	(0.16)	(−0.98)	(−0.98)	(−0.43)	(−0.42)
lag_capitalpercapita	−0.1221	−0.0935	−0.2835	−0.0546	−0.1215	−0.0909	−0.0924
	(−0.64)	(−0.41)	(−1.23)	(−0.28)	(−0.63)	(−0.40)	(−0.41)
trade	5.0443 ***	3.4533 **	4.1348 ***	4.6668 ***	4.8745 ***	3.4643 **	3.6637 **
	(3.37)	(2.21)	(2.63)	(3.12)	(2.97)	(2.22)	(2.25)
demand	−22.14 ***	−18.86 ***	−19.07 ***	−19.55 ***	−21.03 ***	−18.72 ***	−18.76 ***
	(−3.19)	(−2.73)	(−2.81)	(−2.81)	(−2.83)	(−2.70)	(−2.66)
laborinputscale	−1.1595 ***	−1.0581 ***	−1.2711 ***	−1.0403 ***	−1.1010 ***	−1.0529 ***	−1.0511 ***
	(−3.95)	(−3.38)	(−4.09)	(−3.52)	(−3.74)	(−3.35)	(−3.36)
W_2lag_techschool		−0.1105 ***	−0.1256 ***			−0.1068 ***	−0.1079 ***
		(−3.39)	(−3.64)			(−2.82)	(−3.04)
W_2lag_undergraduate		0.1196 **	0.1777 ***			0.1148 *	0.1217 **
		(2.21)	(3.19)			(1.93)	(2.06)
W_2lag_master		−0.9399 **	−1.2799 ***			−0.9031 *	−0.9519 **
		(−2.23)	(−2.86)			(−1.95)	(−2.07)
W_2lag_doctor		11.6198 ***	10.4285 ***			11.2611 ***	11.3176 ***
		(3.08)	(2.70)			(2.68)	(2.76)
W_3lag_techschool			0.0289 *				
			(1.91)				
W_3lag_undergraduate			−0.0620 ***				
			(−3.07)				
W_3lag_master			0.3999 **				
			(2.48)				
W_3lag_doctor			−0.1835				
			(−0.22)				
W_1y				0.2695 **		0.0292	
				(2.37)		(0.19)	
W_1u					0.2976 **		0.0879
					(2.44)		(0.57)
N	403	403	403	403	403	403	403
LogL	−808.36	−801.08	−792.61	−805.74	−805.66	−801.06	−800.92
LR1	139.76 ***	149.59 ***	128.91 ***	143.49 ***	143.77 ***	149.62 ***	149.83 ***
LR2	-	-	16.94 ***	-	-	9.35 **	9.48 **
LR3	-	-	-	-	-	0.04	0.32
AIC	1636.71	1630.16	1621.22	1633.47	1633.32	1632.12	1631.84
BIC	1676.70	1686.14	1693.20	1677.46	1677.31	1692.11	1691.83
Pseudo.R2	0.5665	0.5863	0.5783	0.5794	0.5709	0.5866	0.5874

Note: *t* value is in parentheses; ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Because of the spatial interaction, the coefficients of the independent variables do not have specific economic meanings. Therefore, we measured the direct and indirect effects of different human capital on TFP growth and used the Markov Chain Monte Carlo (MCMC) method to test the significance level [33]. In Table 4, we compared the short-term effect to long term effect, and it is obvious that the long-term effect was twice that of the short-term effect. This result is consistent with coefficients of the lagged TFP growth, which are significant in Table 3, indicating that graduates have an enlarging effect on TFP growth.

Table 4 indicates that the spillover effects of graduates in all four levels on regional TFP were all significant at the 5% significance level, whereas the direct effects were all insignificant. This can be viewed as evidence for the first hypothesis, which says that higher education affects the economy through spatial spillover effects. Collins (2013) studied mobility patterns of East Asian students; that is, mobility within Mainland Europe and international mobility of UK students. Collins found that more skilled graduates are more likely to migrate, thereby significantly improving the TFP of destination provinces [34]. Specifically, the influences of different education levels of graduates on regional TFP growth are quite different. Furthermore, the effects of bachelor's and doctoral students are significantly

positive. TFP increases by 0.0082% when the number of bachelor's increases by 1000. TFP growth increases by 0.7159% when the number of doctoral graduates increases by 1000. However, as the number of technical school and master's graduates increases, TFP growth decreases. TFP decreases by 0.0071% as the number of technical school graduates increases by 1000. Finally, TFP growth decreases by 0.0641% when the number of master's graduates increases by 1000. For a robust test, we used education years rather than the number of graduates as independent variables and found that the results were robust (Table 5). Thus, the second hypothesis was supported, showing that discrepant education levels affect TFP differently.

Table 4. Effect of graduates on regional TFP growth.

y:tfpch	Short Term Effect			Long Term Effect		
	Direct Effect	**Spillover Effect**	**Total Effect**	**Direct Effect**	**Spillover Effect**	**Total Effect**
techschool	−0.0055 (−0.69)	−0.0032 *** (−3.01)	−0.0033 *** (−3.17)	−0.0119 (−0.71)	−0.0069 *** (−3.02)	−0.0071 *** (−3.18)
undergraduate	0.0024 (0.21)	0.0039 ** (2.18)	0.0038 ** (2.22)	0.0052 (0.20)	0.0083 ** (2.17)	0.0082 ** (2.23)
master	−0.0038 (−0.05)	−0.0293 ** (−2.13)	−0.0285 ** (−2.11)	−0.0082 (−0.05)	−0.0632 ** (−2.15)	−0.0614 ** (−2.09)
doctor	0.0529 (0.16)	0.3415 *** (2.76)	0.3322 *** (2.75)	0.1141 (0.17)	0.7360 *** (2.74)	0.7159 *** (2.75)

Note: ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table 5. Long-term effects of education years on regional TFP growth.

y	x	Direct Effect		Spillover Effect		Total Effect	
		Coefficient	***t* Value**	**Coefficient**	***t* Value**	**Coefficient**	***t* Value**
tfpgrowth	techschoolh	−0.0008	−0.69	−0.0005 ***	−3.01	−0.0005 ***	−3.17
	undergraduatea	0.0003	0.21	0.0005 **	2.18	0.0005 **	2.22
	master	−0.0004	−0.05	−0.0033 **	−2.13	−0.0032 **	−2.11
	doctor	0.0050	0.16	0.0320 ***	2.76	0.0311 ***	2.75

Note: ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

4.2. Channels of Heterogeneous Human Capital affect Regional TFP Growth: Decomposition

To explore the pathway of different education levels on TFP growth, we decomposed TFP growth into the technical progress factor and technical efficiency factor, utilizing the DSLX model for testing. The results are shown in Table 6.

Table 6. Long-term effects of human capital on regional TFP growth decomposition.

y	x	Direct Effect		Spillover Effect		Total Effect	
		Coefficient	***t* Value**	**Coefficient**	***t* Value**	**Coefficient**	***t* Value**
Technical progress	techsch	−0.0023	−0.23	−0.0088 ***	−6.72	−0.0086 ***	−6.74
	undergraduatea	−0.0047	−0.33	0.0040 *	1.83	0.0037 *	1.75
	master	0.0218	0.24	−0.0300 *	−1.76	−0.0283 *	−1.7
	doctor	0.4462	1.1	0.7316 ***	4.76	0.7224 ***	4.81
Technical efficiency	techschoolh	−0.0056	−0.31	0.0077 **	3.26	0.0073 **	3.17
	undergraduatea	0.0111	0.43	0.0027	0.69	0.0030	0.78
	master	−0.0983	−0.61	−0.0178	−0.58	−0.0204	−0.68
	doctor	−0.1878	−0.25	−0.5596 **	−2.04	−0.5476 **	−2.04

Note: ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

It is apparent that technical school graduates would impact TFP growth through both the technical progress channel and technical efficiency channel. However, the technical progress level decreases by 0.0086%, and technical efficiency increases by 0.0073%, with an increase of 1000 graduates. These

results probably arise since, with the increase of technical school graduates, return to scales decreases and the PPF retreats, so that the technical level regresses. Technical efficiency is improved. Nonetheless, the movement towards the PPF scale is less than the retreated scale, and as a result, the total effect is negative. Bachelor's and master's graduates impact TFP growth only through the technical progress channel; that is, technical progress increases by 0.0037% with an increase of 1000 bachelor graduates and decreases by 0.0283% when master graduates increase by 1000. The negative effects of the master could be as a result of misallocation and over education. For doctoral education, both technical progress and technical efficiency channels were significant, but signs of coefficients are opposite to those found for the technical school education. It is possible that an increase in doctoral graduates can improve PPF, but technical efficiency is not used sufficiently. Overall, the effects are positive.

4.3. Robust Test

When defining the spatial weight matrix to represent the spillover effect using economic distance, it could be time-varying, and more importantly, endogenous, in a spatial panel data model. Usual the estimation procedure leads to estimation bias. Qu and Lee (2015) [35] overcome the endogeneity problem by using the law of large numbers (LLN) for the spatial near-epoch dependence (NED) process in a cross-sectional case. Based on this, Xi et al. (2017) established an asymptotic distribution of quasi-maximum likelihood (QML) estimators by using spatial-time LLN and central limit theorem (CLT) for a martingale difference sequence, which can be applied to the endogenous spatial dynamic situation [36]. In addition, to ensure that the results were robust, we changed the index for TFP growth and run regression again, which is regional GDP per capita instead of TFP growth [37]. Quasi-maximum-likelihood estimation results are displayed in Table 7.

Table 7. Long-term effects of heterogeneous human capital on regional GDP per capita.

tfpch:GDP/L	Direct Effect		Spillover Effect		Total Effect	
	Coefficient	***t* Value**	**Coefficient**	***t* Value**	**Coefficient**	***t* Value**
Techschool	0.0011	0.16	−0.0042 ***	−4.14	−0.0040 ***	−4.07
undergraduate	−0.0195 ***	−1.84	0.0028 *	1.67	0.0020	1.27
master	−0.0151	−0.23	−0.0723 ***	−5.56	−0.0704 ***	−5.56
doctor	0.5606 ***	1.87	0.8537 ***	7.43	0.8443 ***	7.52

Note: ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Compared to Table 4, we found that the spillover effects remained significant in Table 7. Other than bachelor's education, the three levels of education were all significant at the 1% level. Based on these robust tests, we conclude that our estimation results are robust.

5. Conclusions

Considering the heterogeneous and spatial spillover effects, we constructed a spatial weight matrix to model mutual relationships among provinces according to graduate flowing patterns, and to illustrate the influence of heterogeneous human capital on regional TFP growth from 2003 to 2016. Our conclusions are as follows:

Heterogeneous human capital in different education levels has significant effects on regional TFP growth, and the spatial spillover effect plays an important role. However, different human capital has distinct effects. Bachelor's and doctoral graduates have significantly positive effects on regional TFP growth; nevertheless, the effects of technical school and master's graduates are significantly negative.

Furthermore, we decomposed regional TFP growth into the technical progress factor and technical efficiency factor to explore the influence mechanism. It was concluded that heterogeneous human capital has different channels. Technical school education affects TFP growth through both channels, but has a positive effect on technical efficiency and negative effect on technical progress. Since the technical progress effect is larger than the technical efficiency effect, the total effect is negative; doctoral

graduates also have two channels to impact TFP growth, but, conversely, the technical progress channel is positive and the technical efficiency channel is negative. The latter is less, and consequently, the total effect is positive. Both undergraduate and master's graduates have only one channel, which is technical progress. The difference is that undergraduates' effect is positive, whereas that for master's is negative.

Given its primary role as a knowledge producer, higher education can serve as a powerful means to help create a more sustainable future. Thus, the concept of 'education for sustainable development' has become, in recent years, one of the core educational initiatives to help address many problems associated with human development. The current study pays attention to the direct impact of higher education itself on economic sustainability, which is one of the important aspects of sustainable development in China. To this extent, the paper suggests another way of thinking about the role of higher education in sustainable development.

The empirical results indicate that higher education has a significant influence on TFP growth and hence affects sustainable economic growth. Furthermore, different levels of higher education have different influences on sustainable economic growth. Therefore, the Chinese government could promote sustainable economic growth by directly adjusting the structure of higher education levels. Specifically, policymakers should optimize the higher education structure by enlarging scales of bachelor and doctoral enrollment in order to make them play a function of improving TFP growth. Based on the empirical results that the effects of master and technical school's graduates on TFP growth are both negative, policymakers should improve the provision quality of such degrees. In addition, the findings suggest that policymakers should encourage higher educated graduates' mobility, particularly bachelor's and doctoral graduates, because they have a significantly positive spillover effect on TFP growth by easing the hukou system in China, which is related to the central government's restrictions on the movement.

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References

1. Feng, C.; Wang, M.; Liu, G.; Huang, J. Sources of economic growth in China from 2000–2013 and its further sustainable growth path: A three-hierarchy meta-frontier data envelopment analysis. *Econ. Model.* **2017**, *64*, 334–348. [CrossRef]
2. Dasgupta, P. The idea of sustainable development. *Sustain. Sci.* **2007**, *2*, 5–11. [CrossRef]
3. Kumar, S. *Is India on a Sustainable Development Path*; Yokohama National University: Yokohama, Japan; TERI University: New Delhi, India, 2009.
4. Ahmed, A.; Stein, J.A. Science, technology and sustainable development: A world review. *World Rev. Sci. Technol. Sustain.* **2004**, *1*, 5–24. [CrossRef]
5. Lucas, R.E. On the mechanics of economic development. *J. Monet. Econ.* **1988**, *22*, 3–42. [CrossRef]
6. Romer, P.M. Endogenous technological change. *J. Political Econ.* **1990**, *98*, 71–102. [CrossRef]
7. Hua, P. Impacts of different levels of education on TFP growth: Evidence from China. *China Econ. Q.* **2005**, *4*, 147–166.

8. Gu, J.; Levin, J.S.; Luo, Y. Reproducing academic successors or cultivating versatile experts: Influences of doctoral training on career expectations of Chinese PhD students. *High. Educ.* **2018**, *76*, 427–447. [CrossRef]
9. Bloom, D.; Canning, D.; Chan, K.; Luca, D. Higher education and economic growth in Africa. *Int. J. Afr. High. Educ.* **2014**, *1*, 22–57. [CrossRef]
10. Wolff, E.N. The Role of Education in the Postwar Productivity Convergence among OECD Countries. *Ind. Corp. Chang.* **2001**, *10*, 735–759.
11. Vedder, R. *Going Broke by Degree: Why College Costs Too Much*; Aei Press: Washington, WA, USA, 2004; Volume 6, p. 294.
12. Guo, Q.; Jia, J. Public education policy, economic growth and human capital premium. *Econ. Res.* **2009**, *10*, 22–35.
13. Birdsall, N. Public spending on higher education in developing countries: Too much or too little. *Econ. Educ. Rev.* **1996**, *15*, 407–419. [CrossRef]
14. Hanushek, E.A. Will higher education improve economic growth? *Oxf. Rev. Econ. Policy* **2016**, *32*, 538–552. [CrossRef]
15. Sun, B.; Ning, X.; University, Q. The value and significance of education modernization for the construction of livable and happy city—The case study of Qingdao. *Rev. High. Educ.* **2016**, *12*, 16–23.
16. Becker, G.S. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*; National Bureau of Economic Research: New York, NY, USA, 1964.
17. Griliches, Z. Issues in assessing the contribution of research and development to productivity growth. *Bell J. Econ.* **1979**, *10*, 92–116. [CrossRef]
18. Spence, M. Job market signaling. *Q. J. Econ.* **1973**, *87*, 355–374. [CrossRef]
19. Zhang, K.; Chen, Z.; Economics, S.O. A study of the factors influencing university graduates' employment quality. *Popul. Econ.* **2017**, *1*, 75–84.
20. Renuka, M.; Kali, K. Singapore's manufacturing sector's TFP growth: A decomposition analysis. *J. Comp. Econ.* **2000**, *28*, 828–839.
21. Hanushek, E.; Kimko, D. Schooling, labor-force quality, and the growth of nations. *Am. Econ. Rev.* **2000**, *90*, 1184–1208. [CrossRef]
22. Yesilyurt, M.E.; Elhorst, J.P. Impacts of neighboring countries on military expenditures. *J. Peace Res.* **2017**, *10*, 777–790. [CrossRef]
23. Abbas, Q.; Mujahid-Mukhtar, E. The role of human capital in economic growth: A comparative study of Pakistan and India. *Pak. Dev. Rev.* **2000**, *39*, 451–473. [CrossRef]
24. Goldsmith, B.E. Arms racing in 'Space': Spatial modelling of military spending around the world. *Aust. J. Political Sci.* **2007**, *42*, 419–440. [CrossRef]
25. Silva, D.F.C.D.; Elhorst, J.P.; Neto, R.D.M.S. Urban and rural population growth in a spatial panel of municipalities. *Reg. Stud.* **2017**, *51*, 894–908.
26. Ugarte, M.D. Introduction to spatial econometrics. *J. R. Stat. Soc.* **2011**, *174*, 513–514. [CrossRef]
27. Ligon, C.E. Economic distance and cross-country spillovers. *J. Econ. Growth* **2002**, *7*, 157–187. [CrossRef]
28. Skogstad, K. Defence budgets in the post-cold war era: A spatial econometrics approach. *Def. Peace Econ.* **2016**, *27*, 323–352. [CrossRef]
29. Willis, S.L.; Margrett, J.A. Aging and education. *Int. Encycl. Soc. Behav. Sci.* **2001**, *26*, 299–304.
30. Zhang, J.; Wu, G.; Zhang, J. The estimation of China's provincial capital stock: 1952–2000. *Econ. Res. J.* **2004**, *10*, 35–44.
31. Isaksson, A. *Determinants of Total Factor Productivity: A Literature Review. Research and Statistics Staff Working Paper*; United Nations Industrial Development Organization: Vienna, Austria, 2007.
32. Cai, F.; Wang, M. How fast and how far can China's GDP grow? *China World Econ.* **2002**, *5*, 9–15.
33. Elhorst, J.P. *Spatial Econometrics: From Cross-Sectional Data to Spatial Panels*; Springer: Berlin, Germany, 2014.
34. Collins, F.L. Student mobilities, migration and the internationalization of higher education. *High. Educ. Policy* **2013**, *26*, 285–288. [CrossRef]
35. Qu, X.; Lee, L.F. Estimating a spatial autoregressive model with an endogenous spatial weight matrix. *J. Econom.* **2015**, *184*, 209–232. [CrossRef]

36. Qu, X.; Lee, L.F.; Yu, J. QML estimation of spatial dynamic panel data models with endogenous time varying spatial weights matrices. *J. Econom.* **2017**, *197*, 173–201. [CrossRef]
37. Chen, S.; Chen, D. Haze pollution, government control and economic development. *Econ. Res.* **2018**, *2*, 20–34.

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Higher Education Input, Technological Innovation, and Economic Growth in China

Guangyou Zhou [1] and Sumei Luo [2,*]

[1] School of Economics, Fudan University, Shanghai 200433, China; zgy@fudan.edu.cn
[2] School of Finance, Shanghai University of Finance and Economics, Shanghai 200433, China
* Correspondence: luosumei@shufe.edu.cn; Tel.: +86-21-65908396

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Abstract: Based on the theoretical analysis of the relationship between China's higher education input, technological innovation, and economic growth, this paper chooses the 1997–2015 sample data of China, and uses a vector auto regression (VAR) model to test the relationship between the three. The results show that educational input, technological innovation, and economic growth form an interaction mechanism featuring dynamic circulation. Higher education input and technological innovation are two important factors influencing economic growth. In the meantime, higher education input is an important source and driving force of technological innovation, and technological innovation will further promote economic growth. However, technological innovation has a delayed positive effect on economic growth, so higher education input demands a long-term view and thinking for quick success, and instant benefits should be avoided.

Keywords: higher education; education input; technological innovation; economic growth; VAR model

1. Introduction

For a long time, the study of the relationship between education input and economic growth is an enduring topic in theoretical circles, often with new thoughts being gained when it is discussed. The classical economic theory holds that a country's economic growth depends mainly on capital growth, labor growth, human capital growth, and technological progress, and higher education is an important way to increase human capital. It is considered that higher education and economic development mutually influence and reinforce each other. On the one hand, higher education promotes technological innovation by improving the quality of workers, and, thus, effectively boosts economic growth. On the other hand, economic growth is the material basis and condition for education development. Economic growth can also drive the development of higher education with an increased social demand and expanded human capital. Lewis, an American economist who won the Nobel Prize in Economics, concluded that "education -based knowledge growth" is one of the three main causes of economic growth. The vector auto regressive method (VAR) provides an effective method for us to study the dynamic relationship between the three from an empirical point of view. Through the simultaneous form of multiple equations, the method regresses the lagged variable in all endogenous variables of the model to avoid the instability of a structural equation caused by the complexity of economic theory. It shows a strong applicability in the process of economic prediction and analysis.

However, in China, although there is relevant research on the relationship between education input, technological innovation, and economic growth, the research fails to provide a good answer to these questions: How does education input, especially higher education input, promote economic growth through technological innovation? How does economic growth support higher education

development? Is the relationship between the three a direct or indirect mutual reinforcing relationship? How much is the degree of relevance between them? What is the mechanism of action between the three? Unfortunately, most of the relevant studies remain at the level of qualitative analysis, there are few empirical studies, and the theoretical support is insufficient, thereby reducing the reliability of the conclusions.

In this paper, higher education input, technological innovation, and economic growth are put into the same theoretical analysis framework. Based on the theoretical analysis of the relationship between the three, the relevant data in China is selected to construct the VAR model. The two-way causal relationship between higher education input, technological innovation, and economic growth is tested by Grainger. The impact of higher education input and technological innovation on economic growth is analyzed by the impulse response. Then, the contribution of higher education input and technological progress to economic growth is analyzed by a variance decomposition.

Therefore, it is of theoretical and practical significance to study this problem and initially give an answer to the interaction between higher education input, technological innovation, and economic growth in the context of China's strategic shift from a manufacturing country to an innovation country.

The main differences between this paper and the existing research are as follows: (1) The view is unique. This paper analyzes the economic growth from the perspective of higher education and technological innovation; (2) it tries to explore the relationship between higher education, technological innovation, and economic growth and memory mechanism from the theory; and (3) it verifies the relationship between higher education, technological innovation, and economic growth by using actual data in China.

The following research contents include: The second part is a literature review and the literature is about the influence of education; the third part is a theoretical analysis, and it clarifies the relationship between higher education, technological innovation, and economic growth; the fourth part mainly studies the research method, variables, and data, and introduces the VAR model, the basis of the variable selection and data source; the fifth part analyzes the test results and conducts an in-depth analysis of the test results through the VAR model test; and the sixth part is the conclusion and suggestions. It proposes the corresponding policies and suggestions based on the summary.

2. Literature Review

Foreign scholars had an earlier start on research of the relationship between education and economic growth. There is abundant relevant research, but a clear controversy exists on whether education promotes economic growth.

Schultz (1956) [1] found that education played an important role in the growth of American agricultural production after the war, and then put forward the theory of human capital. Denison (1996) [2] estimated the contribution of education to US economic growth using the growth accounting method, finding that the contribution rate of education expenditure to national income growth was 13.7% during the period of 1929–1982. Lucas (1988) [3] established an endogenous growth model that illustrates the mechanism of education action on economic growth, and he believed that people should be encouraged to invest in education and learning to gain more human capital to promote sustained economic growth. On this basis, that human capital input affects technological progress and has a long-term effect on economic growth has been demonstrated in many endogenous growth models. For instance, Glomm and Ravikumar (1998) [4] and Blankenau and Simpson (2004) [5] expounded the internal operation mechanism of government education expenditure, human capital, and economic growth from the public education investment point of view. Barro (1991) [6] demonstrated that the economic growth of 98 countries between 1960 and 1985 was highly dependent on the initial level of human capital, which was measured by the enrollment rate and GNP per capita. Mankiw et al. (1992) [7] further extended the Solow model by introducing human capital, with education as the standard, into the model and found a significant contribution of human capital to economic growth. Gylfason and Zoega (2003) [8] found that education promotes economic

growth not only by raising human capital, but also by raising material capital and social capital. Blankenau and Simpson (2004) [5] established an endogenous model of human capital-driven economic growth. Studies have shown that the impact of public education spending on economic growth is nonmonical within a certain range, depending on government investment and construction, expenditure levels, tax structures, and technological production parameters. Research by Hanushek and Woessmann (2012) [9] based on organization for economic co-operation and development (OECD) panel data shows that education can significantly contribute to economic growth. Studies by Barro and Lee (2013) [10] based on the panel data of 146 countries suggests that education plays a significant role in promoting economic growth.

Crespo Cuaresma, Doppelhofer, and Feldkircher (2014) [11] used a Bayesian model averaging (BMA) to find robust determinants of economic growth between 1995 and 2005 in a new data set of 255 European regions. They found that income convergence between countries is dominated by the catching-up of regions in new member states in Central and Eastern Europe, whereas convergence within countries is driven by regions in old European Union member states. Regions containing capital cities are growing faster, particularly in Central and Eastern European countries, as do regions with a large share of workers with a higher education. The results are robust when allowing for spatial spillovers among European regions. Pustovrh and Jaklic (2014) [12] argued that innovation policy research can benefit from utilizing new research methods as they might lead to different policy recommendations. They demonstrated this by using a set-theoretic fuzzy-set qualitative comparative analysis (fsQCA) method to analyze the data on innovation policies in the European Union (EU). It shows that the use of correlation-based statistical methods is not appropriate for the evaluation of innovation policies due to their causally complex nature that correlational statistical methods cannot unravel. This paper demonstrates this by focusing on the special importance of linkages among actors and innovation commercialization through entrepreneurship, and the notion that they represent a necessary condition for innovation success. Results confirm that the single factor of linkages and entrepreneurship is the necessary condition for innovation success, thus, emphasizing the importance of an open innovation framework for innovation policy-making. Results also show three combinations of sufficient conditions (but no single factor) lead to innovation success. They confirm the causal complexity of innovation policy and confirm that using different research methods leads to different policy recommendations.

Ferreira and Dionísio (2016) [13] analyzed the relation between the level of innovation and the economic effects and applied a fuzzy-set qualitative comparative analysis to study the relation between six conditions and two different outcomes. The data came from the Union Innovation Scoreboard. The study found that research systems, linkages and entrepreneurship, and intellectual assets are necessary conditions for the outcomes of a high level of innovation and positive economic effects. The main sufficient condition for both outcomes is a good research system. Ferreira and Dionísio (2016) [14] used a crisp-set qualitative comparative analysis of data from European Union countries to establish which conditions could be considered necessary and sufficient to make these countries converge. Based on six different conditions (GDP, secondary education, life expectancy, fertility rate, government consumption, and inflation rate), this study found that the main conditions affecting convergence are the government consumption ratio (lower levels will increase convergence), education levels, and life expectancy (both with a positive influence on convergence). The first two conditions show quite interesting results: In fact, a reduction of government expenditure and budget constraints are an open debate; and the European Union's aim to become a more competitive economy can only be attained with higher levels of education.

Walheer (2016) [15] extended the previous approach by considering a multi-sector setting. This setting allows the proposal of a more realistic and complete country-level analysis, while keeping the same advantages as previous methodology offer. Walheer also tackled the criticism of less reliable data at the sector level than at the country level by showing how the multi-sector approach can easily be adapted. They applied it to OECD countries in the period of 1995 to 2008. The results confirmed

the non-neutrality of technological change. It was also found that capital accumulation plays the biggest role in the increase of output-labor productivity, while technological change and human capital accumulation also play an important role, but it is twice as small as capital accumulation. Barro's (2016) [16] research showed that China cannot deviate forever from the global historical experience, and the per capita growth rate is likely to fall soon from around 8% per year to a range of 3–4%. China can be viewed as a middle-income convergence-success story, and China's transition from a middle- to upper-income status should not be hindered by a middle-income trap, which seems not to exist.

In contrast, Benhabib and Spiegel (1994) [17] argued that human capital, as measured by workers' years of education, cannot effectively explain an increase in per capita output. Brauninger and Vidal (1999) [18] found that, on the one hand, education spending improves average skills of individuals, thus, contributing to economic growth, but, on the other hand, education spending crowds out the accumulation of material capital, and weakens the effect of learning by doing, which is not conducive to growth. Bils and Klenow (1996) [19] argued that, in any case, the positive correlation between education and output growth cannot indicate that education affects economic growth. On the contrary, education and output growth may be promoted by the total factor growth, which is neglected by us in this study. Coincidentally, Pritchett (2000) [20] has also proved that the length of education time as a variable has little effect in explaining cross-border economic growth. Temple (1999) [21] argued that human capital cannot explain its significant relationship with growth very well due to the presence of many outsiders. Horii et al. (2008) [22] proved that a higher level of education improves personal income, but its long-term effect on economic growth is not so clear. Blankenau et al. (2007) [23] argued that, based on panel data from 23 developed countries and 57 developing countries, education spending has a strong catalytic effect on the economic growth of developed countries, but has no significant impact on the economic growth of developing countries.

In China, study on education input, technological innovation, and economic growth has also attracted scholars' attention. According to the principle of knowledge spillover, Huang Yanping (2013) [24] used a metrological regression model to analyze different effects of education at different levels on China's economic growth, and argued that both higher education and primary education promote economic growth, and, in the present stage, primary education plays a better role than higher education in economic growth. Second, education expenditure's effect on GDP is a long-term accumulation process because the Chinese government's education spending is at a low level, and its positive effect on economic growth has not yet been shown. Tang Weibing et al. (2014) [25] pointed out that the foreign capital imitation effect and technology spillover are beneficial to improvement in the intensification of economic growth, and that technological innovation is negatively correlated with the intensification level of economic growth owing to the ability of digestion and absorption, technical gap, and so on. Moreover, the role of technological innovation and economic growth is unclear depending on specific samples. Li Miaomiao et al. (2015) [26] found that there is a long-term equilibrium co-ordination between technological innovation and economic growth, with China's technological innovation as the direct cause of economic growth. Empirical studies by Wang Shuqiao et al. (2015) [27] showed that there is a long-term equilibrium relationship between technological innovation, higher education input, and economic growth. In the second order of the time lag, technological innovation and higher education input are the Granger reasons for economic growth, with both positively promoting economic growth in the long term, and technological innovation being the driving force of economic growth. However, there is a certain lag.

To sum up, the impact of education input and technological innovation on economic growth is still controversial. Although there are also Chinese scholars' empirical tests of the relationship between the three, to clarify the relationship between them, appropriate theoretical support is lacking. To this end, this paper incorporates education input, technological innovation, and economic growth into the same theoretical framework, tests the correlation between them based on the theoretical analysis of

the interaction mechanisms of the three, and then explores the dynamic evolution mechanism and interaction between the three.

3. Theoretical Analysis

The interaction between educational input, technological innovation, and economic growth can be analyzed from the following three levels.

3.1. The Relationship Between Education Input and Technological Innovation

Technological innovation is the driving force of social and economic development, while education is an important way for knowledge precipitation and accumulation in technological innovation. The first step is to improve the quality of personnel through education input, gradually increasing the accumulation of human capital, and, thus, promoting technological innovation and progress (Figure 1).

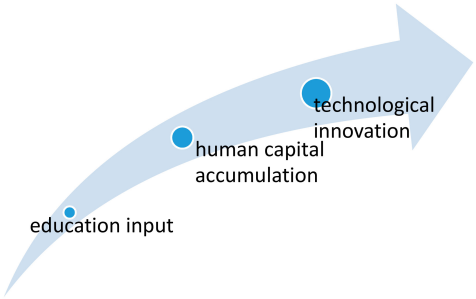

Figure 1. The relationship between education input and technological innovation.

3.2. The Relationship Between Technological Innovation and Economic Growth

Although neoclassical economics recognizes the role of technological innovation in economic growth, it treats the endogenous variable of technological innovation as an exogenous variable, fails to distinguish the source of technological progress, and exaggerates the promoting role of technological innovation in economic growth. The new economic growth theory holds that technological innovation is mainly affected by factors, such as human resource accumulation and human resource level, and establishes different analysis models according to the depth and breadth of analysis. As economic growth theory has gone through a long period of development, it has many genres and analysis methods. However, it has currently reached a consensus on the understanding that technological innovation is the core driving force of economic growth. Technological innovation and economic growth interact as both cause and effect, mutually promote and contain each other, and also form a two-in-one relationship. That is, technological innovation and economic growth are intertwined, the two synchronously change in the same direction, and such a relationship shows the promoting role of technological innovation in economic growth. First, the process of achieving technological innovation is to achieve economic growth, and technological innovation is not a means, but a purpose to promote economic and social development. Second, technological innovation and economic growth come one after the other, technological innovation is reflected in the results of economic activity, and technological innovation must be demonstrated by economic growth. Finally, there is a correspondence between technological innovation and economic growth. Different stages of technological development correspond to corresponding stages of economic development, and different levels of economic development in developed countries and developing countries are the result of technological innovation at different stages.

3.3. Interaction Between Education Input, Technological Innovation, and Economic Growth

It can be known from the above analysis that education input and economic growth are not in a simple causal relationship, education input will not directly lead to economic growth, but will

ultimately affect economic growth through the accumulation of human capital and technological innovation, and the affecting process is a dynamic circulation. Therefore, the relationship between educational input, technological innovation, and economic growth is relatively complex. For the sake of a more intuitive effect, Figure 2 is used to illustrate the relationship between the three.

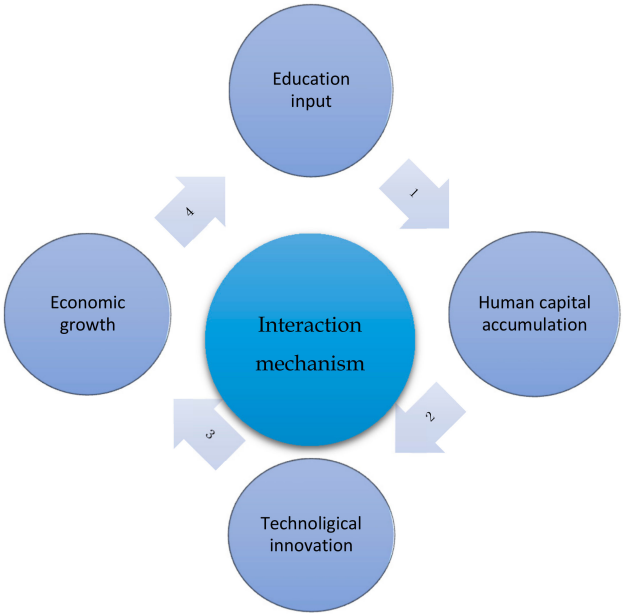

Figure 2. Interaction mechanisms between educational input, technological innovation, and economic growth.

It can be seen from Figure 2 that, first, the accumulation of human capital can be increased through education input. Secondly, human capital accumulation, to a certain extent, will bring technological innovation and progress. Furthermore, technological innovation and technological progress will further promote economic growth. Finally, economic growth makes more education input possible. A further increase in education input will begin a new round of circulation, promoting technological innovation once again through the accumulation of human capital, and, thus, promoting economic growth. This is a spiral escalating, self-strengthening process. In this circulation, although education input is not directly related to economic growth, because of the accumulation of human capital and technological innovation, economic growth will eventually be promoted. At the same time, economic growth can create conditions for education input, which shows that economic growth means a direct and positive support for education input. Thus, education input, technological innovation, and economic growth form an interaction mechanism, featuring dynamic circulation.

4. Methodology, Variables, and Data

4.1. Methodology

Vector auto-regression (VAR) is a typical used econometric model, which was created by Christopher Sims in 1980 (Christopher, S., 1980) [28]. In the economic system, each endogenous variable is considered as a function of the entire system, and the endogenous variable's hysteretic value is used to construct a model by VAR, forecasting the time-series system among them, and analyzes the dynamic impact caused by random disturbance on the variable system to explain various economic impacts on the formulation of economic variables (Tiemei, G., 2009) [29]. It is a generalization of AR model, which has been widely used currently.

Vector auto-regression (VAR) is a model based on the statistical properties of data; it constructs the model by considering every endogenous variable in the system as a function of the hysteresis value of all endogenous variables in the system, and then generalizes the univariate autoregressive model to a "vector"

autoregressive model composed of multivariate time series variables. VAR is one of the easiest models to deal with regarding the analysis and prediction of multiple relative economic indexes, and, under certain conditions, is formulated by the models of multivariate Moving Average Model (MA) and Auto-Regressive and Moving Average Model (ARMA). It has drawn increasing attention from business administrators in recent years, hence, the VAR model was chosen as the subject to study in this paper.

The basic mathematical expressions for the VAR (p) model are:

$$y_t = \Phi_1 y_{t-1} + \ldots + \Phi_p y_{t-p} + \mathrm{H}x_t + \varepsilon_t,\ t = 1, 2, \ldots, T \tag{1}$$

where y_t is the column vector of the k-dimensional endogenous variable, x_t is the column vector of the d-dimensional exogenous variable, p is the lag intervals for the endogenous, T is the number of samples, $\mathrm{k} \times \mathrm{k}$ dimension matrix $\Phi_1, \ldots, \Phi_\mathrm{p}$ and $\mathrm{k} \times \mathrm{d}$ dimension matrix η are the coefficient matrixes to be estimated, and ε_t is the K-dimensional perturbed column vector. The above expression can also be expanded as follows:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \\ \vdots \\ y_{3t} \end{pmatrix} = \Phi_1 \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \\ \vdots \\ y_{3t-1} \end{pmatrix} + \cdots + \Phi_p \begin{pmatrix} y_{1t-p} \\ y_{2t-p} \\ \vdots \\ y_{3t-p} \end{pmatrix} + \begin{pmatrix} x_{1t} \\ x_{2t} \\ \vdots \\ x_{dt} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \vdots \\ \varepsilon_{kt} \end{pmatrix},\ t = 1, 2, \ldots, T \tag{2}$$

Compared with ordinary simultaneous equations, the VAR model deals with all variables as endogenous variables, reducing the uncertainty in the simultaneous equation model due to subjective error and eliminating the prediction of endogenous variables in the process of establishing common simultaneous equations. In addition, VAR also embodies its unique superiority in the following aspects: (1) It is relatively easy to estimate parameters; (2) the model has a wide range of applications, since the VAR model is not based on financial economics theory, it can, to a large extent, have other explanatory variables be added to it; and (3) the advantages of forecasting as the predicted results of a small and reasonably set VAR model are usually better than that of a larger, structured simultaneous system, especially for short-term predictions. This is because AR models can often avoid the effects of constraints imposed to ensure the identifiable nature of structural models. While, on the other hand, it only describes the interaction between variables in the lagging period and their current period, and neglects the structural relationship between them, affecting the accuracy of the study to some extent due to the structural relationship between relative economic variables hidden in the random perturbation term. However, it does have an advantage in its forecasting

4.2. Variables and Data

The paper focuses on the relationship among higher education investment, technological innovation, and economic growth, employing an empirical study on their causal relationship as well as the dynamic influence among them. The quantity of patent authorizations and patent applications are the most common two indexes to reflect the technical innovation level. Because the patent authorization quantity is influenced by human factors, such as government organization, the number of patent applications authorized is selected as the proxy variable to measure technological innovation. While the proxy indexes for economic growth and higher education input will be expressed by using the current measured GDP and the national financial education funds, respectively.

Based on the comprehensive consideration of the above factors, data from 1991 to 2016 are selected as the sample for this study. They come from the corresponding year of such books as the "China Statistical Almanac", "Chinese Education Fund Statistics Yearbook", and "Chinese Education Statistics Almanac", and are studied empirically on the basis of unifying solutions to the annual growth rate of the variable, with the symbols of GDP, Budget, and Patent to represent the current annual growth rate of the GDP, the annual growth rate of national fiscal education funds, and the annual growth rate of patent application authorizations, respectively.

The variation trend of the above variables is expressed in Figure 3.

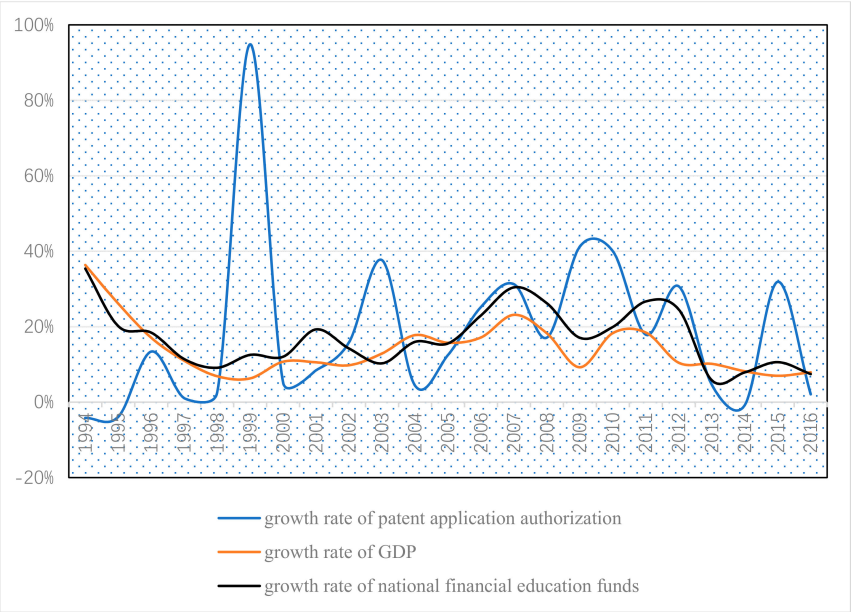

Figure 3. Vibration trend of variables.

From the analysis of Figure 3, we can simply see that over the years from 1998 to 2008 the annual growth rate of the GDP, as measured by the current price, is rising, with some fluctuations. In the meantime, the national financial education fund growth rate also appears to be increasing, but there is a slight uplift in the fluctuation range of the growth rate of the patent application quantity. It is noteworthy that the annual growth rate of the GDP, the growth rate of the national financial education fund, and the growth rate of patent application authorizations have shown the same fluctuation trend, while in a downward trend since 2009.

5. Analysis of Test Results

5.1. Variable Unit Root Test

Time series were employed for the paper's empirical test, which must be checked prior to the model establishment and analysis to avoid pseudo regression between variables. If the sequence is stable or is a stationary sequence, that is, the same order single integer sequence, that can be acquired after the same difference operation, then the subsequent modeling analysis begins. In this paper, we used the common unit root test method, Augment Dickey-Fuller (ADF), to test the time series and implemented this with the operation of the Eviews7.2 software. The results are shown in Table 1.

Table 1. Augment Dickey-Fuller (ADF) Variable unit root test results.

Variable	Test Form (I,T,P)	ADF Test Value (*t* Statistics)	Probability	Test Results (the Data Showed Significant at 5%)	Test Results (the Data Showed Significant at 10%)
GDP	(I,N,0)	−2.335673	0.0046	Stable	Stable
Δ*GDP*	(I,N,0)	−4.266645	0.0503	Unstable	Stable
Budget	(I,N,2)	−2.127141	0.0644	Unstable	Stable
Δ*Budget*	(I,N,1)	−4.258338	0.0004	Stable	Stable
Patent	(I,N,1)	−4.440905	0.0003	Stable	Stable
Δ*Patent*	(I,N,1)	−4.181977	0.0000	Stable	Stable

Note: (1) I and T in the teaching and research form represent the constant term and the trend term, N means that the test equation does not have the term, and p represents the lag order determined by the AIC (Akaike Info criterion); (2) Δ represents a first-order difference calculation for a variable.

Based on the ADF unit root test, we found that the sequence of this empirical test under the 10% confidence level satisfies the single integer serial or the first order serial. As per the requirements for series stability, the original sequence or the first order difference sequence can all be used to formulate the Vector Autoregression (VAR model.

5.2. Estimation of VAR Model

To study the interaction among higher education investment, technological innovation (progress), and economic growth, and further decomposition of the impact of various factors, as well as the changes in the short-term and long-term influences, we used the first-order difference of the annual growth rate of the GDP as well as the authorized number of patent applications and the original value of the national financial education funding growth rate as endogenous variables to construct the three-factor VAR model, with the parameters estimated by the Eviews7.2. software. The consequences are as follows:

$$\begin{bmatrix} dGDP_t \\ dPatent_t \\ Budget_t \end{bmatrix} = \begin{bmatrix} 0.051481 \\ 0.005033 \\ 0.098589 \end{bmatrix} + \begin{bmatrix} 0.310043 & 0.068010 & -0.335969 \\ -2.240479 & -0.599841 & -0.136455 \\ 0.637669 & -0.016912 & 0.437204 \end{bmatrix} \begin{bmatrix} dGDP_{t-1} \\ dPatent_{t-1} \\ Budget_{t-1} \end{bmatrix} \quad (3)$$

Since the VAR model establishes a dynamic system and does not make a strict distinction between the dependent variable and the independent variable, we do not focus on the significance of the unilateral process. However, the estimated results still show that the equations in the model have good significance (see Table 2). The results of the stationary test of the VAR model show that all the characteristic roots of the model are in the unit circle (Figure 4), so the model is a stationary VAR model. Combining the internal relationship of the economic system, the VAR model we selected is a model with a lag order of 1. Therefore, we can further analyze the relationship between variables based on the VAR model.

Table 2. Vector auto-regression (VAR) Variables statistical characteristics and model significance.

	c	$dGDP_{t-1}$	$dPatent_{t-1}$	$Budget_{t-1}$	R^2
$dGDP_t$	0.02392 [2.15027]	0.18030 [1.71957]	0.03007 [2.26145]	0.12455 [−2.69744]	0.401332
$dPatent_t$	0.15488 [0.03250]	1.16736 [−1.91926]	0.19471 [−3.08070]	0.80640 [−0.16921]	0.358301
$Budget_t$	0.03423 [2.87985]	0.25803 [2.47129]	0.04304 [−0.39295]	0.17824 [2.45284]	0.454796

Note: The first row is the standard deviation of the estimating coefficient. The square brackets ([ ]) contain the statistics of the estimating coefficient.

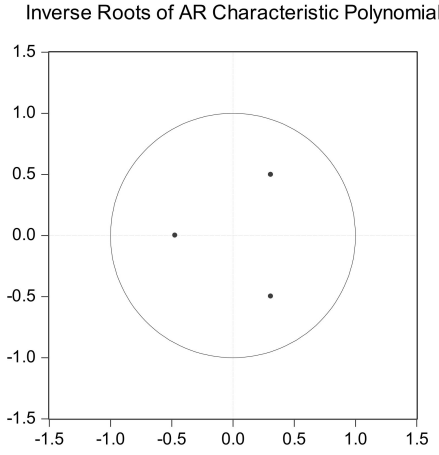

Figure 4. VAR stability test.

5.3. Granger Causality Test

The Granger causality test is a statistical explanation of the relationship between variables, which is essentially a test of whether a variable's lag variable can be introduced into other variables' equations. We have used the stationary sequence to establish the VAR model, and verified its stability. Considering this, we also carried out the Granger causality test to distinguish between endogenous variables and exogenous variables. The results are shown in Table 3.

Table 3. Vector auto-regression (VAR) Granger causality test results.

Equation	Primary Hypothesis	χ^2 Statistics	Degree of Freedom	*P* Value	Testing Results
dGDP	dPatent cannot Granger cause DGDP	5.114158	1	0.0237	Reject **
	Budget cannot Granger cause DGDP	7.276193	1	0.0070	Reject **
	ddPatent, *Budget* both cannot Granger cause *dGDP*	12.26413	2	0.0022	Reject **
dPatent	*dGDP* cannot Granger cause *dPatent*	3.683571	1	0.0550	Reject *
	Budget cannot Granger cause *dpatent*	0.028634	1	0.8656	Accept
	ddGDP, *Budget* both cannot Granger cause*dPatent*	3.875851	2	0.1440	Accept
Budget	*dGDP* cannot Granger cause *Budget*	6.107287	1	0.0135	Reject **
	dPatent cannot Granger cause *Budget*	0.154413	1	0.6944	Accept
	dGDP, dPatent both cannot Granger cause *Buget*	7.632743	2	0.0220	Accept

NOTE: ** means to reject the original hypothesis at 5% confidence, * to reject the original hypothesis at 10% confidence level.

The Granger causality test of the VAR model we set up shows that the first-order difference of the annual growth rate of the patent application authorizations and the annual growth rate of the national financial education fund are the Granger causes of the first-order difference of the GDP annual growth rate, and, in turn, the first-order difference of the GDP annual growth rate is also the Granger reason of the annual growth rate of the patent application authorizations and the change of the yearly growth rate of the national financial education funds. The results of the Granger causality test supported our analysis theoretically. Meanwhile, the significance of the causal relationship between variables also supported categorizing the three variables as endogenous variables to establish the VAR model. Considering this, we believe that this research has some value in its analysis.

5.4. Impulse Response Function and Variance Decomposition

The results of the stationary test of the VAR model show that all characteristic roots of the model are in the unit circle (Figure 4). That is why it is a stationary VAR model, and, simultaneously, the Granger causality test verifies that the first-order difference of the annual growth rate of the patent application authorizations and the annual growth rate of the national fiscal education funds are the Granger reasons for the alteration of the annual growth rate of the GDP. Therefore, considering this, the paper proceeds with the implementation of the impulse response and variance decomposition in the effect of the first-order difference of the annual growth rate of patent applications and the annual growth rate of the national fiscal education funds.

Based on establishing the VAR model, we use the impulse response function (Impulse Response Function, IRF) to analyze the feedback of the first order difference value of the annual GDP growth rate on one unit when the perturbation term of an endogenous variable is added to different dimensions.

Figure 5 reflects the effect of a positive impulse reacting to the first-order difference in the annual growth rate of patent applications and the annual growth rate of funding for higher education on the influence of the first-order difference of the annual growth rate of the GDP at different time dimensions. From the perspective of impact time, the growth rate of patent application authorizations and the

annual growth rate of national financial education funds have a more obvious medium and long-term effect on economic growth, and the influence can last for about eight periods.

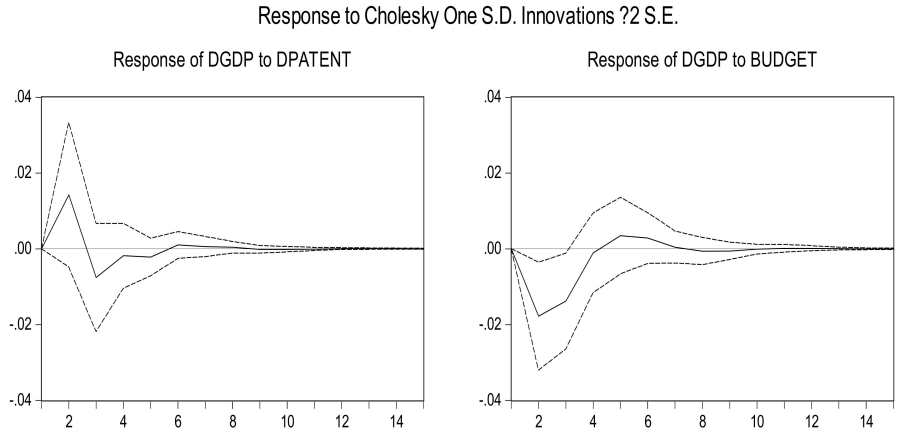

Figure 5. Economic growth response function caused by the impact of the quantity of patent application (Left) and the funding for higher education (Right).

From the angle of influence, patent applications and national fiscal education funds tend to fluctuate in their growth rate, in which the growth of patent application authorizations leads to a direct increase of the GDP growth rate, and produces a positive cumulative effect in the medium and long term. Expanding of the national financial education funds generally needs to be transformed by technology to trigger GDP growth, while the growth of patent application authorizations has a more direct impact on the growth rate of the GDP. We have verified that the change in the growth rate of national financial education funds is the Granger reason for the variation in the number of patent applications. As seen from the impulse map, the increase of the national financial education funds' growth rate imposed a positive effect on GDP growth after the fourth period.

To further the analysis of the contribution of each structural impact to the growth rate of the GDP, and the evaluation of the importance of each impact at different time dimensions, we used the method of variance decomposition to decompose the contribution of the annual growth rate of patent applications and the annual growth rate of higher education funds to the GDP growth rate.

Considering the results of the variance decomposition, as shown in Table 4, there is an evident inertia reaction to the GDP growth rate caused by its own innovation, or the innovation from the growth rate of patent applications the national financial education funds. At the beginning of the ninth period, the GDP growth rate remains at a stable level, with the strongest effect from its own innovation, which is kept at 74% or above. The effect of innovation from the change in the number of patent applications is close to 9%; while in the state's financial education fund it is close to 17%. In summary, out of the two factors that we examined, the change in the national financial education funds' growth rate has a stronger influence on the GDP growth rate.

Table 4. *dGDP* variance decomposition.

Variable	Period	*dGDP*	*dPatent*	*Budget*
dGDP	1	100.0000	0.0000	0.0000
	3	74.40299	8.685590	16.51024
	5	74.70537	8.615701	16.67893
	7	74.61637	8.586434	16.79719
	9	74.59861	8.588031	16.81336
	13	74.59897	8.587961	16.81307
	17	74.59895	8.587963	16.81308
	20	74.59895	8.587963	16.81308

6. Discussion

(1) How does education input, especially higher education input, promote economic growth through technological innovation? Technical innovation is the power source of social and economic development, and education is an importance approach to technical innovation, knowledge precipitation, and accumulation. Therefore, education input, especially higher education input, improves personnel quality, increases the accumulation of human capital gradually, and, thereby, promotes technical innovation and progress. Furthermore, the kernel variable technology, which determines economic growth, has innovation and progress, which inevitably accelerates economic growth. Meanwhile, different technical development phases correspond to corresponding economic development phases. Different economic development levels of developed countries and developing countries are the result of technical innovation at different stages. Thus, education input, especially higher education input, accelerates economic growth through technical innovation.

(2) How does economic growth support higher education development? This can be analyzed from two aspects for the influence of economic growth on the development of higher education. Firstly, economic growth provides a material basis for the coordinated development of education. To a certain extent, education refers to the activities that form through the basic form of human capital investment, and are cultivated and trained for the ability of labor according to a plan. From this point of view, the investment and operation of education can be regarded as an input and output process of an industry. From the perspective of the main body of the burden, educational cost can be divided into two parts: Social cost and personal cost. The expansion of higher education requires an increase in the related inputs. For the sake of the coordinated development of education, it is essential to ensure long-term and sustained educational input, which must be based on sustained and stable economic growth. Secondly, economic growth has a restrictive and guiding role in educational development. The level of economic development determines the scale, content, organization form, teaching methods, and educational means of education, which also determines the quality of labor and the quality of education and training of qualified personnel. Fundamentally, as an activity to cultivate people, education is an important part of social development, whose development is ultimately restricted by the level of economic development. The level of economic development determines not only the quantity of education investment, but also the supply of educational investment, which will inevitably require the scale and speed of education at all levels to match the scale and speed of economic development, and to be coordinated in quantity.

(3) Is the relationship between the three a direct or indirect mutual reinforcing relationship? Education input and economic growth is not a simple causal relationship. Education input does not cause economic growth directly. Instead, it conducts economic growth through the accumulation of human capital and technical innovation. Moreover, the conductive process is a dynamic cyclic process. In the circulation, although education input and economic growth do not have a direct relationship, they promote economic growth ultimately through the conduction of human capital accumulation and technical innovation. At the same time, economic growth can also create conditions for education input, which shows that economic growth has a direct and positive supporting effect on education input. As a result, there is a dynamic and periodic interactive mechanism among the three.

(4) How much is the degree of relevance between them? From the Grainger causality, scientific and technological progress and education input are the causes of economic growth. Conversely, economic growth will also lead to scientific and technological progress and educational input. From the impulse response, investment in science and technology and education has obvious long-term effects on economic growth, while the effects can last for about eight phases. Furthermore, from the direction of the influence, the impact of scientific and technological progress and educational input on economic growth shows a trend of repeated fluctuations. Among them, scientific and technological progress directly stimulates economic growth in the short term and has a positive, cumulative effect in the medium and long term. After the fourth phase, higher education investment has a positive impact on the economic growth rate. From the degree of contribution, economic growth is affected by its own

innovation, technological progress, and new input into education, which has an obvious inertia and is stable at the beginning of the ninth phase. From a comprehensive view, the progress of science and technology has a stronger impact on economic growth.

(5) What is the mechanism of action between the three? Education input, technical innovation, and economic growth have a direct or indirect interactive relationship. Education input can increase the accumulation of human capital. The accumulation of human capital, to a certain extent, will result in technical innovation and progress. Furthermore, technical innovation and progress also promotes economic growth. Then, economic growth has more possibilities for education input. If we increase education input further, they will enter a new cycle. Moreover, it promotes technical innovation through the accumulation of human capital and, thereby, accelerates economic growth. Thus, it is a helical and self-reinforcing process. Technical innovation and economic growth not only have the relationship of reciprocal causation, which promotes and restricts each other, but also have a two-in-one relationship, which means technical innovation and economic growth are intertwined. The two synchronously change in the same direction. The relationship manifests the role of technical innovation in promoting economic growth.

7. Conclusions

Through the above analysis, the following basic conclusions can be obtained.

Higher education input and technology are two factors that affect economic growth. The test results show that indicators representing higher education spending and indicators of technological innovation are continuing, influencing factors of economic growth fluctuations, either in the short or long term, and both have made contributions that cannot be ignored. It is noteworthy that the impact of superposition of higher education input and technological innovation has a certain long-term nature, which does not diminish over time, but has increased to some extent, which is in line with our theoretical analysis that higher education input and technological transformation and innovation go through a process of accumulation, transfer, and transformation to ultimately affect economic growth. As seen from the direct relationship, increases in higher education input is a driving force for technological innovation, and technological innovation is a factor for economic growth. As seen from the analysis of the impulse response results, primary technological innovation provides a cumulative positive effect on economic growth, which slowly decays over time and has a strong long-term nature that corresponds with the general rule of the gradual elimination of introduced new technology.

Education input and economic growth are not in a simple causal relationship, and education input will not directly lead to economic growth, but will ultimately affect economic growth through the accumulation of human capital and technological innovation, and the affecting process is a dynamic, self-reinforcing, circular process. Higher education input is an important source of technological innovation, and the positive effect of technological innovation on economic growth can only be shown over a long time. Therefore, higher education input demands a long term view and thinking for quick success, and instant benefits should be avoided.

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References

1. Schultz, T.W. *Agriculture and the Application of Knowledge, A Look to the Future*; W. K. Kellogg Foundation: Battle Creek, MI, USA, 1956; pp. 54–78.
2. Denison, E.F. *The Sources of Economic Growth in the United States and the Alternatives before US*; Committee for Economic Development: New York, NY, USA, 1996.
3. Lucas, R. On the mechanics of economic development. *J. Monetary Econ.* **1988**, *22*, 3–42. [CrossRef]
4. Glomm, G.; Ravikumar, B. Flat-Rate Taxes, Government Spending on Education and Growth. *Rev. Econ. Dyn.* **1998**, *1*, 306–325. [CrossRef]
5. Blankenau, W.F.; Simpson, N.B. Public education expenditures and growth. *J. Dev. Econ.* **2004**, *73*, 583–605. [CrossRef]
6. Barro, R.J. Economic Growth in a Cross-Section of Countries. *Q. J. Econ.* **1991**, *2*, 407–443. [CrossRef]
7. Mankiw, N.G.; Romer, D.; Weil, D. A Contribution to the Empirics of Economic Growth. *Q. J. Econ.* **1992**, *107*, 407–438. [CrossRef]
8. Gylfason, T.; Zoega, G. Education, Social Equality and Economic Growth: A View of the Landscape. *Econ. Stud.* **2003**, *4*, 557–579. [CrossRef]
9. Hanushek, E.A.; Woessmann, L. Do Better Schools Lead to More Growth? Cognitive Skills, Economic Outcomes, and Causation. *J. Econ. Growth* **2012**, *17*, 267–321. [CrossRef]
10. Barro, R.J.; Lee, J.W. A New Data Set of Educational Attainment in the World, 1950–2010. *J. Dev. Econ.* **2013**, *104*, 184–198. [CrossRef]
11. Cuaresma, J.; Doppeihofer, G.; Feldkircher, M. The Determinants of Economic Growth in European Regions. *Reg. Stud.* **2014**, *1*, 44–67. [CrossRef]
12. Pustovrh, A.; Jaklic, M. National innovation policies in the EU: A fuzzy-set analysis. *Econ. Bus. Rev.* **2014**, *1*, 39–62.
13. Ferreira, P.; Dionísio, A. What are the conditions for good innovation results? A fuzzy-set approach for European Union. *J. Bus. Res.* **2016**, *11*, 5369–5400. [CrossRef]
14. Ferreira, P.; Dionísio, A. GDP growth and convergence determinants in the European Union: A crisp-set analysis. *Rev. Econ. Persp.* **2016**, *4*, 279–296. [CrossRef]
15. Walheer, B. Growth and convergence of the OECD countries: A multi-sector production-frontier approach. *Eur. J. Oper. Res.* **2016**, *2*, 665–675. [CrossRef]
16. Barro, R.J. Economic Growth and Convergence, Applied to China. *China World Econ.* **2016**, *5*, 5–19. [CrossRef]
17. Benhabib, J.; Spiegel, M.M. The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data. *J. Monetary Econ.* **1994**, *34*, 143–173. [CrossRef]
18. Brauninger, M.; Vidal, J.P. Private versus Public Financing of Education and Endogenous Growth. *J. Popul. Econ.* **1999**, *13*, 387–401. [CrossRef]
19. Bils, M.; Klenow, P.J. Does Schooling Cause Growth or the Other Way Around? *NBER Work. Pap.* **1998**, *5*, 1160–1183.
20. Pritchett, L. Where Has All the Education Gone? World Bank, Policy Research Working Paper No. 1581. December 2000. Available online: https://sites.hks.harvard.edu/fs/lpritch/Education%20-%20docs/ED%20-%20Econ%20Growth,%20impact/where%20has%20all%20the%20education%20gone.pdf (accessed on 24 July 2018).
21. Temple, J. The New Growth Evidence. *J. Econ. Lit.* **1999**, *1*, 112–156. [CrossRef]
22. Horii, R.; Kitagawa, A.; Futagami, K. Availability of higher education and long-term economic growth. *Jpn. Econ. Rev.* **2008**, *2*, 156–177. [CrossRef]
23. Blankenau, W.F.; Simpson, N.B.; Tomljanovich, M. Public Education Expenditures, Taxation and Growth: Linking Data to Theory. *Am. Econ. Rev.* **2007**, *97*, 393–397. [CrossRef]
24. Huang, Y.; Liu, Y.; Wu, Y.; Li, W. Economic Growth and Regional Inequality in China: Effects of Different Levels of Education. *Econ. Res. J.* **2013**, *4*, 94–105. (In Chinese)
25. Tang, W.; Fu, Y.; Wang, Z. Technology Innovation, Technology Introduction and Transformation of Economic Growth Pattern. *Econ. Res. J.* **2014**, *7*, 31–43.
26. Li, M.; Xiao, H.; Zhao, S. Study on the Relationship among the Financial Development, Technological Innovation and Economic Growth: Based on China's Provincial Panel Data. *Chin. J. Manag. Sci.* **2015**, *2*, 162–169.

27. Wang, S.; Wang, H.; Yin, J. Educational Investment and Technological Innovation and Economic Growth. *Educ. Res. Mon.* **2015**, *5*, 14–19.
28. Sims, C.A. Macroeconomics and Reality. *Econometrica* **1980**, *1*, 1–48. [CrossRef]
29. Tiemei, G. *Econometric Analysis Methods and Modeling—Eviews Application and Examples*; Tsinghua University Press: Beijing, China, 2009; p. 269.

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