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Human capital and productivity growth: A comparative analysis of Turkey*

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Abstract

This paper analyzes the role of human capital in productivity growth for a panel of around 50 countries from different levels of development, including Turkey. We particularly focus on the relevance of different quantitative measures of human capital in explaining productivity growth and a detailed examination of the case of the Turkish economy. The analysis covers the period 1981-2002 and the average years of education of the labor force and schooling rates for different education levels are proxy variables used for human capital. The initial year productivity level, physical investment, foreign direct investment, export intensity and the share of agricultural employment in total employment are other

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productivity growth explanatory variables considered in the study. Confirming the majority of other relevant studies, this study finds a positive contribution from human capital to productivity growth for the whole sample of countries considered. However, we find that this relation is not valid for the Turkish economy. Beside the quality dimension of human capital, the low level of human capital accumulation and lack of adequate environment conducive for both ordinary production and technological activities are regarded as possible explanations for this finding.

1. Introduction

Human capital in general and education in particular are among the most critical elements of modern economic and social structures. In many countries, resources allocated to education have reached 6% of national income, schooling rates for some education levels have increased to 100%, compulsory education have become a main element of national policies and education has been considered as the highest priority area in the allocation of public resources. Assuming that the ratio of total investment to national income is around 20% in developed and developing countries, expenditures on education correspond to 1/3 of total investment.

According to the estimates of Cohen and Soto (2001), average years of formal education of the labour force increased to 12.1 in high-income countries and 5.7 in low-income countries in 2000 as compared to 8.7 and 2.1, respectively, in 1960. Considering the average years of formal education of the labour force in high income countries, it is very interesting to note that this figure accounts for around 1/4 of the potential working period of 49 years calculated by the usual definition of the labour force, population aged between 15 and 64. The crucial importance of education in resource allocation becomes more evident if we take into account a variety of informal learning activities.

Compared to many other activities, the basic characteristic of education is that it is related to investment for the future of individuals, firms and societies. In this context, education plays a crucial role in the transformation of economic and social structures, and hence in an increase in the welfare of societies and quality of life. On the economic front, education lies at the center of increasing the rate of productivity growth, which is the fundamental source of economic growth and competitiveness.

In the 1980s, the Turkish economy experienced one of the main turning points in its development history. The inward looking growth strategy was replaced by an outward oriented growth strategy in which the focus of the policy agenda was shifted to enhancing competitiveness and to increase productivity with a view to attain a higher growth performance. However, the expected outcome has not materialized in most of the previous periods. Although the re-orientation of the growth strategy in line with market economy principles had structural impacts on many aspects of the economy, particularly in foreign trade, the growth and productivity effect of the strategy has largely been disappointing. The rate of capital accumulation slowed down, the employment creation capacity of the economy declined and, except in the second half of 1980s, the productivity and growth performance of the economy weakened (Saygılı *et al.* 2001; 2005). Consequently, the weakness in capital accumulation and productivity growth has formed a basis for the divergence of the per capita income of Turkey from developed countries in the 1990s and early 2000s.

As one of the core variables explaining productivity, human capital indicators in Turkey have displayed a mixed picture in the last three decades. Although some variables such as gross enrolment rates at different education levels and the average years of education of the labour force have improved considerably, indicators such as the share of total public education expenditure in GDP and student/teacher ratio at different education levels haven't shown any significant improvement. In 1970, gross enrolment rates in secondary and tertiary education were around 26 and 5, but increased to about 76 and 25, respectively, in the early 2000s. According to the data provided by Barro and Lee (2000), the average years of the labour force more than doubled between 1970 and 2000, and increased from 2.6 to 5.3 years. However, other indicators of human capital accumulation are mostly disappointing. The student/teacher ratios in secondary and tertiary education were 21.9 and 21.0 in 1975 and were 19,7 and 25 in 2002, respectively. The share of public education expenditure in GDP was around only 2.5 per cent in the early 1980s and hasn't shown any systematic improvement until the implementation of the 8-year compulsory education program in 1997, indicating that the rise in the enrolment rates was not accompanied by a rise in the allocation of resources to education. By the same token, the share of education expenditures in the consolidated public budget was 13.1 per cent in 1983, but declined to 11.4 per cent in 2002. Additionally, public

education expenditures have been mostly composed of current expenditures in which investment expenditures have accounted only for around 12 per cent of total expenditures. Naturally, the mixed picture of indicators on human capital accumulation on the one hand and the poor productivity performance of the economy on the other, raises a serious question on the relevance of human capital variables in explaining the growth process of the Turkish economy. There is no doubt that analyzing this issue will provide an important insight in designing policies for improving human capital and consequently for attaining a sustainable growth path.

This study analyzes empirically the validity of the human capital-productivity growth linkage for a panel of around 50 countries from different levels of development. The analysis covers the period 1981-2002 and uses the average years of education of the labour force and schooling rates for different education levels as proxies for human capital. In this context, we particularly explore the role of human capital in explaining the weak productivity performance of the Turkish economy. We assess the human capital-productivity growth linkage in the Turkish economy by comparing the estimates on the contribution of human capital to productivity growth for Turkey and for the rest of the countries in the analysis. In general, our findings support the importance of human capital in attaining a higher productivity growth for the whole sample of countries analyzed and also indicate that the poor productivity performance of the Turkish economy could be linked to a deficiency in improving human capital.

The remaining part of the paper is organized as follows. Section 2 summarizes the findings of recent theoretical and empirical works on human capital and growth. The estimation method and data are described in the following section. The empirical findings are presented in Section 4, and the conclusions are given in the final section.

2. Human capital and growth

Following the studies by Schultz (1963), Becker (1964), Nelson and Phelps (1966) and Mincer (1974), there have been an increasing number of researches on the nature of human capital and its role in development process. The introduction of endogenous growth theories in the economic growth literature in 1980s (e.g. Lucas (1988) and Romer (1990)) has intensified further the research interest on this topic.

In general, human capital is regarded as representing the productive capacity of individuals accumulated on the bases of a variety of formal and informal learning mechanisms. It is assumed to capture both the knowledge embodied in individuals and the capability of learning from others as well as adapting to changes in environment. In economic terms, human capital has been considered both as a separate input affecting output and an input contributing to the productivity of other inputs[1]. Notably, in the theoretical model proposed by Lucas (1988), it is the positive externalities coming from the accumulation of human capital that brings the endogenous growth. In this model, there are two different effects from human capital on output or productivity. The first is the internal effect, which is linked to an individual's skill level (human capital) and contributes only to her/his own productivity. The second is the external effect representing externalities from human capital, which is linked to exchanges of information or knowledge between individuals. The essence of external effects is that if the average level of human capital is high, the incidence of learning from others will be higher, and it is likely that there will be greater productivity gains to be derived from exchanging ideas. Consequently, the external effects from the average level of human capital forms the basis for increasing returns in the aggregate production function by contributing to the productivity of traditional factors of production, namely capital stock and effective labour.

At the macroeconomic level, there are numerous studies investigating empirically returns from human capital on economic development. In the remaining part of this section, we briefly present the results of some recent empirical studies on this topic. These studies can be grouped into two broad categories, namely convergence models and human capital models. They generally found a strong relation between human capital and productivity and/or economic growth.

The testing of the convergence theory with reference to human capital forms a remarkable part of the economic growth literature. The theory asserts that improvement in human capital is one of the

[1] There is no doubt that the benefits of human capital are not restricted to economic objectives. At the social dimension, human capital could be regarded as an effective instrument in transforming social structures and improving the quality of life. To be more specific, it could be used as an effective tool to fight poverty, improve distribution of income, ensure social cohesion, attain political stability, preserve the environment, etc.

prerequisites for low-income countries to converge to the per capita income levels of developed countries. Empirical studies on this topic generally support the theory. For a long time ago, Nelson and Phelps (1966) found that human capital plays a critical role in decreasing the technology gap between poor and rich economies. In parallel to this approach, the study by Benhabib and Spiegel (1994) contributes significantly to the literature. They have reached three important results. Firstly, differences in human capital levels lead to different growth performances across countries. Secondly, the laggard countries may converge to the leader country in proportion to their human capital stock. Finally, being a leader country in terms of technology is conditional on having the highest level of human capital stock.

Recently, Papageorgiou (2003) examines the same issue by focusing on the growth rate of human capital rather than the level of human capital. The empirical results of the study acknowledge the role of human capital in increasing the domestic technological innovative capacity that can only be valid for developed countries. Moreover, it is found that human capital provides an opportunity to close the technology gap for developing countries. Beside these results, it is found that the domination of low-skilled profiles of labour force in less developed countries results in low value-added production structures.

Another line of research on human capital-economic growth linkage is the human capital models. In essence, although the convergence models focus on the role of human capital in the catch-up process, the human capital models concentrate on the relevance of human capital measures, such as schooling rates at different education levels and average years of education of the labour force, in explaining the economic growth process. It is hardly worth mentioning that the difference between these two models is negligible and it is often very difficult to categorize empirical studies under these groups. In the following part of this section, we report the main findings of four recent empirical studies utilizing human capital models.

Wolff (2001) empirically tests the relation between productivity growth and schooling levels for 24 OECD countries in the period 1950-1990. He finds that though the coefficients of the variables of enrolment rates for primary and secondary education have the expected signs, they are not statistically significant. On the other hand, he estimates that the enrolment ratio for tertiary education contributes significantly to productivity growth.

Petrakis and Stamakis (2002) use alternative human capital indicators in order to analyze the growth performances of countries at different levels of development. They conclude that development levels of countries associate positively with human capital stocks. More specifically, it is empirically observed that primary and secondary education play a significant role in the determination of economic growth in less developed countries, whereas tertiary education is more vital than the pre-tertiary education in the case of developed economies. It is worthy of note that this empirical result is also supported by many other studies (McMahon, 1998; Kiso, 1993; Esim, 1994; Barro and Sala-i-Martin, 1995; Mankiw *et al.*, 1992; Psacharopoulos, 1994; Cohn and Addison, 1998).

Agiomirgianakis *et al.* (2002) examine the contribution of schooling rates to economic growth for a sample of 93 countries by employing a dynamic panel analysis. The estimation results indicate that there is a positive correlation between education and economic growth. But, more importantly, it is found that the higher the level of education, the higher is the contribution from education on economic growth.

Lau *et al.* (1991) examine the role of education in economic growth in developing countries. The analysis covers 58 countries from 5 different regions (East Asia, South Asia, Africa, Latin America, Middle East and North Africa (MENA)) and uses different human capital indicators. In general, the study asserts that there are significant differences among regions in the context of the role of education on economic growth. It is found that the average years of primary education plays a key role for African and East Asian countries. It is also estimated that the average years of secondary schooling is important for all regions in the analyses. The average years of schooling are found as significantly positive in explaining economic growth, except for Africa and South Asia regions. Another human capital indicator, the interaction term between average years of primary and tertiary education levels, is estimated as significantly contributing to economic growth in South Asia and MENA regions.

Beside cross-country analyses, studies focusing on individual countries provide fruitful insight in understanding human capital and growth linkage. At this point, it is worth to emphasize the results of some studies on an Asian miracle country, namely Taiwan.

Lin (2004) analyzes the effect of tertiary education on the Taiwanese economy. The number of people who graduated from tertiary education and the share of this group in total employment are

considered as representing tertiary education. The analyses are carried out at both aggregate economy and sectoral levels, and lead to the conclusion that tertiary education plays a crucial role both in attaining a higher growth rate and in the structural transformation of the economy. Lin (2003) also examines the relation between education and technological progress in Taiwan, and finds a strong relationship among these variables. In addition, a previous study by Armer and Liu (1993) estimates that there is a powerful relation between the growth rate of the Taiwanese economy and the human capital stock calculated by using the number of graduates from different education levels. Finally, Lee *et al.* (1994) investigate the role of education and technical change in the growth performance of South Korea and Taiwan. They find that while technological progress plays a significant role in South Korea's economic development, educational attainment was the main driving force of Taiwan's economic performance.

There are a limited number of empirical studies focusing on the linkage between human capital and economic growth for the Turkish economy. The first group of these studies explores the linkage by analyzing the relationship between education and wages on the basis of micro-level data (e.g. Tansel (1999) and Sarı (2002)). The second group uses sectoral or industry level data and tests the significance of a number of human capital indicators on output growth or productivity. Among these studies, Güngör (1994) examines the role of education on industrial economic growth for 67 provinces in Turkey by employing a production function. Estimation results indicate that educational attainment of the workers employed in industry has a positive and significant effect on industrial output in the period 1980-90. Taymaz (2001) analyses the determinants of technical change for 79 industrial sectors in the period of 1987-97 and uses the share of technical personnel (engineers and technicians) in employment as an explanatory variable. His analysis shows that this indicator of human capital contributes significantly to the rate of technical change. Using the same indicator of human capital, Saygılı (1998) estimates that human capital contributes significantly only to the technical change component of total factor productivity growth at the manufacturing industry sectors in the period 1985-1993. Moreover, he also finds that the human capital-productivity growth linkage is valid only for high technology industries.

3. Data and estimation method

Our analysis uses panel data for 48 countries from different levels of development to evaluate the relevance of the human capital variable in explaining the productivity growth performance in the last two decades (see Table A1 in appendix for the list of countries). Due to data constraint, we focus only on quantitative measures of human capital. The average years of education of the labour force and schooling rates for different education levels are used as proxy variables for human capital. We also use, the initial year per capita income level, domestic investment, foreign direct investment, export intensity and the share of agricultural employment in total employment as the control variables.

The sample period of the analysis changes depending on the human capital variable used. It is 1981-2000 in the case of average years of education of the labour force and is 1982-2002 in the case of schooling rates. In the analyses, we split time periods into sub-periods and use the simple averages of the variables in the respective sub-periods. The sub-periods are 1981-1985, 1986-1990, 1991-1995 and 1996-2000 for the average years of education of the labour force variable, and 1982-1988, 1989-1995 and 1996-2002 for the schooling rates variable. There are two main advantages in using sub-periods in the analysis. Firstly, it is reasonable to expect that the effects of policy shifts, such as improvements in human capital, on productivity improvements would only be observable within a sufficiently long period of time (e.g. 5 years), rather than in consecutive years. Secondly, it is expected to reduce statistical problems, especially of autocorrelation.

Another point needing to be mentioned is that using of schooling rates in explaining productivity growth requires consideration of time lags between graduation date and date of participation to the labour force. Due to the limitation imposed by data, we had to make a general assumption regarding time lags. It is assumed that, except for tertiary education, individuals participate to the labour force when they are 15 years old. In addition, the calculation of time lags necessitates an assumption on graduation dates. In this respect, we assumed that the median of starting and graduation ages of the corresponding education levels is the mean graduation year. Under these assumptions, we use 4 years for primary, 2 years for secondary and 4 years for tertiary education levels as the time lags in the analysis. For pre-primary education level, the availability of data forced us to assume 7 years as the time lag.

Data used in the analysis were compiled from different sources. The average years of education of the labour force data come from Barro and Lee (2000) and data on schooling rates were mainly taken from UNESCO Education Database and supplemented with the World Bank's World Development Indicators 2004 (WDI) data on education and national data sources[2,3]. We used WDI database for other variables in the analysis. Definitions and the basic characteristics of these variables are briefly described below (see Table A2 and Table A3 in appendix for summary statistics of variables).

Productivity Growth (YLF): The percentage rate of growth in national income per labour force. This is the dependent variable of our models and could be termed as a measure of partial productivity growth. Gross Domestic Product (GDP) in 1995 US Dollar prices is used as the measure of national income.

Convergence Term (YLFBAZ): The initial year income per labour force level. For each sub-period, we calculate a separate *YLFBAZ* indicator. This variable has frequently been used in the empirical growth literature and stands for the rate of convergence in the partial productivity levels (Barro, 1991;1997; Barro and Sala-i-Martin, 1995; Mankiw *et al.,* 1992). The coefficient on this variable is expected to have a negative sign and to reflect technological diffusion from advanced countries to other countries.

Domestic Investment (INV): The percentage share of total investment in GDP. It excludes foreign direct investment and is assumed to represent investment financed from domestic resources. The level of investment is one of the main factors contributing to increases in the productive capacity of a country (De Long and Summers, 1992; Levine and Renelt, 1992). It is generally regarded that physical investment is one of the prime instruments in diffusing new technologies in the form of embodied technological progress, enables benefiting from various learning mechanisms, and is the main factor in achieving economies of scale.

Foreign Direct Investment (FDI): The percentage share of FDI in GDP. In the literature, FDI is considered as an important tool for the diffusion of technology across countries (Romer, 1993; Coe and Helpman, 1995). More specifically, aside contributing to the capital

[2] For a limited number of countries data on schooling rates, especially of pre-primary education, were unavailable for some years. If this is the case, we referred to other data sources. In the case of unavailability of data from other sources, we interpolate the missing data by taking into account the long-term trend of the available data.

[3] We use gross enrolment rates for education levels owing to the limitation of data.

stock of a country, it is expected that, foreign firms bring their organizational structures, knowledge and experiences to the home country. Moreover, it is thought that increases in FDI are associated with increases in competitive pressures in domestic market.

Export Intensity (X): The percentage share of total exports of goods and services in GDP. It is expected that export intensity contributes to productivity growth through a finer division of labour, increases in competition pressure and market scale, learning from abroad, etc. Previous studies find that outward orientation is associated with a faster economic growth (Dollar, 1992; Sachs and Warner, 1995; Romer and Rivera-Batiz, 1991). Moreover, there also studies showing a significant correlation between export orientation and technological change (Stern and Porter, 2000).

Agricultural Employment (AGRL): The percentage share of agricultural employment in total employment. The reallocation of resources from sectors with low productivity to sectors with high productivity can contribute to growth in a country by increasing efficiency in resource use. Previous studies show that, there has been a substantial transfer of labour from agriculture initially into industry and then into services sector in the development process of countries (McCombie and Thirlwall, 1994; Maddison, 1991). In that respect, the coefficient of this variable is expected to be negative and reflects structural differences across countries and efficiency problems originating from the agricultural sector.

Notations used for human capital variables in the analysis are as follows: The Average Years of Education of the Labour Force: *EDUYEAR*; Pre-primary School Gross Enrolment Rate: *ENPRE*; Primary School Gross Enrolment Rate: *ENPRI*; Secondary School Gross Enrolment Rate: *ENSEC*; Tertiary School Gross Enrolment Rate: *ENTER*.

Although the majority of previous studies on growth and/or productivity analysis employed cross-sectional analysis, we apply fixed-effects panel data analyses as the econometric technique.[4] As compared to a cross-sectional analysis, using fixed-effects panel data model yields a number of advantages. Three of these are worth

[4] We also applied the random effects model for our analysis. However, estimation results did not give statistically reliable results. This probably comes from the nature of fixed-effects and random effects models. Contrary to the random effects model, the country-specific term is assumed to be correlated with the explanatory variables in the fixed effects model, which is intuitively more realistic in explaining growth or productivity dynamics.

mentioning. First, it makes possible to account for country-specific time-invarying factors or structural differences across countries, which are statistically difficult to measure. Secondly, it uses more observation or information on countries, and hence would lead to more efficient estimates. Thirdly, it enables to analyze behavioral relations by utilizing two dimensions, namely time and location/country, instead of one.

The productivity growth equations to be estimated is stated as follows:

$$YLF_{i,t}=\alpha_i-\beta_1 \log(YLFBAZ_{i,t})+\beta_2 INV_{i,t}+\beta_3 FDI_{i,t}+\beta_4 X_{i,t}-\beta_5 AGRL_{i,t}+\gamma_1 EDUYEAR_{i,t}+u_{i,t} \quad (1)$$

$$YLF_{i,t}=\alpha_i-\beta_1 \log(YLFBAZ_{i,t})+\beta_2 INV_{i,t}+\beta_3 FDI_{i,t}+\beta_4 X_{i,t}-\beta_5 AGRL_{i,t}+\gamma_2 EDUYEAR_{R,i,t}+\gamma 3 EDUYEARTUR_{,,t}+w_{i,t} \quad (2)$$

In equation (1), i indexes countries (i= 1,…,48), t denotes time periods (t= 1, …,4), α captures country-specific time-invariant factors, *β*'s represent coefficients of respective explanatory variables, γ_1 stands for the elasticity of productivity growth with respect to the variable *EDUYEAR* and *u* and *w* are the usual disturbance terms. In equation (2), we define two education variables, the first for countries except Turkey ($EDUYEAR_R$), and the second for Turkey ($EDUYEAR_{TUR}$). In this respect, γ_2 stands for productivity growth elasticity of education variable for countries excluding Turkey, and γ_3 stands for that of Turkey. Consequently, equation (1) is specified for analyzing the effect of human capital on productivity growth for all countries in this study, and equation (2) is specified for examining the effect of human capital on productivity growth both for Turkey and for the rest of countries, separately. Therefore, by comparing γ_2 and γ_3, we expect to assess the relative effectiveness of human capital in Turkey in explaining productivity growth. Note that we also use enrolment rates for different education levels as a proxy for human capital, and each human capital variable enters equations separately. In the case of enrolment rates, the number of countries declines to 47 and the number of time periods decreases to 3 as defined before.

Finally, it should be emphasized that the models specified above are consistent with the conditional convergence or catch-up models as well as the human capital models discussed briefly in section 2. In essence, these two types of growth models utilize similar variables in

explaining growth process but differ in terms of interpretation of estimation results[5].

4. Estimation results

The OLS estimations of equations (1) and (2) above are given in Table 1 and Table 2 below. The proxy variable for human capital is the average years of education of the labour force in Table 1 and is enrolment rates in Table 2. In order to assess the contribution of human capital to productivity growth more clearly and to detect the degree of the problem of multicollinearity, first we estimate the equation without including any human capital variable (basic model) and then re-estimate the equation by including a human capital variable into the equation.

Model 1 in Table 1 presents the basic specification in which the human capital variable is excluded from the model. It should be noted that coefficients of all productivity growth explanatory variables have the expected sign and are statistically significant. The coefficient of variable YLFBAZ shows a convergence in productivity levels which means that the lower the level of productivity in the beginning of the period, the higher the rate of productivity growth.

Estimates on the investment variables, both domestic (INV) and foreign direct investment (FDI), indicate that the investment/output ratio is positively related to productivity growth. The comparison of coefficients of these variables shows that marginal return to FDI is considerably higher than that of domestic investment. This finding has at least two interpretations. First, it may reveal that FDI is more productive due to its technological and organizational advantages. Second, it may also suggest that FDI has an advantage of allocating its resources to more productive/profitable activities especially in the forms of merging with or acquisitions of more efficient domestic firms.

The sign of the coefficient of variable X reveals that exports enable countries to attain a higher rate of productivity growth. This may mainly come from benefits from specialization, economies of scale, learning from other countries and an increase in competitive pressures. It should be noted that, in addition to export intensity, we also estimated the basic model by including an openness variable defined as the ratio of total of exports and imports to national income. Estimates on this variable also showed the benefits of integrating to

[5] See Wolff (2001) for the comparison of these models.

Table 1
Estimates of the Productivity Growth Equation
(Average Years of Education of the Labour Force is the Human Capital Variable)

Explanatory Variables	Model 1	Model 2	Model 3
YLFBAZ	-0.083 [a] *(-6.85)*	-0.086 [a] *(-6.97)*	-0.088 [a] *(-7.15)*
INV	0.215 [a] *(4.23)*	0.233 [a] *(4.50)*	0.273 [a] *(5.47)*
FDI	0.442 [a] *(6.72)*	0.444 [a] *(7.01)*	0.468 [a] *(7.58)*
X	0.065 [a] *(2.92)*	0.057 [a] *(2.61)*	0.056 [b] *(2.59)*
AGRL	-0.095 [a] *(-4.15)*	-0.064 [a] *(-2.85)*	-0.058 [b] *(-2.50)*
EDUYEAR	---	0.043 [b] *(2.23)*	---
$EDUYEAR_R$	---	---	0.076 [a] *(3.31)*
$EDUYEAR_{TUR}$	---	---	-0.102 [a] *(-3.84)*
Summary Statistics			
R^2	0.683	0.692	0.707
Adjusted R^2	0.549	0.558	0.577
F Statistic	65.1	53.8	47.9
F Statistic's P-Value	0.000001	0.000001	0.000001
Number of Obs.	173	173	173

Notes: 1) All equations include a constant country-specific term. White-Heteroscedasticity consistent t-ratios are in parentheses.
2) a denotes significant coefficients at 1% level, b denotes significant coefficients at 5% level.
3) Only the variables representing mean years of education of labour force and the convergence term (YLFBAZ) are in logarithmic forms.
4) Since variables are either logarithmic forms or expressed in percentage terms, the coefficients of the explanatory variables should be interpreted as elasticity.

the world markets. However, due to a close relationship between openness and FDI variables, we preferred to report estimation results only on the export intensity variable.

The coefficient of the variable AGRL shows that the allocation of labour from agriculture to other sectors, namely industry and services, contributes to productivity growth. This expected relation probably reflects the inefficient use of labour in agriculture.

As the second step of the analysis, a human capital variable (*EDUYEAR*) is included in the model (Model 2). The variable has the expected sign and is statistically significant. It shows that an increase in the average years of education of the labour force positively contributes to productivity growth. The magnitude of the coefficient of this variable can be interpreted as a one per cent increase in the average years of education of the labour force leads to around 4 per cent increase in productivity growth. It is worthy of note that our estimate on this variable is very similar those of many previous studies (Benhabib and Spiegel, 1994; Papageorgiou, 2003).

We estimated Model 3 in order to assess the relation between human capital and productivity growth for the Turkish economy. Estimation results denote that the coefficient of the education variable is significantly negative for Turkey, whereas it is significantly positive for the rest of countries. This finding shows that human capital has not contributed to productivity growth in the Turkish economy in contrast to other countries in the analysis, on the average. In other words, our estimation results reveal that Turkey hasn't been able to benefit from the productivity growth enhancing effect of increases in quantitative measures of human capital.

Estimates of the productivity growth equation, in which enrolment rates for different education levels are representing human capital, are presented in Table 2. First of all, it should be noted that estimation results on control variables are in line with estimates presented in Table 1. Differences in the magnitude of the coefficients of variables come mainly from the coverage of the time period and using different sub-periods. More specifically, the models in Table 1 cover the period 1981-2000 and involve four sub-periods, but models in Table 2 cover the period 1982-2002 and involve three sub-periods.

Table 2
Estimates of the Productivity Growth Equation
(Enrolment Rates are the Human Capital Variable)

	Model 1	Model 2	Model 3	Model 4	Model 5
YLFBAZ	-0.074 [a] *(-6.11)*	-0.076 [a] *(-5.90)*	-0.075 [a] *(-5.85)*	-0.074 [a] *(-6.09)*	-0.074 [a] *(-6.04)*
INV	0.178 [a] *(2.84)*	0.182 [a] *(2.87)*	0.193 [a] *(3.02)*	0.186 [a] *(2.93)*	0.192 [a] *(2.99)*
FDI	0.334 [a] *(4.70)*	0.337 [a] *(4.68)*	0.344 [a] *(4.74)*	0.333 [a] *(4.70)*	0.339 [a] *(4.74)*
X	0.061 [a] *(2.82)*	0.059 [a] *(2.68)*	0.061 [b] *(2.14)*	0.061 [a] *(2.78)*	0.060 [a] *(2.72)*
AGRL	-0.062 [b] *(-2.31)*	-0.057 [b] *(-2.04)*	-0.061 [b] *(-2.14)*	-0.063 [b] *(-2.32)*	-0.063 [b] *(-2.31)*
ENPRE	---	0.012 *(0.97)*	---	---	---
$ENPRE_R$	---	---	0.011 *(0.89)*	---	---
$ENPRE_{TUR}$	---	---	-0.504[a] (*-5.26*)	---	---
ENPRI	---	---	---	0.020 *(0.59)*	---
$ENPRI_R$	---	---	---	---	0.023 *(0.67)*
$ENPRI_{TUR}$	---	---	---	---	-0.339 *(1.07)*
			Summary Statistics		
R^2	0.783	0.782	0.788	0.781	0.783
Adjusted R^2	0.646	0.641	0.645	0.639	0.637
F Statistic	74.1	57.5	48.9	57.2	47.4
F Stat. P-Value	0.000001	0.000001	0.000001	0.000001	0.000001
Num. Of Obs.	135	133	133	133	133

Notes: 1) All equations include a constant country-specific term. White-Heteroscedasticity consistent t-ratios are in parentheses.
2) a denotes significant coefficients at 1% level, b denotes significant coefficients at 5% level, and c denotes significant coefficients at 10% level.
3) Only the variable representing the convergence term (YLFBAZ) is in logarithmic form.
4) Since variables are either logarithmic forms or expressed in percentage terms, the coefficients of the explanatory variables should be interpreted as elasticity.

Table 2 (continued)

Explanatory Variables	Model 7	Model 8	Model 9	Model 10
YLFBAZ	-0.078 (-6.25)[a]	-0.078 [a] *(-6.26)*	-0.083 (-6.02)[a]	-0.084 [a] *(-6.05)*
INV	0.195 [a] *(3.01)*	0.206 [a] *(3.18)*	0.219 [a] *(3.42)*	0.231 [a] *(3.61)*
FDI	0.323 [a] *(4.57)*	0.325 [a] *(4.59)*	0.303 [a] *(4.76)*	0.306 [a] *(4.80)*
X	0.062 [a] *(2.87)*	0.065 [a] *(2.92)*	0.062 [a] *(2.97)*	0.064 [a] *(3.00)*
AGRL	-0.053 [c] *(-1.83)*	-0.056 [c] *(-1.86)*	-0.051 [b] *(-2.02)*	-0.055 [b] *(-2.11)*
ENSEC	0.019 [b] *(2.07)*	---	---	---
$ENSEC_R$	---	0.022 [b] *(2.45)*	---	---
$ENSEC_{TUR}$	---	-0.101[a] (-3.37)	---	---
ENTER	---	---	0.055 [a] *(3.93)*	---
$ENTER_R$	---	---	---	0.058 [a] *(4.24)*
$ENTER_{TUR}$	---	---	---	-0.173 [a] *(-3.13)*
		Summary Statistics		
R^2	0.785	0.791	0.799	0.805
Adjusted R^2	0.645	0.651	0.668	0.675
F Statistic	58.5	49.8	63.4	54.5
F Statistic's P-Value	0.000001	0.000001	0.000001	0.000001
Number of Obs.	133	133	133	133

Notes: 1) All equations include a constant country-specific term. White-Heteroscedasticity consistent t-ratios are in parentheses.

2) a denotes significant coefficients at 1% level, b denotes significant coefficients at 5% level, and c denotes significant coefficients at 10% level.

3) Only the variable representing the convergence term (YLFBAZ) is in logarithmic form.

4) Since variables are either logarithmic forms or expressed in percentage terms, the coefficients of the explanatory variables should be interpreted as elasticity.

Regarding human capital variables, estimation results reveal that secondary school (ENSEC) and tertiary school (ENTER) enrolment rates are positively and significantly correlated with the rate of productivity growth. Estimates on the coefficients of pre-primary (ENPRI) and primary education (PRI) variables have expected signs but do not significantly differ from zero. Except pre-primary education, our results are in parallel with previous studies (e.g. Barro and Sala-i-Martin (1995), Wolff (2001))[6]. Furthermore, confirming the study by Agiomirgianakis *et al.* (2002), estimation results indicate that the higher the level of education, the higher is the contribution from education to economic growth. Beside, it is worth noting that data on tertiary education shows relatively high and increasing dispersion across countries (Table 3). This means that some countries, especially developed ones, have increasingly been focusing on improving tertiary education activities.

We think that estimation results on pre-primary and primary education need clarifications. First, concerning pre-primary education, this level of education is not an education category in the traditional sense. It is hard to think that a person in the labour force has completed only the pre-primary program. Basically, this education program forms the basis for further education programs. Therefore, rather than analyzing solely the direct effect of pre-primary school enrolment rates on productivity, it would be more meaningful to explore the indirect effects of this education level via interactions with subsequent education programs. We have carried out a simple exercise to account for this possibility by including a variable representing the interaction between enrolment rates in pre-primary and tertiary education levels. The variable was defined as the product of these two enrolment rates by taking into account lag structures. It should be noted that the coefficient of the interaction term is significant with a positive sign, indicating the existence of a complementary relation between these two education programs. Furthermore, the magnitude of the coefficient of the interaction term is bigger than that of tertiary education reflecting positive contributions from pre-primary education on tertiary education in increasing the rate of productivity growth (Saygılı *et al.*, 2005). Secondly, it should also be underlined that, the determination of the time lag structure for this variable was very difficult and the limitation of data forced us to make a very rough assumption, that is 7 years. Consequently, our likely failure in using

[6] To our knowledge, there is no previous study analyzing the relation between pre-primary education and growth or productivity at the macro level.

the correct lag structure might be responsible for the weak estimation results on the pre-primary education variable.

Weak estimation results on primary education might be related to a very low variation in this variable (see Table 3). The analysis of raw data shows that enrolment rates at this level have reached 100% for many countries several years ago. Therefore, it can be said that enrolment rate at primary education might have lost its relevance for being used as a proxy for human capital differences across countries in explaining differences in the rate of productivity growth, especially for developed countries. Moreover, it should be noted that, we use gross enrolments rates in the analyses. Using gross enrolment rates may lead to overestimation of enrolment rates, particularly for primary education, and hence biased estimation results.

Turning to the main objective of the study, as in the case of the previous analysis, we estimate the productivity growth model (equation 2) in order to assess the human capital and productivity growth relation for the Turkish economy. Estimation results are in line with previous estimates that there is no expected human capital-productivity growth relation in Turkey as opposed to other countries in the analysis, on the average. In other words, estimation results on both of our human capital proxy variables consistently show that quantitative increases in human capital have not translated into productivity gains in Turkey. In the case of average years of education of the labour force, the coefficient of this variable ($EDUYEAR_R$) is 0.076 whereas it is -0.10 for the variable ($EDUYEAR_{TUR}$) representing Turkey. Estimates on enrolment rates indicate that the productivity growth elasticity of secondary education and tertiary education enrolment rates are around -0.10 and -0.17 for Turkey as compared to 0.022 and 0.058 for the rest of countries, respectively. Furthermore, the estimates on pre-primary and primary education variables cast serious doubts on the relevance of these education categories in attaining a higher productivity growth in the Turkish economy. Possible explanations for these unexpected results will be given in the conclusion section.

Table 3
Enrolment Rates by Levels of Education (%)

	1970	1975	1980	1985	1990	1995	2000
Pre-primary							
Turkey	---	0.1	0.5	5.0	4.7	7.3	6.1
Other Countries (simple average)	29.9	43.5	49.8	56.3	60.3	65.0	73.4
Standard Deviation (all countries)	30.4	33.8	33.2	32.9	30.1	30.6	29.7
Primary							
Turkey	107.5	107.6	96.4	113.3	99.1	106.7	91.9
Other Countries (simple average)	98.9	99.6	100.7	102.8	103.0	104.4	105.7
Standard Deviation (all countries)	13.3	11.0	9.7	10.9	9.0	9.3	9.5
Secondary							
Turkey	26.0	29.5	34.6	41.6	47.3	57.0	73.3
Other Countries (simple average)	54.7	62.2	69.3	75.8	79.4	91.3	98.2
Standard Deviation (all countries)	25.3	24.6	24.9	23.5	23.3	27.8	25.5
Tertiary							
Turkey	5.0	7.8	5.4	8.9	13.1	19.5	23.8
Other Countries (simple average)	12.7	17.0	19.7	22.8	27.9	35.3	43.8
Standard Deviation (all countries)	10.3	11.4	12.2	14.0	17.6	20.4	20.7

Source: Our calculations based on UNESCO (2005)
Note: Other Countries group includes 46 Countries for pre-primary education level. In case of other education categories, there are 47 countries in this group. The averages are computed by using available data in respective time periods.

In addition to the results of empirical analyses, it should be noted that raw data on human capital variables and productivity growth do not indicate a positive relation between these two variables for the Turkish economy. For this purpose, developments in the relative enrolment rates and productivity level of Turkey are presented in Table 4. Turkey's relative performance in the average years of education of the labour force is given in Table 5. These tables reveal clearly that Turkey has experienced a relatively high rate of increase in both measures of human capital, but she has been unsuccessful on the productivity growth front.

Table 4
Productivity and Schooling Performance of Turkey (%)

	1975	1980	1985	1990	1995	2000
Relative Enrolment Rates						
Pre-primary	0.2	1.0	8.9	7.8	11.2	8.3
Primary	108.0	95.7	110.2	96.2	102.2	86.9
Secondary	47.4	49.9	54.9	59.6	62.4	74.6
Tertiary	45.9	27.4	39.0	47.0	55.2	54.3
Relative Productivity Level	37.4	35.3	38.0	40.9	39.0	36.6

Source: Our calculations based on UNESCO (2005) and the World Bank (2005)

Table 5
Average Years of Education of the Labour Force

	1985	1990	1995	2000	Rate of Change Per Year in 1985-2000 (%)
Turkey	3,69	4,15	5,12	5,29	2,43
Other Countries (simple average)	7,16	7,78	8,11	8,40	1,07
Turkey/Other Countries	*51,5*	*53,4*	*63,1*	*63,0*	---

Source: Our calculations based on Barro and Lee (2000).

Finally, it would be useful to summarize the other main findings of our analysis. First, the inclusion of human capital variables in the basic models affects the magnitude of the coefficients of other (control) variables. The increase in the coefficient of the convergence term means that the rate of convergence is higher when the effect of

human capital is controlled. This finding supports the arguments of conditional convergence stating that the rate of convergence to the productivity levels of developed countries is higher if we take into account the human capital factor. Controlling the effect of human capital increases the coefficient of domestic investment variable, indicating that human capital makes physical investment more productive. The inclusion of the human capital variable in the productivity growth equation is associated with an increase in the coefficient of the variable AGRL, which may reveal that inefficiency in agriculture could be related to weak human capital in this sector, at least to some extent. Estimates on the coefficient of FDI and export intensity variables do not give any clear and consistent indication in this respect.

5. Conclusion

Our findings support the findings of a majority of other relevant studies that human capital contributes significantly to productivity growth. Moreover, we estimated that the productivity growth enhancing effects of education are higher for higher education levels. For the remaining explanatory variables of the analysis, we found that investments, both domestic investment and FDI, export intensity and allocation of labour from agriculture to other sectors play an important role in attaining a higher rate of productivity growth. We also estimated a convergence in productivity level across countries. More importantly, it is found that contribution from these factors on productivity growth is higher when the human capital factor is controlled.

Regarding Turkey, we estimated that although Turkey has experienced a very high rate of increase in our quantitative measures of human capital, she has been unsuccessful in realizing the productivity enhancing effect of this improvement. In this context, beside the usual problem of the quality of data, there are at least three explanations for this phenomenon.

Firstly, although Turkey performed well in terms of quantity measures of human capital, the available data show that she ignored the quality dimension of human capital. A rough measure for the quality of human capital taken from UNESCO (2005), the number of students per teacher, clearly indicates that a high rate of increase in enrolment rates has not coincided with an improvement in this indicator. For example, the number of students per teacher at secondary education was 21.1 in 1985 but, with only a marginal

improvement, declined to 19.7 in 2002. At tertiary education, it was 20.5 in 1985, but increased to 25.0 in 2002. Two successful countries of Asia, namely Japan and S. Korea, have exhibited a rather different and better performance. In Japan, the student/teacher ratio at secondary education was 17.5 in 1985, but declined to 13 in 2002. In the same period, this ratio declined from 9.6 to 8.0 at tertiary education. S. Korea experienced a very high performance in the same period. At secondary education, the ratio declined to 18 from 35, and at tertiary education it decreased to 20 from 42. Following these observations, it can be said that increases in the enrolment rates have not been accompanied sufficiently by a rise in the allocation of resources to education in Turkey.

The second explanation is that even though Turkey exhibited a relatively high performance in increasing schooling rates and the average education years of the labour force, she might have been suffering from being below some critical threshold level in terms of these indicators. As Table 4 in the previous section depicts, schooling rates in secondary and tertiary education in Turkey correspond only to 74.6% and 54.3% of the average of other countries in the analysis in 2000. Similarly, as Table 5 shows, the average years of education of the labour force in Turkey was around 5.3 years and accounted only for 63% of the average level of the other countries analyzed in the same year.

Finally, another possible explanation for the lack of linkage between human capital and productivity growth in Turkey would be related to the failure of Turkey in establishing an adequate environment sufficiently conducive both for ordinary production and technological activities. These may have entailed a sectoral composition of production in favor of low-technology intensive sector, macroeconomic instability, poor governance structures in both public and private sectors, weakness in establishing a competitive market structure, etc. Naturally, this means that the poor productivity growth problem of Turkey is systemic in nature and calls for the development and application of policies in an integrated manner without concentrating merely on a limited number of variables. At the human capital dimension, a special emphasis should be given to increase returns from human capital investment. This should involve measures ranging from a better protection of intellectual property rights to reforming of the education system with the aim of raising individuals who are open-minded, creative and able to work in a team.

Appendix

Table A1
List of Countries

Argentina	Iceland	Peru
Australia	India	Philippines
Austria	Indonesia	Poland
Belgium	Ireland	Portugal
Brazil	Israel	Russia
Canada	Italy	Slovak Republic
Chile	Jamaica	Spain
China	Japan	Sweden
Czech Republic	Jordan	Switzerland
Denmark	S. Korea	Thailand
Egypt	Malaysia	Tunisia
Finland	Mexico	Turkey
France	Netherlands	United Kingdom
Germany	New Zealand	United States
Greece	Norway	Uruguay
Hungary	Paraguay	Zimbabwe(*)

* The human capital data available only for average years of education of the labour force.

Table A2
Summary Statistics of Variables
(Human Capital Variable: Schooling Rates)

Variable Name	Definition of Variables	Mean	Maximum	Minimum	Standard Deviation
YLF	The percentage rate of productivity growth	1.38	9.01	-8.05	2.32
YLFBAZ	The initial year income per labour force	2747 5.9	85016.0	333.9	23014.2
INV	The percentage share of investment in gross domestic product	22.7	39.5	12.8	4.6
FDI	The percentage share of foreign direct investment in gross domestic product	3.7	27.0	0.2	4.3
X	The percentage share of total exports in gross domestic product	32.5	111.0	7.9	17.4

Table A 2 (continued)

AGRL	The percentage share of agricultural labour employment in total employment	16.8	66.0	0.4	16.7
ENPRE	Pre-primary school enrolment rate (in per cent)	52.8	113.5	0.3	31.9
ENPRI	Primary school enrolment rate (in per cent)	103.1	126.5	71.6	8.8
ENSEC	Secondary school enrolment rate (in per cent)	83.5	149.4	29.7	25.9
ENTER	Tertiary school enrolment rate (in per cent)	29.4	86.5	2.1	17.8

Note: The summary statistics are computed for the time period 1982-2002. The time period involves 3 sub-periods.

Table A3

Summary Statistics of Variables

(Human Capital Variable: Average Years of Education of Labour Force)

Variable Name	Definition of Variables	Mean	Maximum	Minimum	Standard Deviation
YLF	The percentage rate of productivity growth	1.52	10.46	-9.05	2.52
YLFBAZ	The initial year income per labour force	27958.7	84655.1	313.0	23062.5
INV	The percentage share of investment in gross domestic product	23.0	40.3	12.0	4.8
FDI	The percentage share of foreign direct investment in gross domestic product	3.4	22.3	0.1	3.9
X	The percentage share of total exports in gross domestic product	31.9	109.3	7.7	16.7
AGRL	The percentage share of agricultural labour employment in total employment	17.1	72.0	0.4	17.1
EDUYEAR	The average years of education of labour force	7.9	12.1	3.3	2.2

Note: The summary statistics are computed for the time period 1981-2000. The time period involves 4 sub-periods.

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Özet

Beşeri sermaye ve verimlilik artışı: Türkiye'nin karşılaştırmalı bir analizi

Bu çalışmada, içerisinde Türkiye'nin de bulunduğu farklı gelişmişlik düzeylerine sahip 50 dolayındaki ülkede beşeri sermayenin verimlilik artışındaki rolü incelenmektedir. Çalışmada verimlilik artışını açıklamada beşeri sermayenin farklı nicel ölçütlerinin geçerliliği üzerine odaklanılmakta ve Türkiye ekonomisi ayrıntılı olarak incelenmektedir. Çalışma 1981-2002 dönemini kapsamakta ve işgücünün ortalama eğitim yılı ile çeşitli kademelerdeki okullaşma oranları beşeri sermayenin temsili değişkenleri olarak kullanılmaktadır. Başlangıç yılı verimlilik düzeyi, fiziki yatırımlar, doğrudan yabancı sermaye yatırımları, ihracat oranı ve tarımsal istihdamın toplam istihdam içerisindeki payı verimlilik artışını açıklamada kullanılan diğer değişkenlerdir. Çalışma, konuyla ilgili çalışmaların çoğunluğunun bulgularını teyit ederek, incelenen ülke grubunun bütününde beşeri sermayenin verimlilik artışını olumlu etkilediğini ortaya koymaktadır. Türkiye ekonomisinde ise bu ilişkinin geçerli olmadığı sonucuna varılmaktadır. Beşeri sermayenin niteliği yanında, beşeri sermaye birikimi düzeyinin düşüklüğü ile üretim ve teknolojik faaliyetleri özendirici ortamdaki yetersizlikler bu bulgunun muhtemel nedenleri olarak ele alınmaktadır.