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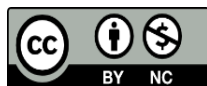
Enis BEGEÇ  <https://orcid.org/0000-0002-7502-1944>

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Labor Productivity and Human Capital: An Interactive Model*

Enis BEGEÇ^a

^aRes. Assist. Ph.D., Aydın Adnan Menderes University, Nazilli Faculty of Economics and Administrative Sciences, Department of Economics, Aydın, TÜRKİYE

 <https://orcid.org/0000-0002-7502-1944>

Abstract

The primary objective of the paper is to examine the hypothesis that human capital affects labor productivity directly and indirectly. The paper investigates this relationship using data from 1991 to 2019 for BRICS-T countries, with panel fixed effects and panel random effects models. Moreover, the paper employs the standard error method to examine the marginal effects of trade openness, savings, labor market reforms, and information and communication technology on labor productivity. According to the analysis results, we find strong evidence supporting the hypothesis that human capital influences not only labor productivity directly but also indirectly. The marginal effects of all variables used in the study are also found to be statistically significant.

Keywords

Labor Productivity, Human Capital, Interactive Model, Labor Market Reforms, Information and Communication Technology

JEL Classification

C33, E24, J24, O15, O47

Contact Enis BEGEÇ ✉ enisbegec@gmail.com 📧 Aydın Adnan Menderes University, Nazilli Faculty of Economics and Administrative Sciences, Department of Economics, Aydın, Türkiye

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Emek Verimliliği ve Beşerî Sermaye: İnteraktif Bir Model

Öz

Makalenin temel amacı, beşerî sermayenin, emek verimliliğini sadece doğrudan değil, dolaylı olarak da etkilediği hipotezini incelemektir. Makale, BRICS-T ülkeleri için 1991-2019 yılları arasındaki verileri kullanarak, panel sabit etkiler ve panel rassal etkiler modelleriyle bu ilişkiyi araştırmaktadır. Ayrıca, makale, ticari dışa açıklığın, tasarrufların, işgücü piyasası reformlarının ve bilgi ve iletişim teknolojisinin marjinal etkilerini incelemek için standart hata yöntemini kullanmaktadır. Analiz sonuçlarına göre, beşerî sermayenin emek verimliliğini sadece doğrudan değil, dolaylı olarak da etkilediği hipotezini destekleyen güçlü kanıtlar tespit edilmiştir. Çalışmada kullanılan tüm değişkenlerin marjinal etkilerinin de istatistiksel olarak anlamlı olduğu bulgusuna ulaşılmıştır.

Anahtar Kelimeler

Emek Verimliliği, Beşerî Sermaye, İnteraktif Model, İşgücü Piyasası Reformları, Bilgi ve İletişim Teknolojileri

JEL Kodu

C33, E24, J24, O15, O47

1. Introduction

Labor productivity and human capital are essential variables whose importance is emphasized in economic development. Labor productivity has several important aspects, such as providing essential information about the labor market, explaining the differences in economic development among countries, and being of critical significance in the growth and development of a nation. Another important aspect of labor productivity is that it ensures price stability and economic growth. For instance, developed countries prioritize increasing labor productivity to ensure price stability and maintain their economic growth. Developing countries also attach importance to increasing labor productivity to increase their economic growth.

An essential feature of human capital is that it provides a comparative advantage. For instance, the high number of female labor force and skilled labor force, the high number of professions such as doctors, engineers, and scientists, and the existence of functioning institutions such as health and law prompt foreign investors to invest in that country, and thus investments in the country increase (Awan, 2012, p.2021). Moreover, education is a crucial issue for raising individuals who can adapt to technological developments and contribute to the development of new technologies (Hanushek & Woessmann, 2008). It would not be incorrect to say that educated people are crucial for economic development, given the rapid advancement of technology worldwide. Education is not solely necessary to keep up with technological innovations; the presence of educated individuals is also important in many areas, such as the development of environmental awareness, the protection of human rights, the improvement of welfare, and the advancement of societies.

Traditional growth theories have suggested that balanced population growth, capital accumulation, technological development, and investment and savings ratios are key factors in a country's development (Solow, 1956; Swan, 1956). Studies published by Becker (1960, 1964) and Schultz (1961, 1963) have also looked over the consequences of human capital and concluded that it is of critical significance in economic development. As for studies conducted by Romer (1986), Lucas (1988), and Mankiw et al. (1992), they aimed to elucidate the consequences of human capital on economic development. They incorporated the human capital variable into traditional growth theories to look over its consequences, and they concluded that it is a fundamental variable in economic development. The East Asian Countries are a convenient example in this regard. East Asian countries have taken significant steps in economic development and achieved notable success. Moreover, it is known that East Asian Countries have achieved their economic development through human capital investment (Collins et al., 1996).

The connection between labor productivity and human capital has been extensively explored in numerous studies. On the one hand, while some papers argue for positive relations, on the other hand, some papers argue for negative relations. Benos and Zotou (2014), in their published study in the case of this situation, have commented on the results as follows: "*There is substantial publication selection bias toward a positive impact of education on growth.*"

Many studies have employed various methods, including estimators and co-integrations, to elucidate the role of human capital. Other studies have also indicated the direction of causality. Numerous papers have aimed to disclose the consequences of human capital on labor productivity using different education levels (tertiary, secondary, and primary) and quality of education variables. For instance, in 1990, Azariadis and Drazen published a paper in which they tested the hypothesis of whether more human capital investment would lead to faster economic growth. They used the ordinary least squares regression method and the 1940-1980 period to test the hypothesis. According to the analysis results, the link between labor productivity and human capital is positive, and the hypothesis is valid. Furthermore, Khan et al. (1991) exploited the causality analysis to test whether literacy rates could affect labor productivity. They demonstrated that literacy rates contributed to increases in labor productivity.

In 1994, Benhabib and Spiegel claimed that an educated labor force is better at creativity, adoption of new technologies, and application of new technologies. They test this hypothesis using

78 countries' variables for the 1965-1985 period. While they provide evidence for the negative function of human capital in growth, they also provide evidence in favor of a positive impact on total factor productivity. On the contrary, in 1999, Temple criticized how some studies concluded that an increase in the skilled labor force affects labor productivity negatively. The criticism in his published paper is that the data and countries employed in previous studies affected the analysis results. He cited as examples Benhabib and Spiegel's (1994) and Pritchett's (1999) studies. He found that human capital positively affects economic growth by eliminating some of the variables and countries used in Benhabib and Spiegel's (1994) study.

Collins et al. (1996) sought to determine whether the major factors in the development of East Asian countries were provided by human capital and physical capital, or technology imported from foreign countries. They conclude that education affected the economic development of East Asian countries by 0.75%. Similarly, Delsen and Schonewille (1999) also concluded that human capital affects labor productivity statistically significantly and positively. Despite the studies that have estimated statistically significant results, some studies have estimated statistically insignificant results in the literature. For instance, Bloom et al. (1998) have investigated which economic policy is convenient for the growth of Africa. The findings from the analysis are as follows: Human capital provides a positive effect. However, the human capital coefficient estimated is not statistically significant.

Many economists have also argued whether these variables have a co-integrating and a causality relationship, different from the above-mentioned studies. There can be cited examples: Astriou and Agiomirgianakis (2001), Sarı and Soytas (2006), and Bronzini and Piselli (2009). In their study, Astriou and Agiomirgianakis (2001) search for the answers to two questions. First, they examined whether people's skills would have affected economic growth in the period of increasing new technology. Second, they have explored the impact of equality of opportunity in tertiary education implemented by the Greek government. They sought to answer these two questions by using causality and co-integration methods throughout the 1960-1994 period. Obtained from the analysis results: Firstly, they discovered a co-integration relation between the variables of interest. Secondly, whereas primary education and secondary education contribute to economic growth, tertiary education does not have the same effect.

The same results are obtained in Sarı and Soytaş's (2006) paper. They looked over the linkage between economic growth and education using data from the 1937-1996 period for Turkey. The study conducted by Sarı and Soytaş (2006) has indicated a co-integration relationship and a causality relationship between these variables. In addition to these studies, Bronzini and Piselli (2009) explained the labor productivity differences between different areas of Italy. According to the analysis results, an existing co-integration relation exists between the variables of interest, and the long-run coefficient estimation is statistically significant and positive. Additionally, they discovered that increasing expenditures on human capital would reduce the disparities in labor productivity between the areas of Italy.

Pereira and Aubyn (2009) seek the impact of tertiary, secondary, and primary education during the 1960-2001 period in their published paper. Regarding the analysis results, while it has been conclusively shown that tertiary education affects productivity with the help of technology, there is a long-term effect of secondary and primary education on productivity. This view is supported by Abel and Gabe (2011). They have mainly been interested in questions concerning how human capital affects different urban areas of America in their paper. According to the analysis results, it was claimed that human capital has beneficial consequences for economic activity.

The analysis results concerning different education levels (tertiary, secondary, and primary) and country groups (developed, developing, and less developed) demonstrate that they vary depending on the country's level of development. For instance, Petrakis and Stamatakis (2002) examine how various educational levels affect different country groups. They found that in less developed countries, secondary and primary education contribute more to economic growth, whereas tertiary education contributes less. Conversely, in OECD countries, tertiary education significantly impacts economic growth, while secondary and primary education contribute less.

Papageorgiou (2003), in his published paper, expresses that the connection of human capital diverges according to countries' level of development. Additionally, in contrast to Petrakis and Stamatakis's (2002) study, he noted that the primary education variable had a significant impact, while other education levels contributed more to innovative and technological changes. Benos and Karagiannis (2016) argue that, except for primary education, all education levels have statistically significant and positive impacts. The sign of primary education is also negative. Baharin et al. (2020) investigated the influence of education levels (tertiary, secondary, and primary) on labor

productivity in the Indonesian sample. They came up with two different findings. First, in the long run, while tertiary education affects labor productivity negatively and has a statistically significant effect, primary and secondary education affect it positively and statistically significantly. Second, all education levels are statistically significant and have favorable results in the short run.

Most of the research concerning human capital in economic literature has investigated the consequences of the impression of the education period and quality on the economy. The reason studies have concentrated on these two fields (education period and education quality) is due to the significant effects of an individual's talent and skills on labor productivity, as it has been determined that skilled and talented individuals increase labor productivity (Golden & Katz, 2008). In addition, most studies in the field of human capital have focused on the direct effects of human capital on labor productivity. However, its indirect effects have not been mentioned. Consequently, we decided to test the hypothesis that human capital affects labor productivity directly and indirectly. For example, the impact of saving depending on human capital (that is, human capital x saving) on labor productivity has not been examined. The reason we follow this approach (human capital x savings) is that it helps to answer the following question: In the case of any change in human capital and/or as a result of investment in human capital, how do savings affect labor productivity? Another reason is that this approach has not been adopted in other studies.

In this paper, with a view to testing the hypothesis, we make use of the production function equation and also add an interaction term (the multiplicative variables, e.g., human capital x saving) to the production function equation. The primary reason we follow this approach is that the production function aims to explain the causes of increases and decreases in the national income, and it also relies on marginal productivity. Apart from previous researchers, this paper uses South Africa, Brazil, India, China, Russia, and Turkey (BRICS-T) country groups as a sample. The expectation is that determining this relationship in the context of indirect effects will contribute to the literature.

This essay includes five sections. The following section mentions the employed model and data. The methods are in the third section. The fourth section contains discussions and results. The conclusions are in the fifth section.

2. Data and Model

2.1. Data

The paper uses the annual data from 1991-2019 period, and labor productivity (LP), gross capital formation (GCF), human capital index (HC), employment to population rate (PART), trade openness (OPN)¹, gross saving (GS), labor market reforms (LMR)², and information and communication technology (ICT) variables for BRICS-T countries. Since the data for the human capital variable are available in the Penn World Table database only up to 2019, and for the labor productivity variable are available in the World Development Indicator database only starting from 1991, the analysis has been limited to this year. All variables are taken from Fraser Institute, Groningen Growth and Development, and World Development Indicators.

2.2. Model

We employ two different models to highlight the consequences of human capital on labor productivity. The first model represents the consequences of the direct effect, and the second model denotes the consequences of the indirect effect. To that end, with a view to settling human capital's direct effects, the first model has been constructed as follows:

$$lp = \beta_0 + \beta_1 hc_{it} + \beta_2 part_{it} + \beta_3 gcf_{it} + \beta_4 \zeta_{it} + \varepsilon_{it} \quad (1)$$

where t indicates the time period. i represents countries. β denotes the variables' coefficient; ζ is the explanatory variable. ε is also the error correction term. All variables have been added to the model by taking the natural logarithms.

Secondly, with a view to testing the indirect impact of the human capital index, Model (1) has been extended as follows:

$$lp_{it} = \beta_0 + \beta_1 hc_{it} + \beta_2 part_{it} + \beta_3 gcf_{it} + \beta_4 \zeta_{it} + \beta_5 \zeta_{it} \times hc + \varepsilon_{it} \quad (2)$$

¹ We use the variables of exports of goods and services, GDP, and imports of goods and services to calculate trade openness. The calculation of trade openness is with the aim of the $(X+M)/GDP$ formula.

² LMR variable is an index prepared by Fraser Institute under the headings of Minimum wage, Hiring regulations, Conscription, Mandated cost of worker dismissal, Hour regulations, Centralized collective bargaining, and Hiring and firing regulations. It takes values ranging from 1 to 10. These variables are obtained from the <http://www.freetheworld.com> website.

where $\zeta \times HC$ denotes the interactive term. To indicate the interaction term of variables, the model has been set as follows: saving $\times$ human capital. To exemplify, to test the effect of saving, the Model (2) is established as follows:

$$lp_{it} = \beta_0 + \beta_1 hc_{it} + \beta_2 part_{it} + \beta_3 gcf_{it} + \beta_4 gs_{it} + \beta_5 gs_{it} \times hc_{it} + \varepsilon_{it} \quad (3)$$

As a third step, we investigate the marginal effects. To this end, we take the partial derivative of Model (3) to determine the marginal effect. For instance, to determine the marginal effect of saving depending on human capital, the partial derivative of Model (3) has been taken with regard to saving, and Model (4) is established as follows:

$$\partial lp / \partial gs = \beta_4 + \beta_5 hc \quad (4)$$

The partial derivative of each variable has been taken the same way and has been hypothesized of Model (4) as follows:

$$H_0: \beta_4 + \beta_5 \times hc = 0$$

$$H_1: \beta_4 + \beta_5 \times hc \neq 0$$

According to the above hypothesis, changes in labor productivity will either increase or decrease depending on the human capital condition.

3. Method

To apply panel data analysis methods, it is necessary to conduct several specification tests, including heteroskedasticity, autocorrelation, cross-section dependency, multicollinearity, and endogeneity. For example, to determine the co-integration, estimator, and unit-root tests to be applied, it is crucial for the consistency of the results to utilize the cross-section dependency test (hereafter CD). By ignoring the presence of the CD, heteroskedasticity, autocorrelation, multicollinearity, and endogeneity problems, test results can become biased and inconsistent. To that end, we apply test methods developed by Breusch and Pagan (1980) for heteroskedasticity, Pesaran et al. (2008) for CD, and Bhargava et al. (1982), Baltagi and Lee (1995), Born and Breitung (2016) for autocorrelation.

Secondly, another important problem is that the independent variables would be endogenous. Some economic variables could affect each other mutually. In other words, this means that dependent and independent variables may influence each other. This situation is referred to as

a simultaneous error, and the use of instrumental variables is suggested to address the problem. Because ignorance of endogeneity would cause measurement errors and simultaneous errors, the long-run coefficient estimation has been examined using Two-Stage Least Squares (hereafter, 2SLS) for the endogeneity problem. Some specification tests must be performed, such as under-identification, weak-identification, and over-identification, so as to apply the 2SLS estimator. Anderson and Kleibergen-Paap LM tests are for the under-identification test. The most convenient test for weak identification is the Cragg-Donald and Kleibergen-Paap Wald test. It is suggested to use the Sargan-Hansen J test for over-identification.

Lastly, when the estimated models exhibit heteroskedasticity, autocorrelation, and the CD, the use of robust estimators becomes necessary to ensure reliable inference. Therefore, the Driscoll and Kraay (1998) estimator, which produces robust standard errors in the presence of heteroskedasticity, autocorrelation, and the CD, was employed. Besides, we calculate the marginal effects of variables. We apply Aiken and West's (1991) standard error test methods to calculate the marginal effects of variables. The reason for choosing the Aiken and West (1991) method is that it is used as an essential tool in the estimation of indirect effects. Another reason is that we can take the partial derivative of the model.

3.1. Cross-Section Dependency Test

The CD tests determine whether the connection between the cross-sections affects other cross-sections or not. Three different CD test methods have been developed. For example, when the time dimension (T) is greater than the cross-section dimension (N), the Breusch and Pagan (1980) method is recommended to determine the relationship between cross-sections. Conversely, Pesaran's (2004) test would be more appropriate in cases where N is greater than T. The test by Pesaran et al. (2008) is recommended for both scenarios ($T > N$ and $N > T$).

Breusch and Pagan (1980) introduced the CD tests. In this test, they used the following model to test whether there is a relationship between cross-sections:

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij}^2 \quad (5)$$

where $\hat{\rho}$ denotes the empirical estimation of the binary correlation of the residuals derived from the application of the ordinary least squares (OLS) methodology for each unit (i). In this test, the

LM statistic $\frac{N(N-1)}{2}$ degrees of freedom have a chi-square asymptotic distribution and are used when the T is larger than the N , under the assumption null hypothesis (Pesaran, 2004).

Pesaran (2004) expanded the LM test and recalculated it in case the N and the T were too large:

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^N (\hat{\rho}_{ij}^2 - 1) \quad (6)$$

this test denotes that there is no cross-sectional relationship in case both the T and the N go to infinity. It also states that in this test, if the T is less than the N , the results can be biased. Pesaran (2004) rearranged the CD_{LM} test according to the following equation for the purpose of determining the cross-section relationship in case the T is less than the N and stated that if the T is less than the N , there will be a CD relationship:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij} \quad (7)$$

this test statistic represents a normal standard distribution. The LM test statistics may be biased because the group and cross-sectional mean are different from zero. Pesaran et al. (2008) established the LM_{adj} test statistic by rearranging the LM test statistic to eliminate this deviation.

Pesaran et al. (2008) included the variance and mean in the LM test statistic and derived the following equation:

$$LM_{adj} = \sqrt{\left(\frac{2}{N(N-1)}\right)} \sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij} \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{\sqrt{v_{Tij}^2}} \quad (8)$$

where μ_{Tij} is the mean of $(T-k)\hat{\rho}_{ij}^2$ and v_{Tij}^2 is the variance of $(T-k)\hat{\rho}_{ij}^2$. The test statistic obtained from LM_{adj} , while $T \rightarrow \infty$ and $N \rightarrow \infty$, indicate that it has an asymptotic normal distribution. The hypotheses of these tests are formed as follows:

$H_0 = \text{No cross - section dependency}$

$H_1 = \text{Cross - section dependency}$

which hypothesis to accept can be decided by looking at the test statistic's result or according to the test statistic's probability values. In other words, in case the critical value is greater than the calculated test statistic, the null hypothesis cannot be rejected, or if it is smaller, the null hypothesis can be rejected. Therefore, if the null hypothesis can be rejected, it means there is a CD between the variables. Conversely, there is no CD.

3.2. CADF Unit Root Test

Pesaran (2007) restructured the ADF (Augmented Dickey-Fuller test statistic), commonly used in time series analysis, based on the panel size and the assumption regarding cross-section. This test statistic gives results both for the whole panel and for each unit. Also, in the case of CD, are valid in both cases $T > N$ and $N > T$. In addition, the CADF test has a standard normal distribution but assumes that spatial autocorrelation and cross-sections are affected by different times in the examined period. The CADF test statistic is calculated via the following equation:

$$CADF_i = t_i(\alpha_i) = \frac{\hat{\alpha}_i}{se(\hat{\alpha}_i)} = \frac{\Delta y_i' M_x y_{i,-1}}{\sqrt{\hat{\sigma}_{\varepsilon,i}^2 (y_{i,-1}' M_x y_{i,-1})}} \quad (9)$$

where M_x is calculated as $M_x = I_{T-1} - x(x'x)^{-1}x'$. The x in M_x is calculated with $x = \Delta \bar{y}, \bar{y}_{-1}$. If $\hat{\sigma}_{\varepsilon,i}^2$, then $\hat{\sigma}_{\varepsilon,i}^2 = T^{-1} \Delta y_i' M_x \Delta y_i$. While CADF test statistics apply to each unit result, the CIPS test statistic apply to the entire panel. Pesaran (2007) calculated the CIPS test statistic as follows:

$$CIPS(N, T) = t - bar = N^{-1} \sum_{i=1}^N t_i(N, T) \quad (10)$$

Pesaran (2007) conducted a comparison between the critical value and the calculated test statistic to ascertain the stationarity of the variables. If the critical value is greater than the calculated test statistic, it indicates that the variable is stationary. Conversely, if it exceeds the critical value, it suggests the presence of a unit root. In this context, the hypotheses are articulated as follows:

$H_0: \alpha_i = 0$ All cross-sections in the panel have unit roots.

$H_1: \begin{cases} \alpha_i = 0, & i = 1, 2, 3, \dots, N \\ \alpha_i < 0, & i = N + 1, N + 2, \dots, N \end{cases}$ Some of the cross-sections are stationary, some are unit rooted.

3.3. Driscoll and Kraay (1998) Estimator

This method helps to produce robust standard errors using the Newey-West method for adjusting heteroskedasticity and also adding lag length for adjusting autocorrelation. The estimator is developed to be an alternative to PCSE and Parks-Kmenta estimators used in situations where N is greater than T and uses pooled OLS for estimating the coefficient. The model uses a robust covariance matrix via square roots of the diagonal elements to evaluate the coefficient, and is calculated as follows:

$$V(\hat{\beta}) = (X'X)^{-1}\hat{S}_T(X'X)^{-1} \quad (11)$$

where $\hat{S}_T$ parameter is assessed with $\hat{S}_T = \hat{\Omega}_0 + \sum_{j=1}^{m(T)} w(j, m)[\hat{\Omega}_j + \hat{\Omega}_j']$, similar to Newey and West (1987). $m(T)$ is the lag length, which is used to adjust the autocorrelation problem. Moreover, $w(j, m(T)) = 1 - \frac{j}{m(T)+1}$ is used as a Bartlett method for long-run consistent variance. There are two reasons for using the Bartlett method. The first is provided for $\hat{S}_T$ parameter to be positive. The second is also that the auto-covariance function allows the high lag length to take low values. $\hat{\Omega}_j$ matrix in the model is calculated as $\hat{\Omega}_j = \sum_{t=j+1}^T h_t(\hat{\beta})h_{t-j}(\hat{\beta})'$. The equality of $h_t(\hat{\beta}) = \sum_{t=j+1}^T h_t(\hat{\beta})$ condition has to be provided. $h_t(\hat{\beta})$ represents $(K+1) \times 1$ dimensional, the square of each t moment condition (Tatoğlu, 2018, p.276-277; Hoechle, 2007, p.287-288).

3.4. Two-Stage Least Squares (2sls)

A few problems were encountered in econometric analysis. One of them is the endogeneity problem. This situation occurs in the case of any correlation between the error correction terms and the independent variable. If there exists an endogeneity problem in the variables, the standard OLS method estimation results may be inconsistent, and to solve this problem, using instrumental variables allows the parameter estimates to be consistent. The 2SLS method has been recommended among the methods to be used in such problems. For the estimation of the 2SLS method, an equation must be established as follows:

$$y_1 = Z_1\delta_1 + u_1 \quad (12)$$

where $Z_1 = [Y_1, X_1]$ and $\delta_1' = (\gamma_1', \beta_1')$. Y_1 represents the g_1 endogenous variables number, and X_1 denotes the k_1 exogenous variables number. When $X = [X_1, X_2]$ is exogenous, the estimating

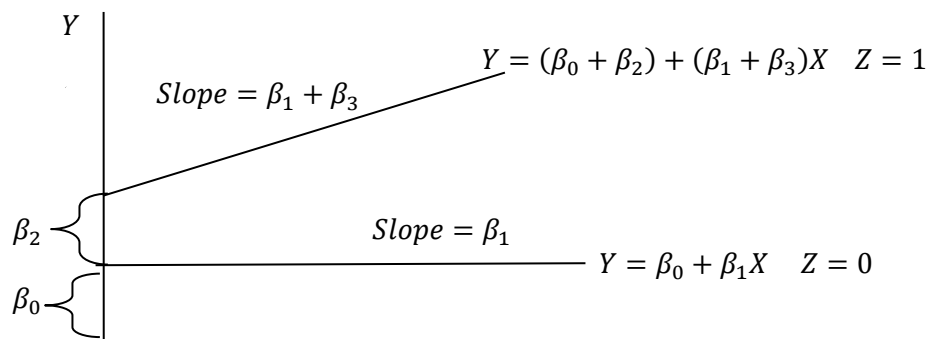
the model requires the use of as many or more endogenous variables as not used in the model (Baltagi, 2013, p. 129).

With a view to using the 2SLS method, the instrumental variables' validity must be tested. To exemplify, eliminating problems such as under-identification, weak-identification, and over-identification is important for the consistency of the results. The methods developed by Anderson (1951), Kleibergen-Paap (2006), Cragg-Donald (1993), and Sargan (1958)-Hansen (1982) J test can be used to determine whether these problems exist. However, to use these tests, it is first necessary to check whether the models exhibit homoskedasticity or heteroskedasticity. Because, while in the case of homoskedasticity, it is suggested that the results of the Anderson test, Cragg-Donald test, and Sargan test, if heteroskedasticity is detected in the models, it is recommended to use the Kleibergen-Paap rk LM test, Kleibergen-Paap Wald test, and Hansen J test.

3.5. Interactive Model

According to the interactive model, so as to investigate the impact of two or more variables that assume there is a relation between the variables, it's required to establish such a $Y = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 XZ + \varepsilon$ (13) model. In this model, any change in X will increase or decrease Y , depending on the conditions of the Z variable. The hypothesis of the model is as follows:

H_1 : An increase in X is associated with an increase in Y when condition Z is met, but not when condition Z is absent.



Source : Brambor et al. (2006)

Graphic 1. Interactive model consistent with H_1 hypothesis

The impact of Y and X variables, which are assumed to be associated with each other, may vary according to the Z variable condition. These conditions might vary in some situations. For instance, when $Z = 0$, if the derivation of Model (12) is taken with respect to X $\frac{\partial Y}{\partial X}$ the slope coefficient

becomes β_1 . On the contrary, if $Z = 1$, the slope coefficient equals $\beta_1 + \beta_3$. This case can be summarized as the X variable could affect the Y variable depending on the Z variable condition (in the case of $Z = 1$) as much as the coefficient of the slope of $\beta_1 + \beta_3$ (Brambor et al., 2006, pp. 64-66).

4. Results and Discussion

In this study, since 6 countries and 29 years were used, it was decided whether there was a CD between the variables of interest in accordance with the test statistic of Pesaran et al. (2008) (hereafter PUY 2008). It has been found that there is strong evidence of CD. This result means that any shock or crisis in one or more countries examined will affect other countries in the BRICS-T region. These results confirm that they corroborate both the phenomenon of globalization and the relations of countries with each other, and are consistent with the expectations.

In the analyses made with non-stationary variables, besides the inconsistency of the t-statistics and F-statistics results, the problem of spurious regression is also encountered. For this reason, we test the variable's stationarity by employing the CADF test. According to the analysis result, all the variables of interest are stationary at the level I (0) value. It can be said that the analysis made in line with these results will not contain spurious regressions, and the results of F-statistics and t-statistics will not be biased.

Table 1

The CADF and CD Test Results

Indicators	Brazil	China	India	Russia	S. Africa	Turkey	CIPS	LM _{ADJ} (PUY, 2008)
LNLP	-3.604**	-3.286*	-2.570	-3.034*	-3.108*	-2.899	- 3.083***	38.272*** (0.000)
LNHC	-1.125	- 4.782***	-1.446	-1.400	-2.777	-3.275*	-2.467**	21.282*** (0.000)
LNGCF	-2.588	-3.763**	-1.785	-2.889	-3.003*	-2.384	- 2.736***	20.600*** (0.000)
LNPART	-1.971	-3.224*	-2.717	-2.176	-2.120	- 4.789***	- 2.833***	30.809*** (0.000)
LNOPN	-3.786**	-2.740	-1.131	- 4.409***	-2.900	- 4.353***	- 3.220***	15.164*** (0.000)
LNGS	-2.503	- 4.362***	-2.678	- 4.735***	-2.236	-3.172*	- 3.281***	39.808*** (0.001)
LNICT	-2.800	-3.392**	- 3.052***	-1.978	-3.516**	-1.311	- 2.675***	22.083*** (0.000)

LNLMR	-	-3.991**	-1.638	-4.035**	-3.636**	-2.637	-	22.988***
	7.535***						3.912***	(0.000)
C	%1	-4.11	-4.11	-4.11	-4.11	-4.11	-2.57	
	%5	-3.36	-3.36	-3.36	-3.36	-3.36	-2.33	
	%10	-2.97	-2.97	-2.97	-2.97	-2.97	-2.21	
C+T	%1	-4.67	-4.67	-4.67	-4.67	-4.67	-3.10	
	%5	-3.87	-3.87	-3.87	-3.87	-3.87	-2.86	
	%10	-3.49	-3.49	-3.49	-3.49	-3.49	-2.73	

Notes. *** 1%, ** 5%, * 10% represent critical values. **PUY**: Pesaran, Ullah, and Yamagata (2008) for CD, **C+T**: Constant and Trend Model, and **C**: Constant model. The most convenient lag length was determined as two according to the “Schwarz” information criterion for CADF, and for the CD test as one.

Deciding on the estimator according to the heteroskedasticity, autocorrelation, endogeneity, and CD relationship between the variables means that the coefficient estimation results will show the appropriate relationship. In that respect, Driscoll and Kraay’s (1998) estimator was employed due to the existence of heteroskedasticity, autocorrelation, and CD. The 2SLS estimator was used to address the endogeneity problem. To determine heteroskedasticity, autocorrelation, and CD, we apply test methods developed by Pesaran et al. (2008), Bhargava et al. (1982), Baltagi and Lee (1995), Born and Breitung (2016), and Breusch and Pagan (1980). The results are presented in Table 2. Heteroskedasticity, autocorrelation, and CD are present in all models.

Table 2

The Result of Direct Models

Variables	D-K Model-1	2SLS Model-1	D-K Model-2	2SLS Model-2	D-K Model-3	2SLS Model-3	D-K Model-4	2SLS Model-4
LNHC	1.564*** (0.000)	1.789** (0.015)	1.306*** (0.000)	1.479** (0.019)	1.737*** (0.000)	1.900** (0.023)	1.372*** (0.000)	1.670** (0.032)
LNGCF	1.006*** (0.000)	1.022*** (0.002)	0.835*** (0.001)	0.859*** (0.010)	0.952*** (0.000)	0.963** (0.017)	0.698*** (0.000)	0.818** (0.011)
LNPART	- 3.541*** (0.000)	-3.286** (0.048)	-3.252*** (0.000)	-2.974* (0.072)	- 3.025*** (0.000)	- 2.913** (0.034)	- 3.066*** (0.000)	-2.998** (0.043)
LNOPN	-0.261* (0.092)	-0.359* (0.099)						
LNGS			0.086 (0.550)	0.064 (0.648)				
LNICT					0.315*** (0.005)	0.223** (0.004)		
LNLMR							1.013** (0.013)	0.400 (0.686)
Constant	19.420** * (0.000)	18.081** * (0.001)	18.996*** (0.000)	17.743** * (0.004)	16.933** * (0.000)	16.506* (0.000)	18.415** * (0.000)	17.810** * (0.000)
R²	0.4125	0.4143	0.6575	0.6474	0.2217	0.2066	0.6478	0.5542

F and Wald Test	846.35** (0.0000)	39.57*** (0.0000)	87.63*** (0.0000)	41.57*** (0.0000)	769.87** (0.0000)	13.52* (0.0090)	148.58** (0.0000)	18.41* (0.0010)
Hausman	1.7260 (0.7859)	0.83 (0.9344)	51.8330** (0.0000)	94.10*** (0.0000)	2.9621 (0.5641)	1.57 (0.8148)	16.9950* (0.0019)	24.56*** (0.0002)
Hansen Test		1.967 (0.1607)		2.346 (0.1256)		3.240 (0.0718)		2.678 (0.1017)
Cragg-Donald F Test		4342.304		5137.106		7489.568		6525.846
Kleibergen-Paap Wald F Test		763.496		801.599		1059.553		1797.444
Stock-Yogo ID 10% CV		19.93		19.93		19.93		19.93
Kleibergen-Paap rk LM Test		5.898 (0.0524)		5.037 (0.0806)		4.831 (0.0893)		4.566 (0.1020)
Anderson-Rubin Wald Test		5.17 (0.0606)		4.96 (0.0650)		4.20 (0.0851)		4.45 (0.0775)
LM_H	26.2510*** (0.0000)		76.7682*** (0.0000)		15.9571*** (0.0069)		28.4817*** (0.0000)	
LM_P	963.5853*** (0.0000)		145.4984*** (0.0000)		462.9322*** (0.0000)		100.8743*** (0.0000)	
VIF (Mean)	2.99		3.79		1.89		1.90	
LM_{ADJ} (PUY, 2008)	4.943*** (0.000)		8.043*** (0.000)		2.753*** (0.003)		4.196*** (0.000)	
Number of Observations	174	156	174	156	120	102	120	102
Number of Countries	6	6	6	6	6	6	6	6

Notes. The critical values are *** 1%, ** 5%, and * 10%. **LM_H**: Heteroskedasticity Test, **LM_P**: Autocorrelation Test. **D-K**: Driscoll-Kraay Estimation Test. 2sls are estimated using the vce(robust) command. In parentheses, the probability value is presented. In models 1 and 2, the lag length has been determined endogenously as 3. The lag length for model 3 and model 4 is 2. HC_{t-3} and PART_{t-3} are used as instrumental variables for 2sls.

In all established models, as in line with theoretical expectations, we found a strong positive linkage between human capital and labor productivity. Mankiw et al. (1992), in their published paper, utilize the Solow growth model and conclude that the effect of human capital is positive. Besides, these results are in line with some papers by Delsen and Schonewille (1999) and Astriou and Agiomirgianakis (2011), while it is not in line with Baharin et al. (2020).

There's a meaningful connection between gross capital formation and labor productivity, which highlights their importance together. It is generally accepted that there are sectors such as health, industry, tourism, energy, education, manufacturing industry, and technology among the sub-items of gross capital formation, and that these sectors have positive effects on labor productivity. Most importantly, there has been a consensus that more technological innovation

impacts labor productivity. Additionally, one can assert that gross capital formation sets the basis of different externalities, uses technological innovations, and contributes to the development of more productive areas. While the result is not in line with Ursavaş, it is in line with Choudhry et al. (2016).

Theoretical analysis suggests that employment exerts a negative influence on labor productivity. This might be described by the law of diminishing returns. For instance, the Phillips Curve claims that when unemployment goes down, inflation tends to rise, and vice versa. That is, the unemployment rate will increase in an economy with a low inflation rate. In such a situation, policymakers try to increase aggregate demand and production, thus increasing employment rates with increased labor demand. In this case, labor productivity is also increased. However, in accordance with the law of diminishing returns, as the use of labor increases, labor productivity tends to decrease. In this study, the inflation variable coefficient obtained is in line with the theoretical framework. Besides, the essay's results are in line with Gust et al. (2002) and Choudhry (2009).

It is anticipated that trade openness will have a positive and significant influence on labor productivity. This situation can be considered in this context: When the real exchange rate goes up, it can often cause the national currency to lose value. As a result, national goods will be relatively cheaper than imported goods, and thus, exports will increase because of the cheapening of national goods. As a result of increased exports, employment will rise, and unemployment will decrease. Moreover, the export-based industrial policy applied by a country may prove to achieve sustainable economic growth. This policy will have a positive reflection on the labor market and thus contribute to the rise of labor productivity. Studies conducted by Freund and Bolaky (2008), Kosack and Tobin (2015), and Tran et al. (2019) determined that there are many reasons for a positive relation between variables of interest. Among the reasons are to achieve economic integration, a high education level, and trade openness. In conclusion, countries that have achieved economic integration will be more open to foreign countries and have more capital flow, and thus, they will be able to increase their labor productivity. In addition, considering the study of Kutan and Yiğit (2007), who stated that economic integration's positive effect stems from capital accumulation, the low level of capital accumulation and trade openness in the country group in this study explains the negative relation between the variables of interest.

The expectation is that information and communication technology (ICT) will significantly and positively affect labor productivity. This result can be clarified in the framework of Solow (1957) model. The ICT variable is used in three different ways in Solow (1957) model. Firstly, the impact of ICT on the production of goods and services. Second, the use of ICT as an input in the production of other goods and services. Lastly, it pointed out the beneficial impact of ICT on total factor productivity. Some studies published by Gust and Marquez (2002) and Belorgey et al. (2006) also found similar results.

Table 3

The Interactive Model Results

Variables	Model-1	Model-2	Model-3	Model-4
LNHC	1.623 (0.025) **	1.526 (0.019) **	2.057 (0.032) **	1.905 (0.014) **
LNGCF	1.032 (0.002) ***	0.851 (0.010) ***	0.989 (0.018) **	0.860 (0.010) ***
LNPART	-3.306 (0.053) *	-2.956 (0.069) *	-2.918 (0.028) **	-2.955 (0.040) **
LNOPN	-0.318 (0.138)			
LNHCXOPN	-0.752 (0.000) ***			
LNGS		0.061 (0.656)		
LNHCXGS		0.339 (0.000) ***		
LNICT			0.236 (0.002) ***	
LNHCXICT			0.435 (0.000) ***	
LNLMR				0.219 (0.825)
LNHCXLMR				1.727 (0.000) ***
Constant	18.306 (0.002) ***	17.665 (0.004) ***	16.267 (0.000) ***	17.382 (0.000) ***
R ²	0.3810	0.6463	0.2415	0.5517
F and Wald Statistic	39.42 (0.0000) ***	39.63 (0.0000) ***	12.33 (0.0151) **	20.51 (0.0004) ***
Sargan-Hansen Test	2.129 (0.1445)	2.279 (0.1311)	3.334 (0.0679)	2.826 (0.0927)
Cragg-Donald F Test	320.924	6234.833	1018.259	545.103
Kleibergen-Paap Wald F Test	148.078	624.297	126.015	43.181
Stock-Yogo ID 10% CV	19.93	19.93	19.93	19.93
Kleibergen-Paap rk LM Test	5.521 (0.0633)	5.063 (0.0795)	5.010 (0.0817)	4.281 (0.1176)
Anderson-Rubin Wald Test	4.29 (0.0822)	5.09 (0.0622)	4.35 (0.0806)	5.54 (0.0539)
VIF (Mean)	3.43	3.79	1.89	1.91
Number of Observations	156	156	102	102
Number of Countries	6	6	6	6

Notes. *** %1, ** %5, and * %10 indicate critical values. The probability values are in parentheses. The interaction term and PART_{t-3} are used as instrumental variables. All models are estimated using the vce(robust).

To comment on the result of the marginal effect of human capital, we draw a 95% confidence interval. The confidence intervals of variables have been drawn using Aiken and West (1991) method. The figures below illustrate the marginal effect of trade openness, information and communication technology, labor market reforms, and savings. The line between the lower and upper lines denotes the variable's positive impact on labor productivity depending on human capital. To exemplify, at the upper right side in Figure 2, the result of the savings' marginal effect based on human capital condition on labor productivity is positive.

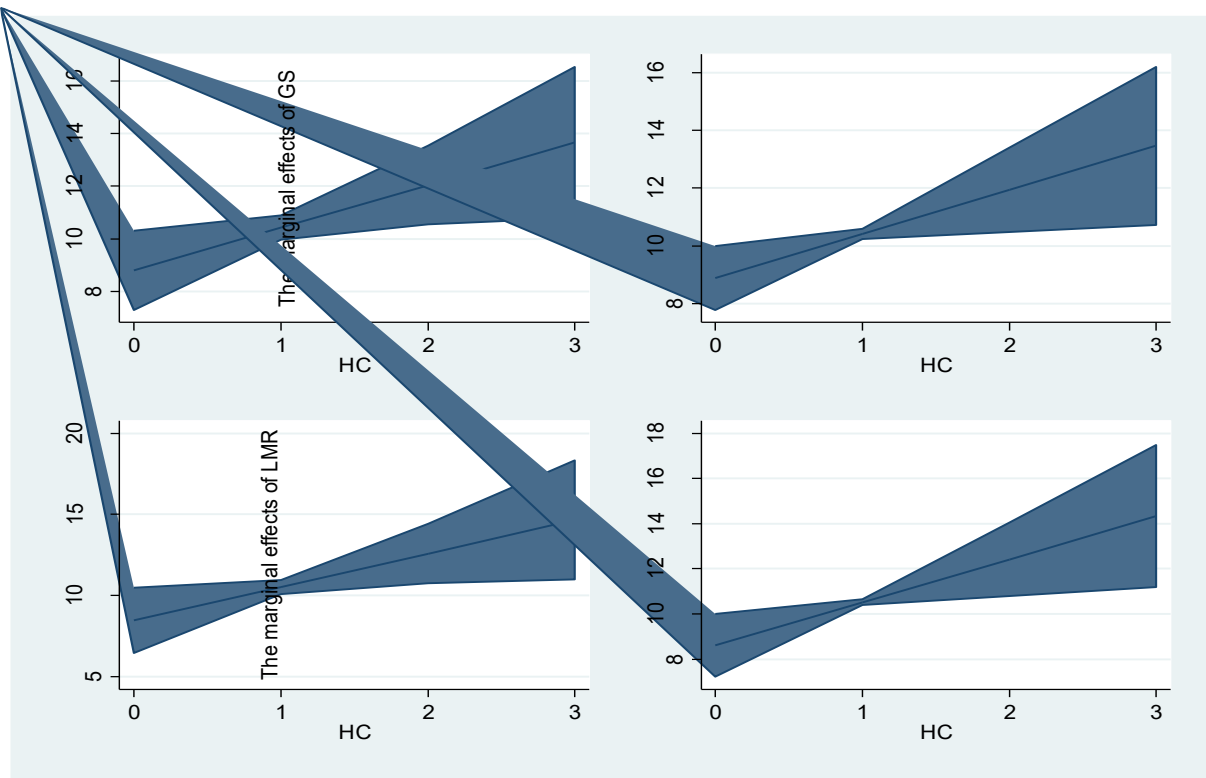


Figure 1. The Marginal Effect of OPN, GS, ICT, LMR

The marginal effect of trade openness (OPN), depending on human capital, at the upper left side of Figure 1, was obtained from the first model in Table 3. This relation could be discussed in the context of the stock of knowledge. Domestic innovation might increase or decrease productivity growth. Since the increase in domestic innovations is related to human capital, countries with a lower stock of knowledge will quickly imitate those with higher stocks (Edwards, 1997: 6-7).

The information and communication technologies (ICT) marginal effect, depending on human capital, on the lower left side of Figure 1, which corresponds to the third column of Table 3, is demonstrated. The positive relationship can be clarified as follows: adding ICT lectures to the

education curriculum from primary to tertiary levels can provide a more productive evaluation of the learning process. Thus, by using ICT, the training provided can be more effective and lasting. Training given using ICT helps people to be more practical in solving problems with different learning techniques, and thus can be more productive by saving more time.

Lastly, the marginal effect of saving (GS) depending on human capital is illustrated at the upper right side in Figure 1. The result is obtained from the sixth column in Table 3. This case can be interpreted by financial education literacy. Individuals who become conscious of issues such as investment, budget management, consumption, and savings with financial education literacy will manage their financial situations more effectively, and this will have a positive reflection on labor productivity. In this regard, many seminars and studies are organized by the OECD and the World Bank to increase financial education literacy.

5. Conclusion

The hypothesis that human capital affects labor productivity directly and indirectly has been investigated for BRICS-T countries during the 1991-2019 period. In accordance with the analysis results, human capital has a beneficial influence on labor productivity, as indicated by both direct and indirect model results. Bhargava et al. (1982), Baltagi and Lee (1995), Born and Breitung (2016), LM_{adj} PUY (2008), and Breusch and Pagan (1980) used for determining some specification tests such as autocorrelation, heteroskedasticity, and cross-section dependency. We apply Driscoll and Kraay (1998) and Two-Stage Least Squares to adjust for endogeneity, heteroskedasticity, and autocorrelation. Additionally, we employ Aiken and West's (1991) standard error test methods to calculate the marginal effect of variables. As a result, the hypothesis tested in this study is valid.

It is likely that human capital investment is a crucial variable, particularly in labor-intensive countries, and that investing more in human capital will have a significant impact on labor productivity. Table 3 shows that variables depending on human capital have a strongly significant impact on labor productivity. This illustrates the importance of human capital. In this direction, disseminating lifelong education and providing training tailored to the needs of all fields will be appropriate policies to increase labor productivity.

Education constitutes a fundamental component of human capital. Examining education's contribution to the economy, Barcenilla-Visús and López-Pueyo (2018) concluded that the unskilled labor force increases imitation in European Union countries, while the skilled labor force

contributes to the economy via innovation. In this respect, investments to enhance education quality, especially in labor-intensive countries, will help increase both national welfare and labor productivity. The increase in skilled individuals may be reflected in labor productivity increases through the production of technology-intensive goods and the rise in exports of these products. From this perspective, it would not be wrong to say that more inputs will be provided to the country, and labor productivity will increase as a result.

The skilled labor force's contribution to the country's economy can be evaluated in two ways: (i) socioeconomic and (ii) economic. From a socioeconomic perspective, both the health of the skilled labor force and the increase in their welfare level will benefit their social development. If we evaluate it from an economic perspective, socioeconomically developing individuals will be more efficient in developing new production techniques in the production process. However, implementing policies that focus solely on human capital investment will not be sufficient. If skilled individuals cannot be employed and their wages are low, migration movements will begin. We can see this circumstance more clearly in Türkiye sample. In Türkiye, situations such as decreased purchasing power due to high inflation, the validity of the phenomenon of jobless growth, and low real wages cause the skilled labor force to migrate.

In conclusion, educated individuals can more quickly and efficiently manage situations, such as developing technological innovations in the production process, adapting to new techniques, and using the most efficient way to do a job. Furthermore, they can contribute to increasing inputs by enabling the faster production and export of technology-intensive goods. However, focusing not only on human capital investments but also on macro variables such as technology, economic integration, production, employment, and the labor market will positively affect labor productivity.

Declaration of Research and Publication Ethics

This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement

Since the author is the sole author of the article, his contribution rate is 100%.

Declaration of Researcher's Conflict of Interest

There are no potential conflicts of interest in this study.

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