Fiscaoeconomia
E-ISSN: 2564-7504
2024, Volume 8, Issue 1, 244-255
https://dergipark.org.tr/tr/pub/fsecon

Submitted/Geliş: 20.11.2023
Accepted/Kabul: 11.01.2024
Doi: 10.25295/fsecon.1393482

Research Article/Araştırma Makalesi

The Role of Knowledge on the Economic Growth Performance of Türkiye, 1960-2019[1]

Bilginin Türkiye Ekonomisinin Büyümesi Üzerindeki Rolü, 1960-2019

Fatma Muazzez UTKU İSMİHAN[2]

Abstract

In recent decades, there has been a notable shift in the global economy towards a knowledge-based economic framework. This transformation has been influenced by many key factors, sometimes referred to as pillars of knowledge. These pillars encompass human capital, research and development (R&D), information and communication technologies (ICTs), and foreign trade. This study examines the influence of knowledge on the economic growth performance of Türkiye from 1960 to 2019. It employs a production function framework and utilizes the Autoregressive Distributed Lag (ARDL) technique. This study additionally presents a knowledge index as a means to assess several dimensions of knowledge in a unified form. The empirical results indicate that higher level of knowledge has had a positive impact on the growth rate of Turkish economy over the sample period.

Jel Codes: *O11, O40, O47, O49*
Keywords: *Knowledge, Knowledge Index, Productivity, Economic Growth*

Özet

Son yıllarda küresel ekonomide bilgiye dayalı ekonomik çerçeveye doğru kayda değer bir dönüşüm yaşandı. Bu dönüşüm, bazen bilgi sütunları olarak da adlandırılan birçok temel faktörden etkilenmiştir. Söz konusu sütunlar insan sermayesini, araştırma ve geliştirmeyi (Ar-Ge), bilgi ve iletişim teknolojilerini (BİT'ler) ve dış ticareti kapsamaktadır. Bu çalışma, 1960'tan 2019'a kadar olan dönemde bilginin Türkiye'nin ekonomik büyüme performansı üzerindeki etkisini incelemektedir. Çalışmada üretim fonksiyonu modeli ve ARDL tekniği kullanılmaktadır. Bu çalışma ayrıca bilginin farklı boyutlarını birleşik bir biçimde değerlendirmenin bir yolu olarak bir bilgi endeksi sunmaktadır. Ampirik sonuçlar, daha yüksek bilgi düzeyinin, örneklem döneminde Türkiye ekonomisinin büyüme oranı üzerinde olumlu bir etkisi olduğunu göstermektedir.

Jel Kodları: *O11, O40, O47, O49*
Anahtar Kelimeler: *Bilgi, Bilgi Endeksi, Verimlilik, Ekonomik Büyüme*

[1] This paper is an extensively revised and updated version (in terms of both method and data) of the second essay in Fatma Muazzez UTKU İSMİHANs' Ph.D. Thesis (Utku-İsmihan (2016)).
[2] EU Expert and Part Time Lecturer, MoAF and METU, fmutku@yahoo.com, ORCID: 0000-0002-6842-5879)

Citation/Atıf: Utku İsmihan, F. M. (2024). The Role of Knowledge on the Economic Growth Performance of Türkiye, 1960-2019. *Fiscaoeconomia, 8*(1), 244-255. Doi: 10.25295/fsecon.1393482

1. Introduction

The global economy is increasingly transitioning into what is commonly referred to as a "knowledge economy". Human capital, research and development (R&D), information and communication technologies (ICTs), and international trade are main factors that have influenced this transformation. These factors have the capacity to enhance both the level of productivity and the accumulation of resources in the economy and hence influence overall economic growth performance and are referred to as the dimensions or pillars of knowledge.

Among the pillars of knowledge, research and development (R&D) is the most extensively explored pillar in both cross-country and country-specific analyses. A substantial body of research has been conducted subsequent to the seminal studies by Shultz (1953), Griliches (1958), Romer (1990), Grossman & Helpman (1991), Aghion & Howitt (1992), and Griliches (1992), in this particular area of research. In a study conducted by Bravo-Ortega & Marin (2011), an examination of data from 65 nations spanning the years 1965 to 2005 revealed that a 10% increase in research and development (R&D) expenditure resulted in a 1.6% rise in total factor productivity over the long-term.

Research conducted on several domains of knowledge, such as human capital, foreign trade, and information and communication technologies (ICTs), has consistently demonstrated their positive impact on productivity levels and therefore the economic growth of nations. Nevertheless, there is a limited body of research that has integrated all of these pillars of knowledge in a comprehensive analysis. In a cross-sectional analysis conducted by Chen & Dahlman (2004), the authors examined data from 96 countries spanning the years 1960 to 2000. Their findings indicated that strengthening the economic and institutional regime, as well as investing in an educated and skilled population, dynamic information infrastructure, and an efficient innovation system, led to an increase in the accumulation of knowledge used in production. This, in turn, had a positive impact on economic growth by influencing total factor productivity (TFP). The Knowledge Assessment Methodology (KAM), which was introduced by Chen & Dahlman in 2004, is a widely recognized paradigm in the field. The Knowledge Economy Index (KEI) and Knowledge Assessment Methodology (KAM) were developed by the World Bank in order to rate countries. The knowledge indicators are comprised of intricate structures that encompass a broad range of characteristics. Hence, a significant constraint of these knowledge indicators is in the restricted availability of data for each variable and country.

Furthermore, it is undeniable that cross-country studies, such as the work of Chen & Dahlman (2004), offer valuable insights into the influence of knowledge on economic growth. However, as emphasized by Pritchett (2000), growth patterns vary significantly among developing nations. Consequently, conducting country-specific studies on growth dynamics may yield more dependable and precise empirical findings and perspectives. However, despite the significant discovery made by Pritchett (2000), there has been a lack of focus on country-specific time series analysis within the field of growth literature. This can be attributed to various factors, including the limitations of time series techniques, the restricted size of available samples, challenges related to data availability, and the presence of multicollinearity issues among the knowledge variables. For example, when the sample size is low, it is not feasible to include more than a few variables in the analysis of cointegrated vector autoregression (CVAR). The aforementioned constraints have compelled scholars to concentrate on the impact of individual or specific domains of knowledge on economic growth.

To address the aforementioned constraints, this study constructs a composite knowledge index to assess the influence of different fundamental aspects of knowledge on the overall level of knowledge throughout the economy. The development of such a knowledge index serves as a solution to address the possible problems of multicollinearity among the knowledge variables. This will be achieved by utilizing a knowledge index and considering the four aspects of knowledge indicated earlier. In this endeavor, our primary objective is to construct an augmented production function, by utilizing the influential research conducted in several branches of endogenous growth theory.

This study aims to examine the effect of knowledge on economic growth in Türkiye from 1960 to 2019, by employing a production function approach. In this study, unit root tests and ARDL method were employed to examine the impact of knowledge on economic growth in Türkiye. The next section provides an overview of the existing literature, while Section three introduces our proposed model and the knowledge index. Section four presents the empirical findings, while section five offers the concluding thoughts.

2. Literature Review

The Solow model posits that the economic growth performance of a country is impacted by exogenous forces, specifically technology and population growth.[3] Solow (1956) considered the exogenous nature of technology and hypothesized that the sole variable influencing productivity levels was time. The exogenous technology term was introduced in order to explain long-term economic growth.[4]

In their seminal papers, Arrow (1962), Nelson & Phelps (1966) and Uzawa (1965) introduced the ideas of education and learning by doing into the literature. Nelson & Phelps (1966), for instance, argued that education speeded up technological diffusion simply because educated people was much faster in adopting the new technology.

During the mid-1980s, Lucas (1988) and Romer (1986) stressed the importance of human capital and technological progress in economic growth within the new (endogenous) growth theory. Therefore, from the late 1980s onwards the dominant research area in growth theory has been the role of the accumulation of knowledge via innovation or human capital. This new strand of growth theory by internalizing technological progress tried to explain the growth rates of countries.

Subsequently, the R&D sector has been recognized as the primary driver of economic growth, as evidenced by the influential contributions of Romer (1990), Grossman & Helpman (1994),

[3] Technology enters the production function as a residual of total factor productivity, i.e. the Solow residual.
[4] More detailed information on endogenous growth theories can be found in Aghion & Howitt (2008) and Barro & Sala-i Martin (1990).

Griliches (1992), Cameron et al. (2005) and Aghion & Howitt (1992).[5] This particular body of literature posits that the R&D industry utilizes human capital and accumulated knowledge in order to generate new knowledge.[6] Then, the acquired information or innovation is applied in the development of novel products or production methods.

Grossman & Helpman (1989) have underlined the importance of international trade on knowledge accumulation and argued that promotion of liberal trade activities, made it easier for the developing countries to transfer stock of knowledge and increase participation of foreign direct investments. In 1991, Grossman & Helpman (1991) with an open economy framework argued that countries could acquire foreign technology through imports because imported goods embodied technological know-how. Moreover, Madsen (2007) found a robust relationship between imports of technology and TFP, and that 93% of the increase in TFP over the past century has been primarily due to imports of knowledge for the OECD countries over the period 1870 to 2004.

Chen & Dahlman (2004) postulated that when the economic and institutional regime, educated and skilled population, dynamic information infrastructure and efficient innovation system are strengthened, the level of knowledge used in production would increase and this in turn will increase economic growth via affecting total factor productivity (TFP). Chen & Dahlman (2004) model is known as the Knowledge Assessment Methodology (KAM). Later, based on KAM, the World Bank developed the Knowledge Economy Index (KEI) for ranking countries in terms of knowledge. Without any doubt the KEI is useful in providing a general picture regarding the positions and rankings of countries in terms of their overall knowledge base. However, the drawback of KEI is the limitation in the availability of all the variables for a long time period. Thus, this paper attempts to introduce an alternative measurement that is capable of capturing the impact of knowledge indicators available in the country in question for a longer period of time.

3. The Model and Knowledge Index

This section introduces the model and the knowledge index that is used in this study.

3.1. The Model

In this section we attempt to develop an augmented production function model by considering the strands of endogenous growth models on knowledge as explained above.

Therefore, the following Cobb-Douglas production function is used -as the initial specification- in our empirical investigation of the role of knowledge on economic growth.

$$Y_t = \beta_0 O_t^{\beta_1} E_t^{\beta_2} P_t^{\beta_3} C_t^{\beta_4} K_t^{\beta_5} L_t^{\beta_6} \quad (1)$$

[5] See, Versspagen (1995) for a thorough cross-country and cross-section analysis of the relationship between R&D and productivity.

[6] However one should underline that there are serious financial constraints for R&D investment. See, for example Harhoff (1998) for the analysis of R&D investment in German manufacturing firms and Wakelin (2001) for UK manufacturing firms.

Where O represents the trade regime of the economy (e.g. openness to foreign trade), E denotes education, P represents country's level of domestic innovation and C denotes country's communication infrastructure, Y is output, K is capital and L is labor.

It should be noted that TFP (At) is explicitly modeled in Equation (1) and equals to $\beta_0 O_t^{\beta_1} E_t^{\beta_2} P_t^{\beta_3} C_t^{\beta_4}$. Equation (1) can be restated as a log-linear model as follows:

$$LnY_t = \beta_0^* + \beta_1 LnO_t + \beta_2 LnE_t + \beta_3 LnP_t + \beta_4 LnC_t + \beta_5 LnK_t + \beta_6 LnL_t \qquad (2)$$

Where β_0*=Ln β_0 and β_i's represent the respective elasticities (e.g. β_5 is the elasticity of output (Y) with respect to capital (K)).

Equation (2) allows us to investigate the role of the four dimensions (indicators) of knowledge on growth (that is, the role of openness, education, country's level of domestic innovation and country's communication infrastructure) as mentioned in the previous section. However, these four indicators are highly correlated; therefore, we attempt to construct a composite knowledge index (KN). As mentioned before, construction of such an index provides us with a single but comprehensive measure on the "level" of knowledge in the economy, which has multi-dimensional facets (see, for instance, World Bank, 2006). Thus, considering all these issues, equation (2) can be re-written as follows,

$$LnY_t = \beta_0^* + \beta_1 LnK_t + \beta_2 LnL_t + \theta KN_t \qquad (3)$$

Where KN is the knowledge index[7] and all the other variables are as defined earlier.

In line with the literature (see, for example, Chen & Dahlman (2004)) constant returns to scale is imposed on Equation (3) and we obtain the following specification.

$$y_t = \beta_0^* + \beta_1 k_t + \theta KN_t \qquad (4)$$

Where yt [= ln(Y/L)] is the natural log of output per labor, k_t [=ln(K/L)] is the natural log of physical capital per labor and KN is the knowledge index.

Thus, we will use the following empirical (stochastic) log-linear model in the empirical applications.

$$y_t = \alpha_0 + \alpha_1 k_t + \alpha_2 KN_t + u_t \qquad (5)$$

Where u_t is the disturbance term and all other variables are as defined earlier. Note that $\alpha_0=\beta_0^*$, $\alpha_1= \beta_1$, $\alpha_2= \theta$.

Considering the growth models and their implications we expect positive signs for k and KN ($\alpha_1>0$ and $\alpha_2>0$). In other words, we expect to see an increase in broad level of knowledge (KN) and capital per labor (k) to have a positive effect on output per labor (y).

From here onwards our empirical analysis proceeds in two steps. First, we construct the knowledge index then we estimate the production function provided in Equation (5).

[7] Details of the knowledge index are provided in Section 3.2.

3.2. The Knowledge Index

As indicated in the previous sections considering previous studies[8] we consider human capital, R&D, ICTs and trade as the main determinants of Knowledge. When all these indicators are combined via an index, a single comprehensive measure on the level of knowledge capability in an economy is obtained. One of the main advantages of this index is that it helps to prevent the potential problem of multicollinearity (due to the high correlation between knowledge indicators) in empirical analyses.

The KN[9] we use is calculated by using the average of normalized indicators (sub-indices) for each of the four dimensions, i.e. human capital index, R&D index, ICT index and trade index. Each of the four dimensions of Knowledge are in different units and have different ranges (minimums and maximums), therefore as an initial step a common range for all of the dimensions are calculated. In order to do so a minimum and a maximum bound for each indicator is set and as a result an index value that ranges between 0 and 1 for each indicator is obtained. This transformation provides unit free indices, i.e. dimension indices, which can be compared or used together. The formula used to calculate each dimension index is as follows:

$$D_{Xt} = \frac{X_t - Min\,(X)}{Max\,(X) - Min\,(X)} \tag{6}$$

Where D_{Xt} is the dimension index of Knowledge indicator X, X_t is the value of the indicator at time t, Min (X) is the minimum value and Max (X) is the maximum value of variable X during the entire time period (1960-2019) that is being investigated.

After completing the normalization of the indicators and obtaining the dimension indices next, we calculate the KN as a weighted average of the four-dimension indices, as follows:

$$N = w_1D_E + w_2D_{RD} + w_3D_{ICT} + w_4D_T \tag{7}$$

Where KN is Knowledge index, D_E is the education index, D_{RD} innovation index, D_{ICT} communication index, D_T trade index and w_i's denote weights of the respective dimension indices.

Following Alesina & Perotti (1996) among many others, we use the principal component analysis to determine the weights of each dimension.[10]

Principal component analysis results are shown in Table 1. As can be seen from Table 1 the first principal component (Comp 1) explains a high proportion of the variance (89%) in the data compared to the rest of the principal components. Thus, we used the first principal component to calculate the respective weights of our index.

[8] For example, Romer (1986), Lucas (1988) and Grossman & Helpman (1989).

[9] In this study we are using the knowledge index developed by Utku-İsmihan (2016).

[10] Principal components analysis basically takes the high dimensional data and then uses the dependencies between the variables to represent it in a lower dimensional form, with minimum loss of information.

Table 1: Weights Determined by Principal Component vs. Simple Average

Variables	Principal Component Analysis [Relative Weights (wi)]	Analysis with "Simple Average" [Equal Weights (wi)]
D_E	0.2632	0.2500
D_{RD}	0.2603	0.2500
D_{ICT}	0.2212	0.2500
D_T	0.2554	0.2500

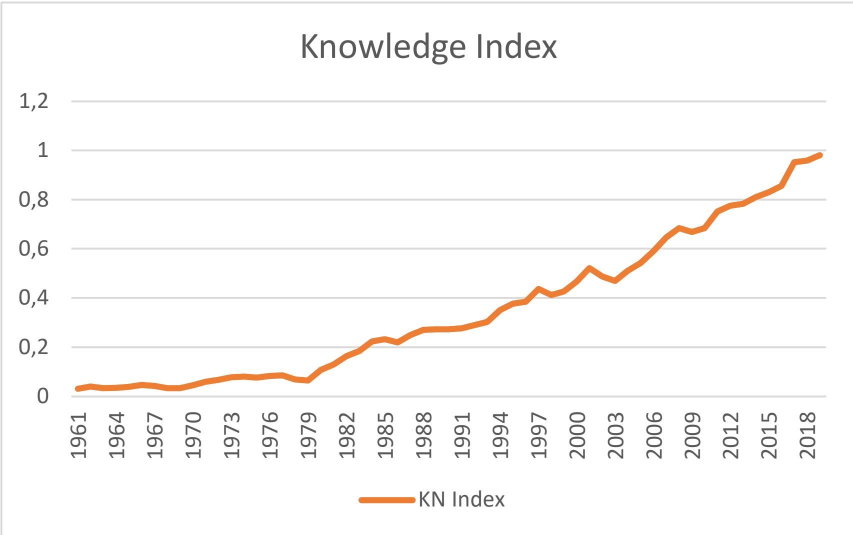
When we use these results our KN becomes:

$$KN= 0.2632D_E+0.2603D_{RD}+0.2212D_{ICT}+0.2554D_T \quad (8)$$

Where all the variables are defined as before.

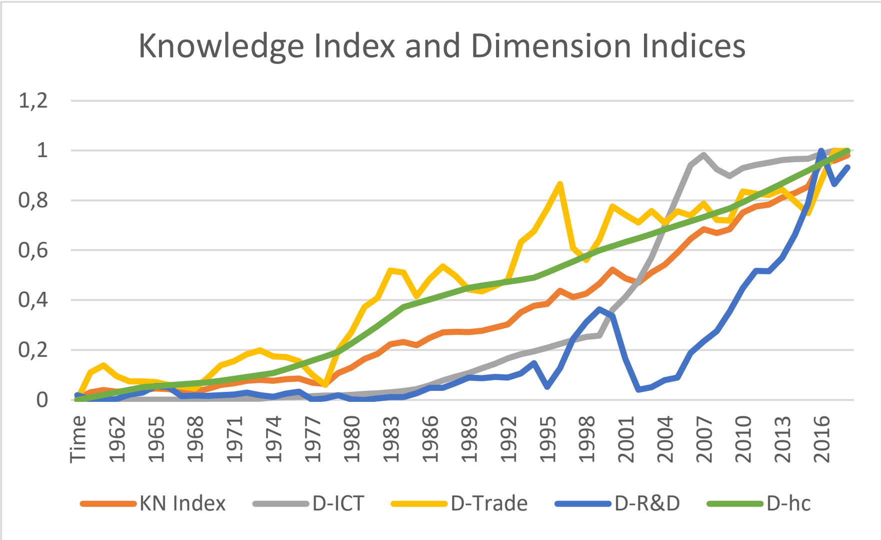
Figure 1 provides the time plot of the KN of Türkiye during the 1960-2019 period. As can be seen over the years there has been a quite steady increase in the level of knowledge of Türkiye.

Figure 1: KN of Türkiye, 1960-2019



KN is a composite measure comprised of four-dimension sub-indices that effectively capture the different dimensions of knowledge. Since KN shows the level of knowledge in a given time period it provides us the opportunity to analyze the performance of Türkiye with respect to the level of knowledge over time. It is clear from Figure 1 that there is an upward tendency in the KN throughout the years, signifying a continuing enhancement of knowledge in Turkey. However, there is a significant difference between pre-1980 (inward-oriented industrialization) and post-1980 (outward-oriented industrialization) sub-periods. We will take this into account in the next section. Finally, it should be noted that certain components of the KN (namely, D_{RD} and D_T) exhibit greater sensitivity to economic fluctuations due to their inherent characteristics (see Figure 2).

Figure 2. KN and Dimension Indices of Türkiye, 1960-2019

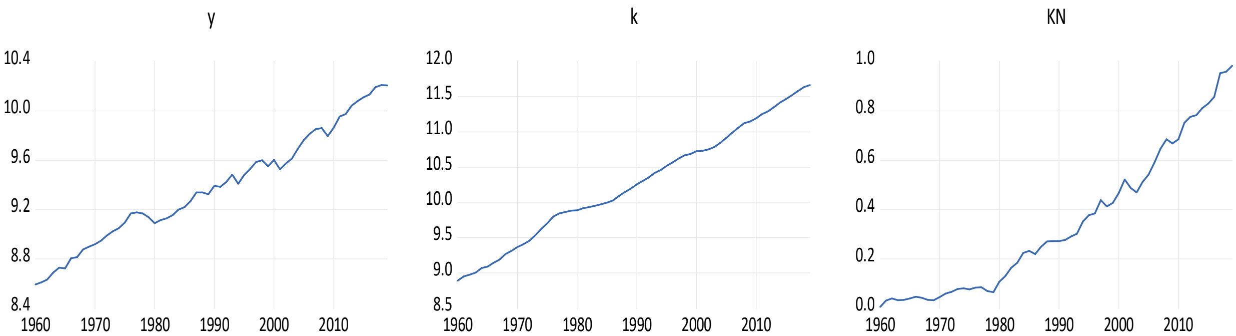


4. The Empirical Results

Before estimating the production function with the yearly time series data from 1960 to 2019, it is essential to check for the presence of a unit root in each series. Figure 3 provides the time plots of y_t [=ln(Y/L)], k_t [=ln(K/L)] and KN. There is visual evidence of nonstationarity in each series (Figure 3).[11]

Table 2 provides the unit root test results. As can be seen from the table the ADF tests indicate that for the levels of all the variables, the null hypothesis of a unit root is not rejected. The null hypothesis of a unit root for the first differences of all variables is rejected. Considering all these results, it can be stated that all variables contain a unit root.

Figure 3: The Time Plot of the Data, 1960-2019



[11] Information on the definitions and the sources of the data is provided in the appendix section.

Table 2: Augmented Dickey Fuller (ADF) Tests

Variables	Test Equation[a]		
	Level		First Difference
	Without Trend	With Trend	Without Trend
y	-0.117549 [0.9423]	-2.357205 [0.3975]b	-8.066610 [0.0000]
k	0.072133 [0.9608]	-2.607250 [0.2788]	-4.230424 [0.0013]
KN	2.723087 [1.0000]	-0.785960 [0.9609]	-6.547345 [0.0000]

a: The optimal lag chosen by SBC (Schwarz Bayesian Criterion) are given in parentheses. P-values are provided in square brackets.

Considering the above time series features of the variables, cointegration approach is used to analyze the dynamic empirical relationship between knowledge, capital and output in the Turkish economy. Therefore, we estimated our model (Equation 5) by using ARDL technique and results are as follows:[12]

$$y_t=4.504+0.463k_t+0.296KN_t \qquad (9)$$
$$(0.000)\ (0.000)\ (0.014)$$

Note: p-values are shown in brackets.

These results indicate that there is a positive long-run relationship between KN, k and y, which is in line with a priori expectations. That is, (log) output per labor is positively and significantly affected by (log) capital per labor and knowledge.

5. Concluding Remarks

This study analyzed the impact of knowledge pillars on the economic growth performance of Turkish economy over the 1960-2019 period.

By following endogenous growth models, we provide an augmented production function model to examine the overall impact of knowledge indicators on economic growth. Our theoretical model identifies four key knowledge channels (pillars) of productivity growth as education, R&D, ICTs and foreign trade. Due to the existence of high correlation between the variables, a knowledge index was constructed to see the impact of various dimensions of knowledge with a single but comprehensive measure of the "level" of knowledge in the economy. Thus, the key contribution of this study is that it gives us the opportunity to analyze the effect of knowledge diffusion channels together on the economic growth performance, which would otherwise be impossible due to the high collinearity between the variables.

[12] Selected Model, with Schwarz Info criterion (SIC), is ARDL(1, 2, 0). The ARDL Bounds test confirms the presence of long-run (cointegration) relationship between y, k and KN at 5% significance level. The relevant diagnostic tests reveal no statistical problems. It should be also noted that we introduced a dummy variable to account for the switch from pre-1980 period to post-1980 period, as mentioned in the previous section. When we exclude the dummy variable, some diagnostic tests revealed statistical problems, e.g. heteroscedasticity (White test) and specification problem (RESET test). Nevertheless, the ARDL Bounds test confirmed the presence of cointegration relationship between y, k and KN and the long-run parameter estimates were very similar to the ones reported above.

The ARDL method is used to analyze the role of knowledge on economic growth in Türkiye over the 1960-2019 period. The empirical results indicate that the higher level of knowledge had a positive and statistically significant impact on the growth rate of Turkish economy over the sample period. Therefore, designing policies that entail knowledge factors should envisage creation of an economic environment that is conducive to enhance the level of knowledge and hence long run economic growth in Türkiye.

According to the results of this study, the primary policy recommendation is to invest in human capital. Moreover, given the increasing speed of technical breakthroughs and the difficulty of keeping up with this quick rate of change, investing in human capital becomes even more critical. To achieve this, first of all, policies should be established with collaboration between government, industry and universities to ensure that they align with the needs of the economy. This will ensure the implementation of comprehensive training programs that cater to the specific needs of industries and economy. Secondly, without any doubt funding for quality education should always be the main priority however investment in vocational training programs and apprenticeships is also crucial to equipping human capital with the necessary skills so that they adapt and continue to effectively work in this rapidly changing technological environment. Thus, policymakers should engage in dynamic education reforms that promote lifelong learning, provide accessible resources and affordable education programs to individuals. Thirdly, policy makers could utilize incentives such as tax exemption or subsidies to encourage firms to prioritize investment in the training of their human capital. Finally, for successful results the policies aiming to improve the quality and effectiveness of the human capital should be regularly monitored and revised as appropriate.

Appendix Section

Output (Y) is measured by Gross Domestic Product (GDP) at constant 2017 national prices (in mil. 2017US$). Source: Penn World Tables (PWT).

Capital Stock (K) Capital stock at constant 2017 national prices (in mil. 2017US$). Source: PWT.

Labor (L) Number of persons employed (in millions). Source: PWT.

Foreign trade to GDP ratio (O) is used as an indicator of the openness of the Turkish economy. It is calculated as the ratio total foreign trade to GDP (i.e. (export+import)/GDP). Source: World Development Indicators.

Human Capital (H) is human capital index, based on years of schooling and returns to education. Source: PWT.

A Country's Level of Domestic Innovation (P) is measured by using patent data from World Bank (WDI).

Total number of telephone subscribers (C) including mobile phone subscribers, is used to represent communications infrastructure. The data on telephone subscribers are obtained from World Bank (WDI)

Bibliography

Aghion, P. & Howitt, P. (1992). A Model of Growth Through Creative Destruction. *Econometrica, 60*(2), 323-351.

Aghion, P. & Howitt, P. (2008). *Endogenous Growth Theory*. Cambridge, MA: MIT Press.

Alesina, A. & Perotti, R. (1996). Income Distribution, Political Instability, and Investment. *European Economic Review*, *40*, 1203-1228.

Arrow, K. J. (1962). The Economic Implication of Learning by Doing. *Review of Economic Studies*, *62*, 155-173.

Barro, R. J. & Sala-i Martin, X. (1990). *Economic Growth*. New York: McGraw-Hill.

Cameron, G., Proudman, J. & Redding, S. (2005). Technological Convergence, R&D, Trade and Productivity Growth. *European Economic Review, 49*, 775-807.

Harhoff, D. (1998). Are There Financing Constraints for R&D and Investment in German Manufacturing Firms?. *Annales d'Economie et de Statistique, 49/50*, 421-456.

Chen, D. H. C. & Dahlman C. J. (2004). Knowledge and Development: A Cross-Section Approach. *World Bank Research Working Paper 3366*, August 2004.

Griliches, Z. (1992). The Search for R&D Spillovers. *Scandinavian Journal of Economics*, *94*, 29-47.

Griliches, Z. (1958). The Demand for Farm Fertilizer: An Econometric Interpretation of a Technological Change. *Journal of Farm Economics*, *40*(3), 591-606.

Grossman, G. M. & Helpman, E. (1994). Endogenous Innovation in the Theory of Growth. *Journal of Economic Perspectives*, *8*(1), 23-44.

Grossman, G. M., & Helpman, E. (1991). *Innovation and Growth in the Global Economy*. Cambridge, Mass. and London: MIT Press.

Madsen, J. B. (2007). Technology Spillover Through Trade and TFP Convergence: 135 Years of Evidence for the OECD Countries. *Journal of International Economics*, *72*(2), 464-480.

Nelson, R. R. & Phelps, E. S. (1966). Investment in Humans, Technological Diffusion and Economic Growth. *American Economic Review, 56*(2), 69-75.

Pritchett, L. (2000). Understanding Patterns of Economic Growth: Searching for Hills among Plateaus, Mountains, and Plains. *World Bank Economic Review*, *14*(2), 221-250.

Romer, P. M. (1990). Human Capital and Growth: Theory and Evidence*. Carnegie-Rochester Conference Series on Public Policy*, *32*, 251-86.

Shultz, T. (1953). *The Economic Organization of Agriculture*. New York: McGraw Hill.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*,*70*, 65-94.

Utku-İsmihan, F. M. (2016). *Essays on the Impact of Knowledge on Economic Growth*. Doctoral Dissertation, Middle East Technical University. http://etd.lib.metu.edu.tr/upload/12619923/index.pdf

Uzawa, H. (1965). Optimum Technical Change in An Aggregative Model of Economic Growth. *International Economic Review*, *6*(1), 18-31.

Verspagen, B. (1995). R&D and Productivity: A Broad Cross-Section Cross-Country Look. *The Journal of Productivity Analysis, 6*, 117-135.

Wakelin, K. (2001). Productivity Growth and R&D Expenditure in UK Manufacturing Firms. *Research Policy, 30*, 1079-1090.

Acknowledgement: I would like to thank Prof. Dr. Teoman PAMUKÇU, Prof. Dr. Fikret ŞENSES, Prof. Dr. Erkan ERDIL, Prof. Dr. Ozan ERUYGUR and Prof. Dr. Semih AKÇOMAK for their valuable comments that has shaped the initial version of this study. Last but not least I would like to thank Prof. Dr. Mustafa ISMIHAN for his valuable feedback.

Ethical Approval: The author declares that ethical rules are followed in all preparation processes of this study. In the case of a contrary situation, Fiscaoeconomia has no responsibility, and all responsibility belongs to the study's author.

Etik Beyanı: Bu çalışmanın tüm hazırlanma süreçlerinde etik kurallara uyulduğunu yazar beyan eder. Aksi bir durumun tespiti halinde Fiscaoeconomia Dergisinin hiçbir sorumluluğu olmayıp, tüm sorumluluk çalışmanın yazarına aittir.