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A Generalized Method of Moments Estimation

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BULLETIN OF SOCIAL SCIENCES AND HUMANITIES
Graduate School
TOKYO INTERNATIONAL UNIVERSITY
No. 4 offprint September 20, 2019

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Abstract

This study aims to examine the relationship between human capital and economic growth. Besides the direct impact of human capital endowments on economic growth, the study examines the indirect effect of human capital on growth process through the interaction of human capital with the economy's industrial specialization. Following Barro and Sala-i-Martin (2003), the study extends their cross-section analysis into large panel analysis using a dynamic panel GMM (Generalized Method of Moments) technique, so-called system GMM. Results suggest that human capital and industrial specialization are essential factors to promote a country's economic growth. In addition, the indirect impact of human capital on economic growth is negative. It implies that the mismatch between structural change processes and the human capital endowments can make a negative impact on the growth process.

Keywords: Economic growth, Human capital, Structural change, System GMM
JEL Classification: J24; O11; O15; O47

1. Introduction

In recent decades, there has been a growing number of empirical works regarding economic growth topic. The analysis of factors of economic growth has been one of the fundamental subjects of extensive literature. Researchers worldwide have analyzed the effect of certain variables on economic growth. In fact, both the theoretical literature and empirical studies have highlighted a number of economic, political, and social determinants of economic growth. However, this study is going to focus on human capital for a number of reasons.

Firstly, there is a long history of interests in human capital and economic growth from social scientists. Human capital is the economist's term representing knowledge and skills that a worker acquires through education, training, and experience. It includes the skills accumulated not only in early childhood programs, grade school, and high school but also from college and on-the-job training for adults in the labor force. Workers with more education are more productive and innovative, therefore human capital has a direct effect on economic growth. It leads to making of new ideas and improving productivity factors. In addition, human capital is a complex term that eschews a simple definition and measurement, and also a concept that has been investigated from a variety of perspectives by social scientists. Finally, there is an intuitive appeal to the proposition that human capital accumulation ought to make a country richer in the long run. "Investment in human capital is important for a country's long-run economic success" (G.Mankiw, 2010).

However, previous studies mainly concentrated on the direct effect of human capital on economic growth. There is a lack of studies which analyze the impact of human capital on economic growth through the process of changing the structure of economy. Therefore, this study is going to figure out both the direct and indirect impacts of human capital on economic growth, taking into account the interaction of human capital with the country's industrial specialization.

2. Literature review

2.1. Human capital

Human capital refers to education, health, on-the-job training, and the skills acquired through the interaction of people or societies. The definition of human capital is "the skills the labor force possesses and is regarded as a resource or asset." It encompasses the notion that there are investments in people (e.g., education, training, health, etc.) and that these investments increase an individual's productivity. In more technical term, human capital is defined as the aggregation of the innate abilities and the knowledge, and skills that individuals acquire and develop throughout their lifetime. As an economic concept, human capital is more than two centuries old. In 1776, Adam Smith mentioned the idea of human capital in his fourth definition of capital - "The acquisition of talents during education, study, or apprenticeship, costs a real expense, which is capital in person. Those talents are part of his fortune and likewise that of society".[2] In 1897, Irving Fisher was the earliest formal use of the term "human capital" in economics. The late 1950s, this term became considerably more popular. Studies focusing on the role of human capital endowments in determining economic growth are numerous. In the study of Wilson (2004), an in-depth appraisal of the links between education and training in Europe and its economic growth was found. The study concluded that the impact of investment in education and training on national economic growth is positive and significant. Also, the indirect effect of education on non-economic benefits is also examined in the context of the technological, spatial, and environmental gains to society.

Mankiw (2010) believes that investment in human capital is at least as necessary as investment in physical capital for a country's long-run economic success because human capital promotes the quality of labor force, thus, increases its productivity. It is normal to consider that an additional school year will raise the productivity and efficiency of labor force, and therefore their income will increase. In addition, human capital is particularly important for economic growth since human capital conveys positive externalities. Externality is the impact of one person's actions on the well-being of other people. For example, a person who has a high-level education might create new ideas about how to make the best goods and services. If these ideas enter society's pool of knowledge in which everyone can use them, then the ideas are an external benefit of education. It implies that the return to schooling for society is higher compared to the return for the individual. Besides, some empirical researchers found the evidence to show that differences in the average schooling of countries are related to different economic growth rates (Benos and Zotou, 2013). Easterly and Levine (1997) showed that low economic growth is associated with low schooling in the case of Sub-Saharan Africa. Moreover, several studies proved that human capital is an important factor to promote Research and Development (R&D) - refers to innovative activities undertaken in developing new services or products or technologies. In other words, the more educated the labor force of a country is, the higher the advantages of the R&D activities in terms of economic growth got. Workers, for instance, who have high-skill as well as high-level education, can easily absorb new ideas and technologies already created by developed countries. Therefore, through the process of importing equipment and technologies, human capital will promote higher investment in physical capital (Benhabib and Spiegel, 1994).

Furthermore, human capital also affects economic growth through its interconnections with institutions. Sianesi and Reenen (2003) showed that education, besides increasing the productivity of the labor force, tends to improve health levels, environmental conditions, and social cohesion. Similarly, Glaeser et al. (2004) proved that human capital accumulation supports economic growth because it contributes to shaping effective policies, more political stability, and less criminal. Therefore, investment in human capital affects not only on individual returns but also drives a spillover effect that produces social benefits (Dias and Tebaldi, 2012).

2.2. Structural change

Structural change has been one of the major concerns in economics over the last few decades. The definition of structural change is that the shifts in sectoral composition where certain industries gain relative shares in an economy (Krelle, 2002). In fact, many empirical studies showed that the productive structure of an economy and especially its dynamics emerge as an important determinant of economic growth (Montobbio, 2002; Saviotti, 2008; Teixeira and Fortuna, 2011). In Krelle's study (2002), dynamic multi-sector world model was applied to examine the impact of structural change on economic growth. The result showed that economic growth is inevitably connected with structural change. In a study related to the growth experiences (Silva and Teixeira, 2011), the results proved that the shift in structure affected economic growth. All 21 countries in the sample had relatively similar economic structures in the late 1970s. However, these countries' structures changed from 1979 to 2003, leading to the difference in growth rate in each state. Therefore, besides the importance of human capital accumulation, the differentials in economic growth across countries should be traced by structural change, and the complexity underlying their productive structures.

In the literature, the impact of structural change on economic growth has been a highly contentious issue. Based on evolutionary and economic development related approaches, several studies showed a positive relationship between structural change and economic growth. In contrast, studies followed supply-side approaches based on cost disease (Baumol, 1967) believe that structural change leads to a continuing decline in aggregate productivity growth. According to Pendeder (2003), and Silva and Teixeira (2011), structural change in favor of specialization in more advanced technological industries leads to stimulate economic growth because those industries can create direct impacts on growth process by making new ideas of production that will result in a more efficient reallocation of resources. Also, those technological sectors can attract more skilled workers because they pay better salary. However, according to structuralist theories, stressing economic specialization itself is not sufficient to promote economic growth, depending instead on the sector that dominates the economy. Aditya and Acharyya (2013), with a sample of 65 countries for the period 1965–2005, analyze the relationship between export and economic growth. The study showed that the growth of high technology exports contributes to the output growth; the relationship becomes stronger for countries that have the share of manufacturing exports in their total exports higher than the world average. Thus, a shift in specialization towards industrial products can enhance economic growth.

Besides the impact of structural change on economic growth, economists have also considered the relationship between human capital and structural change. From the structuralist point of view (Justman and Teubal, 1991), human capital is considered as an important factor of economic growth because it advances structural change. In fact, previous studies have proved that human capital has a critically important role in the evolution of a country's specialization because structural change and the specialization of countries mainly depend on skills and workers' productivity, factors which are closely related to human capital. Krishna and Levchenko (2013) showed that less developed countries with low levels of human capital would specialize in less complex goods. High-technological sectors will tend to locate in countries with a high stock of human capital. In addition, using data for a large sample of countries, Ciccone and Papaioannou (2006) showed a significant positive impact on human capital levels and human capital accumulation on output and employment growth in human-capital-intensive industries. Besides, the country with a higher level of human capital has the benefit to absorb new technology from other countries. Meanwhile, structural change is related to the transfer of technology from developed countries to developing countries. Teixeira and Fortuna (2011) indicated that though human capital has a substantial direct impact on the total factor productivity, the latter's indirect impact, by means of machinery and equipment imports, is tremendous. Through the technological catching-up process, countries can have productive structures with more technological content. However, in order to get successful processes, those countries need a minimum threshold of human capital since creative and innovative methods require larger stocks of human capital. Moreover, when the country's stock of human capital increases, consumers become more talent and smart. It means that they will look for 'high-tech' services and goods, which also contributes to the structural change of an economy (Justman and Teubal, 1991).

3. Methodology

3.1. Model and variables

Barro and Sala-i-Martin (2003) conducted an empirical analysis of economic growth to answer an interesting question whether poor economies tend to "catch up", which means tend to grow faster than rich economies. They used an empirical framework that relates the real capital growth rate to two types of variables: first, initial levels of state variables such as the stock of human capital; and second, other control or environmental variables. In this study, the model is based on the typical cross-country catch up equation (Barro and Sala-i-Martin, 2003). In the dynamic framework, the equation can be written by the following specification:

$$ln\_Y_{i,t} = \alpha * ln\_Y_{i,t-1} + \beta * X'_{i,t} + \mu_i + \varepsilon_{i,t}, \quad (1)$$

where $ln\_Y_{i,t}$ is the natural logarithm of real Gross Domestic Product (GDP) per capita treated as a dependent variable, $ln\_Y_{i,t-1}$ is the natural logarithm of lagged dependent variable and $X'_{i,t}$ represents a vector of variables influencing economic growth, which includes human capital accumulation, structural change, and other potential determinants. $\varepsilon_{i,t}$ is an i.i.d (independently and identically distributed) error term with E[$\varepsilon_{i,t}$] = 0 and the subscripts i and t denote country and time period, respectively. μ_i is unobserved individual-specific effects that is not correlated with the error term ($\varepsilon_{i,t}$).

Besides human capital and structural change, a set of other determinants of economic growth recurrently reported by previous relevant studies are added. In detail, the econometric model estimated, equation (1) can be written as:

$$ln\_Y_{i,t} = \alpha_1 ln\_Y_{i,t-1} + \beta_1\, ln\_hc_{i,t} + \beta_2\, strc_{i,t} + \beta_3\, int_{i,t} + \beta_4\, pub_{i,t} + \beta_5\, inves_{i,t} + \beta_6\, rpop_{i,t} + \beta_7\, dem_{i,t} + \beta_8\, ope_{i,t} + \beta_9\, lar_{i,t} + \mu_i + \varepsilon_{i,t}, \quad (2)$$

where $ln\_hc_{i,t}$ represents the natural logarithm of the human capital index, $strc_{i,t}$ is structural change – the share of high-tech/high knowledge-intensive industries in total employment, $int_{i,t}$ computed by multiplying the value of human capital and structural change ($hc \times strc$) is the variable measuring the interaction between human capital stock and structural change, $pub_{i,t}$ is the share of public consumption in the gross domestic product, $inves_{i,t}$ is the investment rate (in physical capital), $rpop_{i,t}$ is the population growth rate, $dem_{i,t}$ is the level of democracy, and $ope_{i,t}$ and $lar_{i,t}$ are the degree of trade openness and the ratio of workers to population, respectively.

The variables considered are as follows:

Real GDP per capita: To measure the dependent variable, economic growth, the natural logarithm of GDP per capita is used as a proxy. The value for real GDP at constant 2011 prices (in mil.US$) is collected from the dataset of Penn World Table version 9.0 (PWT 9.0). Also, real GDP is divided by population.

Human capital: There are many variables which are used as proxies of human capital (see Appendix **Table A1**). For instance, some studies employed a proxy for human capital accumulation by primary and secondary enrollment rates (Barro, 1991; Levine and Renelt, 1992; Dreher, 2006; Batten and Vo, 2009) while some other studies used expenditure on education and health to measure the stock of human capital (Hartwig, 2012). However, the average years of schooling of the adult are the most widely used as a proxy of the stock of human capital (Rajan and Zingales, 1998; Hall and Jones, 1999; Temple and Womann, 2006; Bodman and Le, 2013; Teixeira and Queiros, 2016).

In fact, selecting a proxy of human capital is a fundamental issue regarding studies of economic growth and human capital. Nowadays, scholars worldwide make a considerable effort to find a good proxy representing human capital. The dataset of Barro and Lee (BL, 2013) and Cohen and Soto (CS, 2007) has been more popular to measure human capital. The BL dataset provides information about the average years of schooling at all levels (primary, secondary, and tertiary) for 146 countries in 5-year intervals from 1950–2010. Meanwhile, the CS dataset shows information on years of schooling across countries in every 10-years between 1960 and 2000. The CS dataset is constructed by the OECD database on educational attainment and from surveys published by UNESCO. The CS dataset has been updated by Cohen and Leker (2014), so-called CSL dataset. The CSL gives the educational attainments of the population of 95 countries.

Pen World Table (PWT) version 8 introduced a human capital index based on the average years of schooling from BL dataset and an assumed rate of return to education, based on Mincer equation (Psacharopoulos, 1994). The PWT dataset presents new data for human capital each year across countries between 1950 and 2010. However, some researchers believe that the BL data have undesirable features related to their inconsistent use of the data source. In fact, the general difficulty in constructing data on the average years of schooling in the population is to combine information from population censuses with information on school enrolment, in the face of difference in classification systems between censuses. Therefore, PWT 9.0 (2015), BL dataset and CSL dataset were combined in compiling the human capital index. They computed a human capital index based on both series as:

$$\phi(s)=\begin{cases} 0.134*s & if\ s \le 4 \\ 0.134*4 + 0.101(s-4) & if\ 4 < s \le 8, \\ 0.134*4 + 0.101*4 + 0.068(s-8) & if\ s > 8 \end{cases} \quad (3)$$

where s is the average years of schooling from either dataset. The assumed rates of return from Psacharopoulos (1994) are applied. The result of combining is that PWT 9.0 gives information yearly for 150 countries throughout 65-year-period from 1950 to 2014. Therefore, the Human Capital Index from PWT 9.0 is used to measure the stock of human capital in the study.

Structural change: This variable refers to long-term shifts in the sectors of an economy. To measure these shifts, employment composition data is used. In detail, these values come from the Groningen Growth and Development Centre (GGDC) 10-Sector Database, which provides information regarding the number of employees in 10 broad sectors. The variable is measured by the share of high tech/high knowledge-intensive industries in total employment. The data is divided into groups, according to the intensity of knowledge that each activity requires. This classification is based on Peneder (2007). Specifically, in this research, Manufacturing, Finance, Insurance, Real Estate, and Business Services sectors are considered as the high tech/high knowledge-intensive industries. The number of employees in high tech/high knowledge-intensive industries later is divided by total employees.

Investment rate: According to most of the empirical studies, physical capital accumulation is measured by the investment share to GDP. Hence, PWT 9.0 dataset is used to obtain this variable. Regarding measuring, from the value of capital stock, the following formula is applied to calculate investment. $I_t = K_t - K_{t-1}) * (1 - \delta)$, where I_t is investment in period t, K_t and K_{t-1} are capital stock at constant 2011 national prices (in mil. 2011US$) in period t and in period t-1, respectively. δ is the average depreciation rate of the capital stock. After that, investment (I) is divided by real GDP.

Public expenditures: This variable is measured by public consumption to GDP ratio. The public consumption data is collected from PWT 9.0. Barro and Sala-i-Martin (2003) believe that a higher value of the government consumption ratio links with a lower steady-state level of output per effective worker. Therefore, it leads to a lower growth rate for given values of the state variables. Afonso and Jalles (2014) also showed that government expenditures had negative effects when they analyzed the impact of fiscal composition on long-term growth in the case of OECD countries.

Population growth rate: This factor is an important determinant of economic growth. In the neoclassical growth model, the population growth rate has a negative effect on the steady-state ratio of capital to the worker. In addition, a high population growth rate also reflects greater resources devoted to child-rearing (Barro, 2003). Thus, it is expected that there is a negative effect of population growth rate on economic growth.

Democracy: This variable is calculated based on two indexes provided by Freedom House (Political Rights Index and Civil Liberties Index). These data began the early 1970s, therefore, another dataset (Bollen, 1990) is added to calculate the democracy variable. The variable has been adjusted to a zero-to-one scale, with zero represents the highest freedom, and one is the lowest. This variable is included in the model to analyze the impact of the quality of institutions and governability of a country on economic growth. The role of governability and institutions in the process of economic growth have been the source of considerable research effort. In fact, these effects of the quality of institutions and governability on growth are quite ambiguous. Thus, through these variables, the study is going to figure out the impact of the quality of institutions and governability of a country on economic growth. We examine the hypothesis that that freer and fairer countries tend to have higher economic growth rates.

The level of trade openness is calculated by the ratio of exports plus imports to GDP. Considering the variable, the study aims to analyze the effect of the trade regime environment on economic growth. Meanwhile, the labor force variable is measured by the ratio of workers to population.

A list of variables with their corresponding description and the source is in the Appendix (**Table A2**), as well as the list of countries included in the sample (**Table A3**). The sample includes 38 countries (10 Asian countries, 7 European countries, 10 American countries, and 11 African countries). The model is estimated for a long period from 1960 to 2014. Besides, this dataset includes a wider range of the levels of economic development and human capital compared to previous studies, therefore, the results will reveal the relationship between human capital and economic growth comprehensively. Last but importantly, the expected conclusions from the study might confirm even more strongly the effect of human capital on economic growth in comparison with other studies.

3.2. Generalized method of moment estimation

Several econometric problems may arise from the estimating equation (1). First of all, three variables (human capital, structural change, and economic growth) may have a bilateral causal relationship. Therefore, the endogeneity problem with the empirical model may arise inevitably. Moreover, as can be seen from equation (1), the dependent variable, that is dynamic, depends on its own past values. Therefore, the lagged dependent variable is correlated with the error term. It means that the regressors are potentially endogenous and will not produce a consistent estimate of a coefficient. That problem renders the traditional “fixed effects” and “random effects” panel estimators inconsistent.

In order to mitigate the endogeneity problem with the explanatory variables, Arellano and Bond (1991) proposed the use of instrumental variables to deduce the generalized method of moments (GMM) of corresponding moment conditions, so-called difference GMM. The basic idea of the method is eliminating the individual fixed effect by proceeding with the first difference of regression equation in the first place. Following that, the lagged variable will be considered as the corresponding instrumental variable of the endogenous variables in the difference equation. However, the lagged levels of the regressors are poor instruments for first-differenced regressors. Hence, it is reasonable to apply the augmented version - "system GMM" (Arelllano and Bover, 1995; Blundell and Bond, 1998). The Arellano-Bover/Blundell-Bond estimators augment Arellano-Bond estimator by making an additional assumption that the first differences of instrument variables are uncorrelated with fixed effect. This assumption allows an introduction of more instruments and can improve the statistical efficiency dramatically. In other words, the system GMM estimator uses the level equation to obtain a system of two equations: one difference and one in levels. By adding the second equation, the additional instruments can be obtained. Thus, the variables in levels in the second equation are instrumented with their own first difference. This usually increases statistical efficiency.

In equation (1),

$$ln\_Y_{i,t} = \alpha * ln\_Y_{i,t-1} + \beta * X'_{i,t} + \mu_i + \varepsilon_{i,t}$$
$$\mathrm{E}(\mu_i) = \mathrm{E}(\varepsilon_{i,t}) = \mathrm{E}(\mu_i\, \varepsilon_{i,t}) = 0$$

Considering the first difference to remove the individual specific effect, we can rewrite (1) as

$$\Delta(ln\_Y_{i,t}) = \alpha * \Delta(ln\_Y_{i,t-1}) + \beta * \Delta X'_{i,t} + \mu_i + \Delta\varepsilon_{i,t} \qquad (4)$$

As mentioned before, one of the immediate problems in applying OLS to this model is that the lagged dependent variable is correlated with fixed effects in the error term, which gives rise to "dynamic panel bias" (Nickell, 1981). It means that the regressors are potentially endogenous and will not produce a consistent estimate of the coefficient. Hence, it is inevitable to use the instrument to deal with the equation (1). Here, $\Delta\varepsilon_{i,t}$ is not serially correlated, and the explanatory variables are weakly exogenous. Therefore, the dynamic panel GMM estimator conducts the following moment conditions based on difference estimator for the equation (1);

$$E[lnY_{i,t-z}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \quad for\ t = 3, \ldots\ldots T,\ z \geq 2$$
$$E[X'_{i,t-z}\,(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \quad for\ t = 3, \ldots\ldots T,\ z \geq 2$$

Which can be written in following matrix form as;

$$\mathbf{M} = \begin{bmatrix} \mathbf{y_{i1}} & \mathbf{0} & \mathbf{0} & \cdots & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \mathbf{y_{i1}} & \mathbf{y_{i2}} & \cdots & \mathbf{0} & \cdots & \mathbf{0} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \cdots & \mathbf{y_{i1}} & \cdots & \mathbf{y_{i,T-z}} \end{bmatrix}$$

Here, M is the instruments matrix corresponding to the endogenous variables, where $y_{i,t-z}$ refers to $lnY_{i,t-z}$ for the equation (4).

However, the efficiency and consistency of the first-differenced estimator are criticized in terms of bias and imprecision. Therefore, to reduce potential biases and imprecision, Blundell and Bond (1998) suggested using system GMM that combines a system in the difference estimator with the estimator in the level. The difference operator in the equation (3) uses the same instrument as above, and the instruments for levels are the lagged difference of the explanatory variables. The intuition here is that the difference in the explanatory variables and the country-specific effects are uncorrelated. Thus the stationary properties are:

$$E[lnY_{i,t+p}\mu_i] = E[lnY_{i,t+q}\mu_i] \text{ and } E[X'_{i,t+p}\mu_i)] = E[X'_{i,t+q}\mu_i)] \ \forall \ p \text{ and } q$$

The additional moment conditions for the levels are

$$E[\Delta lnY_{i,t-1} \ (\mu_i + \varepsilon_{i,t})] = 0$$
$$E[\Delta X'_{i,t-1} \ (\mu_i + \varepsilon_{i,t})] = 0$$

Now, this study applies the system GMM estimation method for the dynamic panel data model to get more robustness of the result. However, GMM cannot be established as a consistent method of estimation unless there is no autocorrelation in the disturbance term. Hence, after running the regression, it is necessary to conduct some tests for checking estimators.

To check GMM estimator, as suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998), two specification tests are used. Firstly, the Sargan and Hansen test for the joint validity of the instruments is standard after GMM estimation. The validity of the moment condition can be directly tested by Sargan and Hansen tests. The null hypothesis of Sargan and Hansen test is that all instruments as a group are exogenous (thus, for the instruments to be valid one should not reject the null hypothesis). However, the behavior of the Sargan test statistic is only well-known when disturbances can be assumed as homoskedastic (Iqbal and Daly, 2014). Moreover, the Sargan test may have low power to reject the null hypotheses, the instruments are valid when the sample size is small (Bowsher, 2002). Given the shortcoming associated with the Sargen test and the fact that the Hansen test is the most adopted in practice, Hansen test is chosen to check the validity of the instruments.

Secondly, Arellano and Bond (1991) also developed a test for a phenomenon that would render some lags invalid as instruments, namely, autocorrelation in the idiosyncratic disturbance term, $\varepsilon_{i,t}$. Of course, the full disturbance ($\mu_i + \varepsilon_{i,t}$) is presumed auto-correlated because it contains fixed effects (μ_i), and the estimators are designed to eliminate this source of trouble. If the $\boldsymbol{\varepsilon_{i,t}}$ are themselves serially correlated of order 1, which make them potentially invalid instruments after all. For instance, $\mathbf{y_{i,t-2}}$ may be endogenous to $\varepsilon_{i,t-1}$ in the error term in differences. To test for autocorrelation without the fixed effects, the Arellano-Bond test is applied to the residuals in differences. Especially, in this study, the Arellano-Bond tests for the first-order (AR(1)) and the second-order (AR(2)) serial correlation in the first-differenced residuals are used to test for autocorrelation. Because the first differences of independently and identically distributed idiosyncratic errors will be serially correlated, rejecting the null hypothesis of no serial correlation in the first-differenced error at the order one does not imply that the model is misspecified. However, rejecting the null hypothesis at higher orders implies that the moment conditions are not valid.

4. Empirical results

The dynamic panel estimation results are presented in **Table 1**, which reports the regression result using System GMM estimators. In detail, the dynamic panel data estimation for the coefficients corresponding to each variable is provided. The results of three tests (Hansen

TABLE 1. RESULTS OF DYNAMIC PANEL-DATA ESTIMATION, SYSTEM GMM

Variable	Dependent variable: GDP per capita (in ln) 38 countries; 55 years (1960-2014)	
GDP per capita (lagged)	-0.992***	(0.003)
Human capital	-0.041**	(0.019)
Structural change	-0.446***	(0.087)
Interaction	-0.431***	(0.089)
Public expenditures	-0.035*	(0.024)
Investment	-0.044**	(0.013)
Population growth	-0.294	(0.282)
Democracy	-0.002	(0.008)
Trade Openness	-0.007	(0.019)
Labor Force	-0.130**	(0.035)

Observations: 2035　AR(1) p-value: 0.000　AR(2) p-value: 0.179　Hansen p-value:1.000

Note: Standard errors are in parentheses ; *,**,* Statistically significant at 1%, 5% and 10%, respectively**

test, AR(1) and AR(2) tests) are also reported in the Table. First of all, the test for the first-order serial correlation in the residuals AR(1) shows that the null hypothesis of no first-order serial correlation is rejected with P-value 0.000. Meanwhile, the test of the second-order serial correlation AR(2) reveals that all estimations have no problem of second-order serial correlation since AR(2) test statistic is unable to reject the null of the second-order serial correlation (P-value 0.179). In addition, the Hansen test for over-identification indicates the null hypothesis of exogenous instruments is not rejected with the p-value of 1.000.

As can be seen from **Table 1**, the coefficient estimation of the lagged GDP per capita variable is strongly significant, positive, and lower than 1. It conveys the typical conditional convergence result, in which countries with low initial GDP per capita levels present, on average, higher growth rates.

As for human capital, this variable shows a significant positive effect on economic growth. It means that countries which have a higher stock of human capital endowment will develop faster than other countries. The result suggests, as postulated in the literature, that countries with a higher human capital grow faster in the considered periods (1960–2014). This conclusion meets the expectation that a higher stock of human capital improves the workforce's skills, which has a positive impact on its productivity (Bodman and Le, 2013). Moreover, the coefficient of structural change is a positive sign with statistical significance. It suggests that the countries where structural change contributes to increasing the share of knowledge-intensive activities required high skills, on average, tend to grow faster. Hartwig (2012) and Zagler (2009) showed that knowledge-intensive activities employ individuals with higher skills and knowledge because they are more productive and capable of enhancing the emergence of new products and processes. Therefore, the growth rates of countries that observe increases in specialization in high-level industries tend to be higher.

The result with System GMM shows that human capital also has an indirect impact on economic growth via productive specialization.

The estimation of the moderating effect of human capital on structural change is significantly negative. Regardless of human capital having a significant positive direct impact on economic growth, its indirect impact via the productive structure in favor of high-level industries is negative. By analyzing the case of 38 countries within sample throughout 55-year-period from 1960 to 2014, the study suggests that economic growth is explained by the dynamics of human capital (education) and by the declining share of knowledge-intensive activities ('high-level'). It seems to prove that in the sample and transition economies, the matching between an adult population with high educational attainment and structural change towards a specialization in knowledge/technology-intensive activities does not contribute to higher economic growth.

Regarding the control variables, the coefficient of public expenditure is a negative sign. Therefore, high public consumption can make a negative effect on economic growth. Our results confirm the idea that high public consumption can create market distortions, inefficiencies, and crowding-out, that negatively affect economic growth. Moral-Benito (2012) suggested that a low level of government share (public expenditure) would promote economic growth since it reduces distortions in the economy. This result supports the finding of seminal studies (Barro, 1991) as well as more recent studies (Dreher, 2006; Batten and Vo, 2009; Afonso and Jalles, 2014). Furthermore, we found that a high investment rate is related to higher economic growth. As can be seen from the **Table**, the coefficient of investment has a significantly positive impact in explaining the variation of GDP per capita. This evidence is in line with the results of Dreher (2006), Batten and Vo (2009). Also, this result meets the conclusion of Barro's (1991) study. Barro believed that the high investment rate has a positive impact on economic growth since high physical capital formation contributes positively to the productivity of production factors. In brief, economies with a high level of investment tend to grow faster than others. In addition, the study suggests that the ratio of workers to population has a positive impact on economic growth. Finally, based on a more heterogeneous sample that includes a wide range of levels of economic development, this study fails to find evidence showing that population growth rate, the level of trade openness, and the democracy variable matter for economic growth.

5. Conclusions

This study aims to examine both the direct and indirect impacts of human capital on economic growth, taking into account the interaction of human capital with the country's industrial specialization in 38 countries over the period 1960-2014. Following Barro and Sala-i-Martin (2003), the study extended their cross-section analysis into large panel analysis using a dynamic panel GMM technique, so-call system GMM. The main findings of this study are as follows:

First of all, the study showed that the human capital endowment has an important influence on economic growth even though the set of data which includes a wider range of levels of economic development and human capital. The study demonstrates unequivocally the fundamental role of formal educational attainment, reflected in improved qualifications and higher skills. Some recent studies have doubted on the merits of 'average years of education' in explaining the long-term growth of countries. For instance, Delgado et al.

(2012) believe that in empirical research, the significance of schooling depends on the sample of observations or the specification of the model. They suggested that the average years of schooling may not provide a more reliable measure of human capital. However, using the Human Capital Index (Penn World Table 9.0) to measure the stock of human capital, this study provides evidence showing that years of schooling is still an effective measurement of human capital. Secondly, this study also contributes to the scientific literature on the relationship between economic growth and structural change. The result suggests that structural change is a critical factor in economic growth. Moreover, the study confirms that increasing specialization in knowledge/technology-intensive industries accelerates the economic growth of countries. Thirdly, our findings demonstrate that the mismatch between structural change processes and the human capital endowments of countries can make a negative influence on economic growth. It is a possibly unexplored issue as far as human capital and structural change interaction. The lack of industrial structures that cannot properly integrate the highly-educated individuals into the productive system, thus, generates disappointing economic returns for this latter set of countries. This outcome is supported by the evidence gathered by Jaoul-Grammare and Guiroment (2009), which analyzed the impact of education on economic growth. That study proves that an increase in mismatches between education and structural change leads to an unfavorable effect on economic growth.

Some policy implications arise from the study. The results suggest that to promote economic growth, countries should contemplate an investment in human capital through education. Furthermore, governments should invest more in technology/knowledge-intensive activities generating high value-added to the economies such as manufacture, financial, computers, business services, and education. In addition, the important point needs to highlight that the educational offer and system need to meet the market demands. The aim will be to promote the matching between skilled labor and economic activities that require these same qualifications. Finally, I acknowledge the limitation of this study and leave it for further research to analyze deeper the effect of the interaction term on economic growth.

Notes

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2) Smith A (2003; orig, publ 1776) “An Inquiry into the Nature and Causes of the Wealth of Nation”.

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Appendix

TABLE A1. LIST OF EMPIRICAL STUDIES RELATED TO HUMAN CAPITAL

No.	Authors	Research Period	Number of countries	Proxies of human capital
1	Barro (1991)	1960-1985	98 countries	Primary and Secondary enrollment rates
2	Levine (1992)	1960-1989	119 countries	Primary and Secondary enrollment rates
3	Mankiw (1992)	1960-1985	98 countries	Working-age population with secondary
4	Temple (2006)	1960-1996	76 countries	The logarithm of average attainment
5	Barro (2003)	1960-2000	112 countries	Educational attainment and health
6	Dreher (2006)	1970-2000	123 countries	Secondary enrollment rate and the logarithm of average life expectancy
7	Hartwig (2012)	1970-2005	18 OECD countries	Expenditure on education and health
8	Das (2013)	1971-2011	20 OECD countries	Working-age population with secondary
9	Moral-Benito (2012)	1960-2000	73 countries	Average attainment of working-age population by Barro and Lee
10	Iqbal (2014)	1986-2010	52 countries	Human Development Index by the United Nations Development Project
11	Teixeira (2014)	1960-2011	21 OECD countries	Average attainment of working-age population by Barro and Lee

TABLE A2. LIST OF VARIABLES USED

No.	Variables	Data source
1	Real GDP per capita	PWT 9.0
2	Human capital	PWT 9.0
3	Structural Change	GGDC 10-Sector
4	Public Expenditures	PWT 9.0
5	Investment	PWT 9.0
6	Population growth	PWT 9.0
7	Democracy	Freedom House, Bollen (1990)
8	Trade Openness	PWT 9.0
9	Labor Force	PWT 9.0

PWT 9.0 refers to Penn World Table version 9.0,
It can be found at https://www.rug.nl/ggdc/productivity/pwt/

TABLE A3. LIST OF COUNTRIES IN THE SAMPLE

Code	Country	Region	Code	Country	Region
1	Ethiopia	Africa	20	Taiwan	Asia
2	Ghana	Africa	21	Thailand	Asia
3	Kenya	Africa	22	Argentina	America
4	Malawi	Africa	23	Bolivia	America
5	Nigeria	Africa	24	Brazil	America
6	Senegal	Africa	25	Chile	America
7	South Africa	Africa	26	Colombia	America
8	Tanzania	Africa	27	Costa Rica	America
9	Zambia	Africa	28	Mexico	America
10	Egypt	Africa	29	Peru	America
11	Morocco	Africa	30	Venezuela	America
12	China	Asia	31	The USA	America
13	India	Asia	32	Denmark	Europe
14	Indonesia	Asia	33	Spain	Europe
15	Japan	Asia	34	France	Europe
16	South Korea	Asia	35	The UK	Europe
17	Malaysia	Asia	36	Italy	Europe
18	The Philippines	Asia	37	The Netherlands	Europe
19	Singapore	Asia	38	Sweden	Europe