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Original Paper

Research on the Impact of Vocational Education on Total Factor Productivity and Mediating Effects

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Abstract

As an important type of education for cultivating high-quality technical and skilled talents, vocational education provides significant human capital support for the high-quality development of the economy. Based on panel data from 30 provinces (autonomous regions, municipalities) in China from 2005 to 2020, this study employs the Malmquist productivity index to measure Total Factor Productivity (TFP). Using a two-way fixed effects and mediation effects model, the study empirically analyzes the impact and mechanisms of vocational education on TFP. The results show that the expansion of higher vocational education has a more significant effect on TFP growth compared to secondary vocational education, with a particularly pronounced influence in the eastern and western regions. The analysis of the mediating mechanisms reveals that human capital and technological innovation are important pathways through which vocational education promotes TFP growth. Therefore, to achieve high-quality development of vocational education and enhance TFP growth, it is recommended to moderately expand the scale, improve the vocational education training system, increase support for vocational education to narrow regional disparities, promote the integration of vocational education with industry to enhance the conversion rate of technological innovation, shift the focus from scale expansion to internal improvement, and promote regional coordinated development.

Keywords

Vocational education, Total factor productivity, High-quality development, Mediation effects

1. Introduction

In the 19th National Congress report, it was emphasized that China's economy has transitioned from a phase of high-speed growth to a phase of high-quality development. One of the core issues in promoting high-quality development is to enhance Total Factor Productivity (TFP). TFP refers to the contribution of economic growth after deducting the contributions of labor and capital inputs (Ma, Zhang, & Wang, 2019). The improvement of TFP measures whether economic growth is driven by extensive factor inputs or by intensive and efficient development through improved factor allocation and quality. Enhancing TFP is crucial for achieving sustainable economic development and improving economic efficiency. The key to promoting TFP improvement lies in human capital. Vocational education can enhance the quality of the workforce, cultivate skilled labor and technical talents, meet the demands of economic transformation and industrial restructuring for skilled personnel, and thereby promote the improvement of TFP, optimize supply structure, enhance resource allocation efficiency, and drive technological progress and productivity improvement. It is the key to promoting high-quality development.

The central government attaches great importance to the development of vocational education. After the National Conference on Vocational Education was held, vocational education was established as having "broad prospects and great potential." Subsequently, the revised Vocational Education Law provided new interpretations of vocational education in terms of its status, functions, management methods, and educational entities. China's vocational education has entered a new stage of high quality and improvement. By 2022, the number of vocational schools in China has reached 8780, with a total student population of over 29 million. In modern manufacturing and strategic emerging industries, 70% of the new labor force comes from vocational colleges. Each year, vocational schools train approximately 10 million high-quality skilled talents, providing strong support for economic and social development (Krueger & Lindahl, 2001).

The improvement in the scale and quality of education contributes to promoting economic growth, while the differences in TFP growth are the core factors leading to regional economic growth disparities (Pritchett, 2001). Based on this consensus, this study focuses on exploring the role of developing vocational education in promoting high-quality economic development, as well as the differential impact and mechanisms of higher vocational education and secondary vocational education on high-quality economic development. Using panel data from 30 provinces (autonomous regions, municipalities) from 2005 to 2020, this study constructs the Malmquist productivity index to measure total factor productivity and investigates the impact of vocational education on high-quality development in China. The study aims to provide data support and promote the high-quality and comprehensive development of vocational education in our country.

2. Literature Review

Research on the relationship between vocational education and Total Factor Productivity (TFP). Scholars believe that education is an important means of developing human capital (Hampf & Woessmann, 2017). Human capital is used to explain the reasons for economic growth, while TFP is an important factor in explaining regional economic growth disparities. As early as the 1950s, scholars began studying the mystery of economic growth, with early research including Schultz's "Human Capital Theory" and later Romer and Lucas's "New Economic Growth Theory," which all emphasized that education can provide society with high-quality human capital and promote sustained economic growth (Lucas, 1988). Education can accumulate human capital, promote technological progress, and improve TFP. Vocational education transforms and develops the population's resources into human resources, turning potential technology into real productivity. Uzawa (1965) and Lucas constructed two-sector models that transform educational inputs into human capital and apply them to the production of final products. Research on developing countries has found that a country's ability to absorb advanced technology largely depends on its level of human capital, which in turn affects the speed of TFP development (Benhabib & Spiegel, 2005) Some studies have established Cobb-Douglas production function models and found that human capital directly affects TFP growth, while treating it as an input factor would lead to equation setup errors; a country's TFP growth is determined by its own level of human capital. Hua et al., using interprovincial panel data, estimated the DEA-Malmquist index of TFP growth in various regions and decomposed it into technological progress and efficiency change. Their research found significant differences in the impact of university education and primary and secondary education on TFP, with primary and secondary education only negatively affecting efficiency change.

Research on the mechanism of vocational education's impact on TFP. Existing research has found that human capital and technological innovation are the main pathways influencing TFP (Romer, 1990). The level of a country's TFP depends not only on its own research and development innovation reserves but also on the absorptive and learning capacity of human capital for foreign technology spillovers. The accumulation of human capital is one of the main ways to achieve technological innovation and diffusion (Grossman, 1993). There is a threshold effect of education level on promoting TFP. When the difference between a region's TFP and the maximum TFP is within a certain range, a highly educated workforce will have a positive effect on TFP growth. Vocational education adjusts the professional settings of institutions based on the current industrial structure and development trends of the local area, guiding the training goals of vocational schools according to regional industrial development needs, thereby promoting the improvement of TFP (Benhabib & Spiegel, 1994). "Learning by doing" and "knowledge spillover effects" in physical capital investment can promote TFP growth, and technological progress is the main pathway for promoting TFP growth, with enterprise R&D activities being at its core.

Existing research provides important references for this study. Based on this, we have the following

marginal contributions: First, from the perspective of vocational education, it explores the impact of the scale of secondary and higher vocational education on TFP growth. Second, it constructs a two-way fixed-effects model and a mediation effects model to empirically examine the impact and mechanism of vocational education on TFP, providing empirical evidence for the research field of vocational education and economic growth.

3. Model Construction and Variable Explanation

3.1 Model Construction

Taking reference from existing literature, this study examines the impact of higher vocational education and secondary vocational education on Total Factor Productivity (TFP) at two levels, aiming to avoid the omission of variables and the influence of time trends on the dependent variable. It controls for regional and time variables while also considering the influence of variables such as the proportion of foreign direct investment (*FDI*), degree of openness (*Open*), and the proportion of output in the tertiary industry (Industry) that affect total factor production. The specific model is as follows:

$$TFP_{it} = \beta_0 + \beta_1 VET_{it} + \beta_2 FDI_{it} + \beta_3 Open_{it} + \beta_4 industry_{it} + \eta_i + \gamma_t + \varepsilon_{it} \quad (1)$$

Where TFP_{it} represents the total factor productivity of province i in year t; *VET* represents vocational education, which is divided into two levels: higher vocational education (*HVET*) and secondary vocational education (*MVET*); η_i represents province fixed effects; γ_t represents year fixed effects; and ε_{it} is the error term. By estimating the coefficients of the variables in the model, this study aims to analyze the individual and combined effects of higher vocational education and secondary vocational education on total factor productivity, while controlling for other relevant factors.

3.2 Variable Explanation

3.2.1 Dependent Variable: Total Factor Productivity (*TFP*)

Following the approach of existing literature, this study calculates total factor productivity using the Malmquist index method. The Malmquist index method does not require specific assumptions about the production function, thus avoiding theoretical and model constraints. In this study, labor and capital stock are used as input indicators, and regional Gross Domestic Product (GDP) is used as the output indicator. The directional distance function is introduced to construct the Malmquist productivity index, which measures the total factor productivity index of each province. The data for the indicators are sourced from the "China Statistical Yearbook" from 2006 to 2021, with regional GDP adjusted to the base year of 2005. Labor is calculated using the annual employment figures for each province. Capital stock is estimated using the perpetual inventory method, a commonly used approach pioneered by Goldsmith in 1951, with the formula: $K_{i,t} = K_{i,t-1}(1-\delta_t) + I_{it} / P_{it}$.

Here, K represents capital stock, δ is the depreciation rate (assumed to be 9%), I is fixed asset investment, and P is the investment price index. This method calculates the rate of change index for total factors, and if the total factor productivity index is greater than 1, it indicates an improvement in

the level of total factor productivity in that year.

The overall trend of China's total factor productivity from 2005 to 2020 was calculated using the MaxDEA 8.0 software. From Figure 1, it can be observed that the mean of total factor productivity is 1.572, indicating that resource allocation efficiency in China's economy is effective. From a temporal perspective, the total factor productivity of China's economy shows a fluctuating trend characterized by initial decline, subsequent increase, followed by decline and another rise.

Specifically, between 2005 and 2006, China's total factor productivity (TFP) showed a clear upward trend, followed by a decline starting from 2007. During the period of 2008-2009, China's economy experienced a relatively low period of development, with total factor productivity consistently below 1. After 2010, China's economy entered a period of rapid development, reaching a peak in 2011-2012 with a Malmquist index of 2.176. After a brief decline in 2014-2015, total factor productivity has remained above 1 starting from 2016, indicating that China's economy has entered a new stage of development characterized by a new normal.

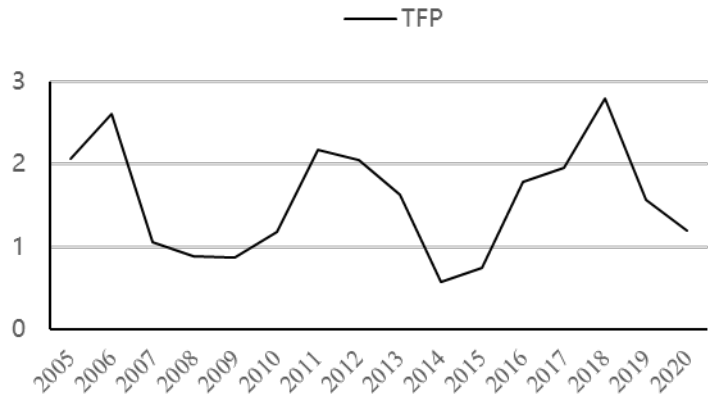

Figure 1. Trend of Total Factor Productivity

3.2.2 Independent Variable: Vocational Education

For the measurement of vocational education, there are indicators such as the number of full-time vocational education teachers, education funding, and school assets, as well as indicators constructed from the input and output aspects of vocational education. The student enrollment scale in vocational education is the most direct indicator of the development level of a country's vocational education system and is a variable that affects the level of vocational education development. According to the provisions of the "Vocational Education Law" in 2022, vocational education in China includes secondary vocational education and higher vocational education. Considering data availability, this study selects the number of graduates from vocational colleges (in tens of thousands) as the measurement indicator of vocational education development, and the data is logarithmically transformed.

From the perspective of development status and trends, the overall scale of vocational education in

China has been continuously growing. Since 1999, the number of graduates from higher vocational education has been steadily increasing each year, while the number of graduates from secondary vocational education shows a trend of initial growth followed by a decline. As of 2023, the annual number of graduates from higher vocational education reached 3.984 million, and the number of graduates from secondary vocational education reached 3.754 million. Due to factors such as college adjustments and a decrease in birth rates, the student enrollment scale in secondary vocational education has been declining each year since 2013, showing a significant gap compared to the national policy requirement of “approximately proportional vocational to general education”.

3.2.3 Control Variables

FDI is an important factor influencing a country’s total factor productivity. FDI brings advanced production technology and management experience, directly stimulating the economic development and employment of the host country, and improving domestic production efficiency, known as embodied technological spillover. The level of FDI in this study is calculated as the ratio of FDI to GDP for each province. Considering that FDI is measured in US dollars, the investment amount is converted to Chinese yuan by multiplying it by the average exchange rate for the respective year.

The degree of openness indirectly affects total factor productivity. Regarding imports, the importation of high-tech and high-quality goods intensifies competition among local manufacturing enterprises, promoting technological and production efficiency improvements and enhancing their competitiveness. Regarding exports, domestic companies enhance their total factor productivity by introducing advanced foreign technologies and management methods, and through participating in international competition, they have the opportunity to access advanced foreign technologies and products, achieving the “learning while exporting” effect. In this study, the proportion of total import and export trade value to local GDP is used as a measure of the degree of openness. Considering that the trade value is measured in US dollars, the trade amount is converted to Chinese yuan by multiplying it by the average exchange rate for the respective year.

Optimization of industrial structure. Existing literature indicates that a higher proportion of the tertiary industry signifies a shift of the national economy’s focus from the primary and secondary industries to the tertiary industry. The optimization of industrial structure promotes economic growth and improves total factor productivity. In this study, the growth value of the tertiary industry and its proportion to local GDP are used to measure the degree of local industrial structure optimization.

3.2.4 Mediating Variables: Human Capital Level and Technological Innovation

This study posits that vocational education primarily affects the improvement of total factor productivity through two pathways: enhancing the level of human capital and promoting technological innovation. The human capital level is measured by the average number of years of education per capita, with the original data sourced from the “China Education Statistical Yearbook.” Technological innovation is measured by the proportion of research and development expenditure, with the original data obtained from the “China Statistical Yearbook.”

Table 1 provides a statistical description of each variable. Across all samples, the average value of the total factor productivity index is 1.613 (greater than 1), indicating that from 2005 to 2020, China's provinces achieved an average annual improvement of 61.3% in economic total factor productivity, indicating relatively effective resource allocation in the country's economy. The average value of the number of graduates from secondary vocational education is 14.98, with a median of 11.46 and a maximum value of 48.83, indicating significant variations in the scale of secondary vocational education between different provinces. The maximum and minimum values of graduates from higher vocational education are 0.22 and 30, respectively, indicating significant variation in the trend of higher vocational education among different provinces. The average value of the human capital level is 9.068, indicating that the average years of education for human capital in China is 9 years, signifying the significant effect of the nine-year compulsory education policy.

Table 1. Descriptive Statistics of the Sample Data

variable	*obs*	*mean*	*sd*	*min*	*max*
TFP	480	1.613	0.750	0.161	2.900
MVET	480	14.98	11.46	0.360	48.83
HVET	480	9.694	7.250	0.220	30
FDI	480	0.023	0.021	0.001	0.105
Open	480	0.298	0.336	0.0183	1.617
Industry	480	0.464	0.092	0.307	0.816
Human	480	9.068	1.099	4.666	12.70
Innovation	480	8.800	1.140	4.920	12.10

4. Empirical Results Analysis

4.1 Basic Regression Analysis

Table 2 presents the regression results of the impact of vocational education on total factor productivity. In terms of model fit, the goodness of fit (*R2*) for medium and higher vocational education on total factor productivity is 0.8695 and 0.8697, respectively, indicating that the constructed model has a relatively ideal fit. Columns (1) and (2) show the regression results without control variables, only controlling for time and provincial fixed effects. Columns (3) and (4) include control variables and time and provincial fixed effects. The results indicate that both medium and higher vocational education significantly promote the improvement of total factor productivity, regardless of the inclusion of control variables.

From a national perspective, medium vocational education shows a significant positive impact on total factor productivity growth at a 5% significance level, with a partial regression coefficient of 0.032. This means that for every 1% increase in the scale of medium vocational education students, total factor

productivity increases by 3.2%. Similarly, higher vocational education also significantly promotes total factor productivity growth at a 5% significance level, with a partial regression coefficient of 0.034. This indicates that for every 1% increase in the scale of higher vocational education students, total factor productivity increases by 3.4%. The partial regression coefficient for higher vocational education is slightly higher than that of medium vocational education, suggesting that the impact of higher vocational education on total factor productivity is greater than that of medium vocational education. This is because the country emphasizes the development of high-end manufacturing industries such as artificial intelligence, which requires higher skills and knowledge from higher vocational education talents, including a large number of professionals engaged in product technology research and development. Therefore, the increased demand for higher vocational education talents leads to the greatest promotion of total factor productivity.

When comparing control variables, the coefficient of Foreign Direct Investment (FDI) as a percentage is significantly associated with TFP growth at a 1% significance level. This indicates a positive correlation between the use of foreign capital and TFP growth, as an increase in the FDI ratio facilitates accelerated TFP growth and has a positive impact on TFP growth, consistent with existing conclusions. The coefficient of openness level (Open) is negative but not significant, suggesting that the proportion of import and export trade is not significantly related to TFP. This is slightly different from our prediction, and the analysis suggests that it may be because China's current imported goods are still mainly production materials, with insignificant technology spillover effects. On the other hand, exported goods are primarily labor-intensive and capital-intensive products, and the low-end structure of import and export trade does not have a significant impact on TFP growth. The level of industrial structure optimization (Industry) promotes TFP growth at a 5% significance level, indicating that through optimal allocation of factors and economic agglomeration, the optimization of industrial structure promotes the growth of total factor productivity.

Table 2. The Impact of Vocational Education on Total Factor Productivity

	MVET	*HVET*	*MVET*	*HVET*
variable	(1)	(2)	(3)	(4)
VET	0.055***	0.037***	0.032**	0.034**
	(0.055)	(0.089)	(0.057)	(0.083)
FDI			3.530***	3.482***
			(0.995)	(0.936)
Open			-0.113	-0.109
			(0.208)	(0.198)
Industry			0.229**	0.202**
			(0.448)	(0.446)

Constant	2.319***	2.362***	1.988***	2.028***
	(0.080)	(0.084)	(0.376)	(0.375)
Province fixed	yes	yes	yes	yes
Year fixed	yes	yes	yes	yes
R^2	0.8666	0.8664	0.8695	0.8697
N	465	465	449	449

Note. *,**,*** indicate significance levels at 10%, 5%, and 1%, respectively.

4.2 Regional Regression Analysis

We further examine the impact of vocational education on total factor productivity in different regions. In the eastern region, the coefficients for vocational education are all significantly positive at a 5% level, indicating that the growth of both medium and higher vocational education significantly promotes the improvement of total factor productivity in the eastern region. Comparing the partial regression coefficients, the coefficient for medium vocational education is 0.009, suggesting that for every 1% increase in the scale of medium vocational education students, total factor productivity increases by 0.9%. The coefficient for higher vocational education is 0.045, indicating that for every 1% increase in the scale of higher vocational education students, total factor productivity increases by 4.5%. The coefficient for higher vocational education is significantly higher than that of medium vocational education, implying that the impact of higher vocational education on total factor productivity is greater than that of medium vocational education. Possible reasons for this are as follows: the eastern region has a well-developed economy and abundant educational resources, which can cultivate the skill-based talents required by enterprises. In addition, the emerging service industries such as finance, accounting, intellectual property rights, and law, as well as the rapid development of high-end manufacturing industries in the eastern region, have high demands for skilled knowledge, resulting in a higher promoting effect of higher vocational education on total factor productivity compared to medium vocational education.

In the central region, the scale of both medium and higher vocational education does not have a significant impact on total factor productivity, indicating a phenomenon of stagnation in the central region. Upon further investigation, it can be found that although the scale of vocational education in the central region is slightly smaller than that in the eastern region, the level of economic development in the central provinces is limited, and the government's assistance policies are also limited. The per capita funding for vocational education students in the central region is much lower than that in the eastern and western regions. The overall level of faculty and vocational education development is not high, resulting in an insignificant effect on TFP growth.

In the western region, the coefficients for vocational education on total factor productivity are significantly positive at a 5% level. Comparing the partial regression coefficients, the coefficients for medium and higher vocational education are 0.009 and 0.045, respectively, indicating that for every 1%

increase in the scale of medium and higher vocational education students, total factor productivity increases by 0.9% and 4.5% respectively. Although the economy in the western region is underdeveloped, according to the data from the "China Statistical Yearbook," the total GDP in the western region from 2015 to 2020 was less than half of that in the eastern region. The lagging economic development level leads to difficulties in attracting enterprise investments and affects the employment of students. Vocational education development faces challenges. However, in recent years, the government has implemented various assistance policies, resulting in higher per capita funding in the western region compared to the central region. By receiving vocational education, individuals and families increase their income, and the poverty reduction effect is significant, improving the local economic development level. Therefore, in the western region, the scale of both medium and higher vocational education has a significant positive impact on total factor productivity.

Table 3. The Impact of Vocational Education on TFP in Different Regions

	Eastern areas		*Central areas*		*Western areas*	
variable	*MVET*	*HVET*	*MVET*	*HVET*	*MVET*	*HVET*
	(1)	(2)	(3)	(4)	(5)	(6)
VET	0.009**	0.045**	0.014	0.133	0.020**	0.223*
	(0.091)	(0.142)	(0.145)	(0.128)	(0.088)	(0.129)
FDI	5.656***	5.549***	4.628*	5.069**	4.804**	5.351**
	(1.802)	(1.829)	(2.800)	(2.219)	(2.160)	(2.195)
Open	-0.238	-0.253	-1.251	-1.055	-0.349	-0.352
	(0.257)	(0.231)	(0.984)	(1.133)	(0.267)	(0.245)
Industry	2.118*	2.140*	0.403**	0.532**	0.036*	0.096*
	(1.240)	(1.197)	(1.079)	(0.938)	(0.742)	(0.922)
Constant	0.475***	0.478***	1.256***	1.463***	2.309***	2.846***
	(0.985)	(0.949)	(0.401)	(0.539)	(0.401)	(0.539)
Province fixed	yes	yes	yes	yes	yes	yes
Year fixed	yes	yes	yes	yes	yes	yes
R^2	0.8604	0.8618	0.8979	0.8982	0.8912	0.8923
Observations	178	178	132	132	139	139

Note: *,**,*** indicate significance levels at 10%, 5%, and 1%, respectively.

4.3 Mediation Analysis

In the previous research, we found that vocational education primarily promotes TFP growth through two mechanisms: human capital accumulation and technological innovation. To examine these two mechanisms, we follow the approach of Wen Zhonglin and Liu Hongyun (Wen & Liu, 2020) and

construct a mediation analysis model to test the mechanisms. The model is as follows:

$$TFP_{it} = \beta_0 + \beta_1 VET_{it} + \beta_2 FDI_{it} + \beta_3 Open_{it} + \beta_4 industry_{it} + \eta_i + \gamma_t + \varepsilon_{it} \quad (2)$$

$$Human_{it} = \beta_0 + \beta_5 VET_{it} + \beta_2 FDI_{it} + \beta_3 Open_{it} + \beta_4 industry_{it} + \eta_i + \gamma_t + \varepsilon_{it} \quad (3)$$

$$TFP_{it} = \beta_0 + \beta_7 VET_{it} + \beta_8 Human_{it} + \beta_2 FDI_{it} + \beta_3 Open_{it} + \beta_4 industry_{it} + \eta_i + \gamma_t + \varepsilon_{it} \quad (4)$$

$$Innovation_{it} = \beta_0 + \beta_6 VET_{it} + \beta_2 FDI_{it} + \beta_3 Open_{it} + \beta_4 industry_{it} + \eta_i + \gamma_t + \varepsilon_{it} \quad (5)$$

$$TFP_{it} = \beta_0 + \beta_9 VET_{it} + \beta_{10} Innovation_{it} + \beta_2 FDI_{it} + \beta_3 Open_{it} + \beta_4 industry_{it} + \eta_i + \gamma_t + \varepsilon_{it} \quad (6)$$

Where “Human” represents the level of human capital and “Innovation” represents technological innovation. The meanings of other variables are consistent with Model (1). The coefficients represent the total effect of vocational education on TFP growth, represents the direct effect of vocational education on TFP growth, and represent the indirect effects of vocational education on TFP growth.

The regression results are shown in Table 4. The results in column (1) indicate that the scale of vocational education has a significant positive impact on TFP growth, with a 1% increase in vocational education promoting a 3.2% increase in TFP. Column (2) shows the regression results of the mediator variables, human capital and the scale of vocational education. The coefficient is significantly positive, indicating that a 1% increase in the scale of vocational education can significantly promote a 3.8% increase in human capital. Column (3) presents the regression results with the mediator variable (human capital) included, and both coefficients and are significant, indicating the presence of a partial mediation effect. This means that vocational education not only directly promotes TFP growth but also indirectly promotes it by improving the level of the workforce.

Column (4) shows the regression results of the mediator variables, technological innovation, and the scale of vocational education. The coefficient is significantly positive, indicating that a 1% increase in the scale of vocational education can significantly promote a 2.15% increase in technological innovation. Column (5) presents the regression results with the mediator variable (technological innovation) included, and all coefficients are significant, indicating the presence of a partial mediation effect. This means that vocational education not only directly promotes TFP improvement but also indirectly promotes it by enhancing technological innovation.

Table 4. Mediation Analysis

	TFP	*Human*	*TFP*	*Innovation*	*TFP*
variable	(1)	(2)	(3)	(4)	(5)
VET	0.032**	0.038**	0.037**	0.215***	0.066*
	(0.057)	(0.056)	(0.054)	(0.078)	(0.072)
Human			0.138*		
			(0.089)		

Innovation					0.149*
					(0.086)
FDI	3.530***	0.755***	3.426***	-0.568	3.397***
	(0.995)	(1.354)	(1.003)	(1.287)	(0.950)
Open	-0.113	-0.033	-0.117	-0.071	-0.099
	(0.208)	(0.127)	(0.202)	(0.105)	(0.193)
Industry	0.229	-0.798	0.118	-0.744	0.091
	(0.448)	(0.644)	(0.458)	(0.657)	(0.455)
Constant	1.988***	3.319***	3.555***	3.219***	3.698***
	(0.376)	(0.510)	(1.037)	(0.536)	(1.017)
Province fixed	yes	yes	yes	yes	yes
Year fixed	yes	yes	yes	yes	yes
R^2	0.8604	0.8618	0.8979	0.8912	0.8923
Observations	449	449	449	449	449

Note. *,**,*** indicate significance levels at 10%, 5%, and 1%, respectively.

5. Research Findings and Recommendations

With the high-quality development of the economy and the improvement of total factor productivity, China's vocational education has entered a new stage of connotation-based high-quality development, shifting its focus from pursuing scale expansion to emphasizing quality improvement. As a type of education closely linked to economic and social development in the education system, vocational education serves as a vital force in the development of the social economy and culture, and it is an important asset for accelerating the improvement of total factor productivity.

Based on the current status of higher vocational education and secondary vocational education in recent years, this article starts with the scale and empirically examines the growth effect and mechanism of vocational education on total factor productivity to reveal whether vocational education promotes China's high-quality economic development. It analyzes and predicts the index of total factor productivity and the scale status and development trends of vocational education, providing support for evaluating the policy of expanding vocational education enrollment and formulating the development strategy of vocational education.

By constructing a two-way fixed regression model and step-by-step testing the mediating effect model, the study verifies the effect and implementation mechanism of vocational education in promoting the growth of total factor productivity, bridging the research gap in the current academic community in terms of vocational education's hierarchical perspective and the impact of different structures on total factor productivity. It also provides decision-making reference for fully unleashing the positive effects of vocational education talents in improving total factor productivity and promoting China's high-quality economic development.

The empirical results indicate that there is a significant positive correlation between the development of vocational education and the improvement of total factor productivity, and the scale of vocational education can promote the improvement of total factor productivity. Comparing the partial regression coefficients of higher vocational education and secondary vocational education, it can be observed that in recent years, the expansion of the scale of higher vocational education has played a greater role in promoting the growth of total factor productivity, while the promotion effect of secondary vocational education on total factor productivity growth is relatively weaker. The impact of the scale of vocational education on total factor productivity varies regionally. Among them, vocational education has a significant effect on the total factor productivity of the eastern and western regions, but it is not significant in the central region, indicating a phenomenon of collapse in the central region. The empirical results of the mediating effect model show that vocational education mainly promotes the growth of total factor productivity through two paths: human capital level and technological innovation.

Based on these findings, the following policy recommendations are proposed: Moderately expand the scale and improve the vocational education training system to promote the growth of total factor productivity. Since 2019, the country has implemented the policy of expanding enrollment by one million, attracting individuals from different backgrounds and starting points to enter vocational colleges. In order to better meet the requirements of high-quality development, which involves the coupling coordination between the supply of high-skilled talents and regional industrial development, we should improve the vocational skills training system. Local governments should design localized training content based on the resources and platforms of local advantageous industries, provide various training subsidies and incentives for enterprises, and broaden the career space for the development of high-skilled talents. In addition, it is necessary to strengthen the popularization of policies such as the “1+X” certificate and establish a credit bank, facilitate vocational skill assessments and unified certification channels across regions, and cultivate a large number of high-quality skilled talents, leading the younger generation to pursue a path of skillful contribution with a craftsman spirit.

Increase support for vocational education and reduce regional disparities. Vocational education, especially secondary vocational education, has the characteristics of public goods and should be a priority area for financial support from the government. The financial department should formulate different funding systems based on provincial differences, improve school conditions, enhance the quality of education, and better supply a large number of high-quality skilled talents to regional industries, promoting regional economic development. Vocational colleges in the central and western regions should leverage the advantages of the “Belt and Road Initiative” and establish professional programs with local characteristics, strengthening the responsibilities of provincial and municipal governments in developing vocational education. Financial transfer payments for vocational education in rural areas and the central and western regions should be increased, and the interprovincial financial transfer payment system should be improved to ensure the implementation of policies, enabling

students from all regions to receive high-quality vocational education.

Promote the integration of industry and education in vocational education and increase the conversion rate of technological innovation. The fundamental way to improve total factor productivity is through technological innovation, which continuously drives economic growth in China through independent innovation. Technical workers play a crucial role in transforming potential productivity into actual productivity. Therefore, it is necessary to establish a talent cultivation model for technological and skill innovation that is guided by industry demands and deeply integrates industry and education. This model aims to enhance the adaptability of technical and skilled personnel to the needs of industrial development, improve the conversion rate of technological innovation, and promote sustainable economic growth. Firstly, vocational schools should create a favorable culture of innovation, advocating a spirit of daringto innovate and providing students with opportunities to engage in practical projects and industry collaborations. Secondly, closer partnerships between vocational schools and industries should be established, including internships, apprenticeships, and joint research and development projects, to ensure that the skills and knowledge taught in vocational education align with the needs of the labor market. Thirdly, continuous professional development programs should be implemented to support the upskilling and reskilling of vocational education teachers and instructors, enabling them to stay updated with the latest industry trends and technological advancements.

Strengthen regional coordination and collaboration in vocational education. Given the regional disparities in the impact of vocational education on total factor productivity, it is important to promote regional coordination and collaboration in vocational education. Regional cooperation can facilitate the sharing of educational resources, expertise, and best practices, leading to more efficient and effective vocational education systems. This can be achieved through the establishment of regional vocational education networks, the implementation of joint programs and initiatives, and the exchange of students and teachers between vocational schools in different regions. By leveraging the strengths of each region and promoting mutual learning, vocational education can be further enhanced, contributing to the overall improvement of total factor productivity in the country.

Conduct regular evaluation and monitoring of vocational education outcomes. To ensure the quality and effectiveness of vocational education, it is essential to establish a comprehensive evaluation and monitoring system. This system should assess various aspects of vocational education, including curriculum design, teaching quality, student performance, and employment outcomes. The evaluation results can serve as a basis for continuous improvement and policy adjustments. Additionally, regular monitoring of the labor market demands and trends can help identify emerging skill gaps and adjust vocational education programs accordingly, ensuring that graduates are equipped with the skills and knowledge needed in the evolving job market.

In conclusion, vocational education plays a significant role in promoting the growth of total factor productivity and contributing to China’s high-quality economic development. To fully realize the potential of vocational education, it is important to expand its scale, improve the training system,

reduce regional disparities, promote industry-education integration, strengthen regional coordination, and establish evaluation and monitoring mechanisms. By implementing these recommendations, China can further enhance the quality and effectiveness of vocational education, leading to a more skilled and productive workforce and sustainable economic growth.

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