

Article

The Impact of Openness on Human Capital: A Study of Countries by the Level of Development

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Abstract: This study investigates the impact of openness on human capital in 112 countries worldwide in 2000–2019. An two-stage least square fixed-effect model with instrumental variables is used to unravel the complicated relationship between human capital and its key determinants. The empirical results show that the impacts of openness vary greatly among different groups of countries. For example, while FDI has no effect on human capital in developed and upper-middle-income developing countries, its effect is positive in lower-middle-income countries and negative in low-income countries. Exports stimulate human capital formation in developed countries but in low-income developing countries, they act as an impediment to human capital formation. Imports have a positive effect on human capital in developing countries; however, in developed countries, the effect of imports on human capital is negative. International cooperation effectively raises the level of human capital in developed, upper-middle-income and low-income countries; however, it has no effect in lower-middle-income countries. In light of mindsponge—mindspongeconomics and the SM3D knowledge management system, the study's findings particularly shed light on the long-term development roadmap associated with human capital and openness expansion in less developed and emerging countries in years to come.

Keywords: openness; human capital; mindspongeconomics; mindsponge; SM3D; developed and developing countries



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1. Introduction

The achievement of high and sustainable economic growth has become a common goal for any country that wishes to raise their people's living standard. Human capital, defined as the stock of knowledge, skills and competency that the labor force possesses, plays an important role in economic growth (Mathur 1999). In economic growth theories, Schultz (1961) and Lucas (1988) recognized human capital as the driving force of economic growth. Classical growth theory scholar Solow (1956) and endogenous growth theory scholar Romer (1990) stressed the importance of technological progress as an engine for economic growth. Technological progress is realized either in the form of the creation of entirely new knowledge or the adaptation of existing technology. In both cases, the success in new technology invention or absorption of existing technology depends on the country's level of human capital. Since the 1990s, the world economy has witnessed an ever growing globalization (KOF Globalization Index 2022). Globalization frees up international trade in goods and services, flows of capital and movement of labor across nations. As countries become more open, their levels of human capital are affected in a number of ways.

Foreign direct investment is well known to be an effective vehicle for foreign technology transfer. As pointed out by Blomström and Kokko (2002), most of the world's advanced technology is owned and controlled by multinational corporations (MNCs) thanks to their large R&D efforts. When MNCs establish their physical presence in host countries, they

can exercise superior technology, which allows them to take advantage of the local firms and enjoy a higher labor productivity. In order to handle the new and superior technology, workers are required to have the needed skills and, therefore, training for local employees is provided. This training can be of various types, including on-the-job training, seminars and formal schooling when employees receive financial assistance provided by foreign firms to sponsor their formal education undertaken in the host country or oversea. Moreover, the forward and backward linkages that MNCs establish with local firms in the host country link their business performance to that of their local counterparts. As a result, MNCs have a strong incentive to provide training and technical assistance to their local suppliers and customers. In addition to its direct contribution, foreign direct investment can create a positive indirect effect on human capital formation in the host country via productivity spillovers. The transmission mechanisms of productivity spillovers from FDI may work through three channels, which are demonstration effect, competition effect and labor mobility (Sari et al. 2016). First, the existence of foreign firms in the host country is the best demonstration of their up-to-date technology, managerial skills and expertise, and the way of conducting business. Based on a close observation, domestic firms can learn, imitate and adapt this knowledge. Second, the introduction of MNCs places more competition pressure on domestic firms, which forces them to become more efficient. To increase their productivity, domestic firms are induced to adopt new and advanced technology and upgrade the skills of their workers. Third is the diffusion of knowledge in the labor market. Through work experiences with foreign firms, local workers acquire new knowledge and skills and those workers, once they change employment, can spread this knowledge, which will benefit other workers in the firms in which they later work.

On the one hand, FDI enhances human capital formation in the host country. On the other hand, foreign investment in the form of efficiency-seeking FDI is attracted to a country with a high level of human capital (Bellak et al. 2008). The increase in human capital raises labor productivity and makes the country become more productive and competitive from the perspective of foreign investors. As human capital is a determinant of FDI attractiveness, host countries have a strong incentive to invest in human capital. To attract FDI, more resources are allocated to education and health, leading to the enrichment of human capital.

Along with FDI, international trade is also considered as an effective channel for knowledge spillovers (Ali et al. 2016). Trade liberalization leads to the importation of high-tech merchandise and services. Advanced technology is embodied in machines and equipment; so, technology transfer occurs when this stock of capital is purchased. However, to foster economic growth, the mere access to foreign technology and know-how is only a necessary condition, but the sufficient condition is how well foreign technology can be absorbed into and diffused in the economy; therefore, human capital is key. Nelson and Phelps (1966) proposed that more technological progress in the economy increases the rates of returns to education and thus motivates people to become more educated.

There is a link between the local investment in human capital and the pattern of a country's exports (Blanchard and Olney 2017). Based on the Heckscher–Ohlin model of comparative advantage, Findlay and Kierzkowski (1983) proposed that a country with a comparative advantage in high-skill intensive goods will see an increase in the relative price of these goods once they open to trade. When a country specializes on the production of high-skill-intensive goods, the demand for high-skilled workers increases, which leads to a rise in high-skilled workers' wages or a higher return to education. This induces more workers to invest in education. The skill composition of the country's exports decides the effect of trade on educational attainment. Educational attainment increases with the growth in high-skill-intensive manufactured exports and decreases with the growth in low-skill-intensive manufactured exports.

Although studies on the impact of openness on human capital have been conducted at the individual country level, aggregate level, group of countries by region or by specific level of development, there is lack of studies investigating the difference in the impact of

openness on human capital among groups of countries by the level of development. With this in mind, our study aims to explore how openness affects human capital in developed and developing countries by answering the following research questions: (i) What are the key determinants of human capital formation across countries worldwide? (ii) How and through what mechanism does openness associated with foreign direct investment, international trade and international cooperation promote human capital development? (iii) What macroeconomic policies are strongly suggested for developing countries, particularly least developed countries (LDCs), to further develop the human capital, contributing to their long-term economic development? It is noted that developed countries have a high similarity in the level of development. They are all high-income countries and belong to the group of high level of human development. The levels of development in developing countries are, however, widely different. The United Nations classifies countries' level of development based on their income level. Developing countries are divided into high-income, upper-middle-income, lower-middle-income and low-income groups.

The rest of the paper is organized as follows. Section 2 presents the literature review and the proposed hypothesis. Section 3 describes the methods associated with the framework, model specification and model validation. The results and discussion are presented in Section 4. Finally, Section 5 is the conclusions and policy implications.

2. Literature Review and Hypothesis

2.1. Economic Development and Human Capital

The two major components of human capital are education and training, and health. There is a direct effect of income growth on educational trends. As proposed by Mincer (1996), education can be viewed as a consumption good when it generates a stream of non-market utilities involving learning and culture and as an investment good when it generates future earnings. When the income increases, the demand for education rises. Attaining a higher education enables people to acquire more knowledge and become more skilled workers. Additionally, a higher income allows people to invest more in their health human capital as they can afford to consume more healthy and nutritious foods and have access to better health care facilities (Goldin 2016). The increase in income enhances human capital formation. Changes in economic structure are associated with changes in human capital level. Herrendorf and Schoellman (2021) argued that the average human capital in non-agricultural industries is higher than that in agriculture. Due to the nature of jobs, workers in non-agricultural industries are required to have more skills than those working in agriculture. As the economy evolves to a higher level of development, the economic structure transforms in the direction of increasing the shares of industry and service sectors and declining the share of agriculture sector. The relative expansion of industry and service sectors creates more job opportunities, but new jobs require new and specific skills. People are therefore motivated to pursue education to acquire the needed skills to qualify for jobs. The national level of human capital should increase to match the rise in the relative share of non-agricultural industries in the economic structure. Therefore, our hypothesis was developed as follows.

H1. Higher economic development results in an improvement in human capital. Specifically:

H1.1. An increased GDP results in an improvement in human capital.

H1.2. A higher share of non-agricultural sector in the economic structure results in a higher improvement in human capital (Figure 1).

2.2. Urbanization and Human Capital

There is an association between urbanization and human capital since urbanization has an impact on education and health. As was argued by Arouri et al. (2014), there is more incentive for residents to invest in education in urban than in rural areas. Firstly, compared to rural areas, the expansion of education systems in urban areas is easier and less costly. Living in urban areas, people have more access to better education at all levels

and therefore higher rates of schooling enrollment are expected. Urbanization provides a mechanism that fosters learning and attaining a higher education. Secondly, urban areas generally have higher returns to education than rural areas. Big cities are concentrated with a numerous number of firms, which provides ample employment opportunities that attract skilled labor. The concentration of skilled labor creates human capital as an external effect when people have a positive influence on the productivity of others through the ways in which various groups of people interact (Lucas 1988). Henderson (2005) concluded that cities enhance knowledge spillovers. According to labor economic theory, the worker's wage is paid depending on their labor productivity. Positive externalities increase labor productivity and thus wages. In addition, since health care systems are more developed in urban areas, urban populations have more access to health facilities, which enhance their health conditions (Arouri et al. 2014). Therefore, hypothesis was developed as follows.

H2. *The growth in urbanization leads to the improvement in human capital.*

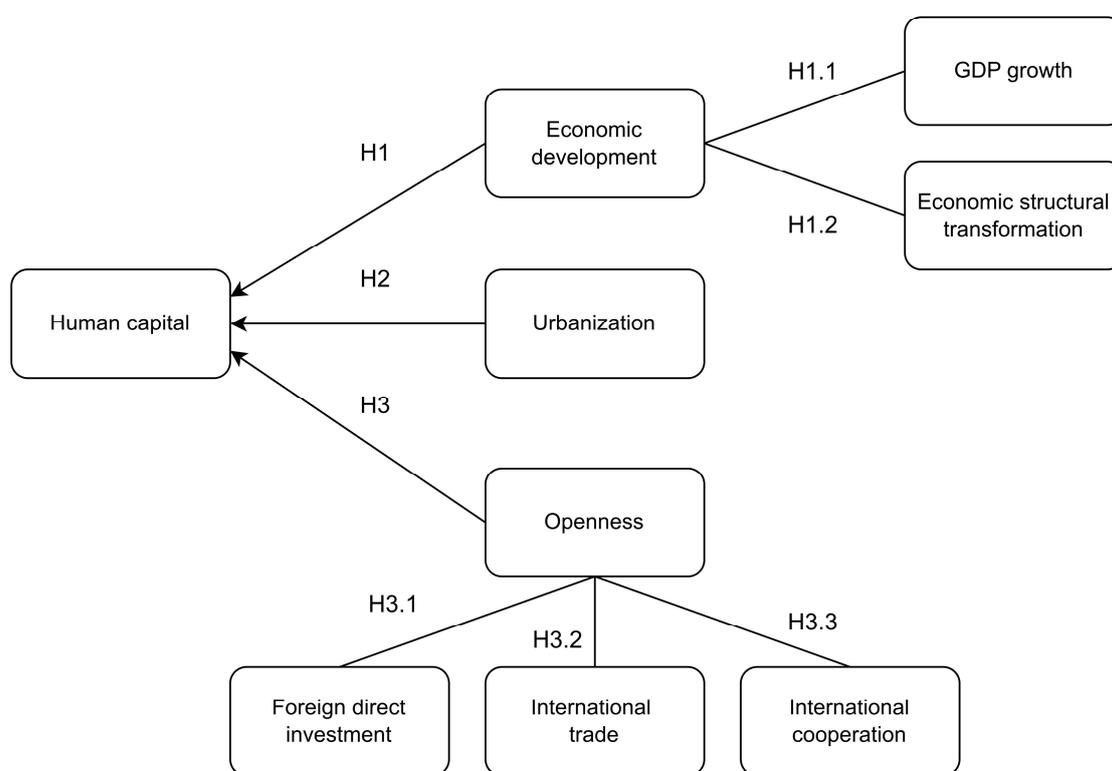


Figure 1. Proposed model of human capital. Source: our own elaboration.

2.3. Openness and Human Capital

There is a considerable number of empirical studies investigating the impact of FDI on the host country's human capital. A study by Mahmood and Chaudhary (2012) in the period from 1972 to 2010 concluded that FDI enhances the human capital level in Pakistan. At the country level, a positive impact of FDI on human capital has been found in various studies (Azam et al. 2015) for 34 developing countries from 1981 to 2013, Kheng et al. (2017) for 55 developing countries from 1980 to 2011, Zhuang (2017) for 16 East Asian countries from 1985 to 2010, and Van Nguyen et al. (2020) for ASEAN countries from 1990 to 2019. Gittens and Pilgrim (2013) studied developing countries in 1970–2010 and concluded that FDI has a positive impact on human capital measured at all levels from primary, secondary and tertiary education. In a study of the Southern African Customs Union countries in the 1990–2018 period, Henok and Kaulihowa (2022) showed a mixed result in the impact of FDI on human capital. FDI enhances primary education but has a negative effect on secondary education. Meanwhile, in their study of Azerbaijan, Uzbekistan, Kazakhstan

and Kyrgyz Republic in 1999–2011, [Yildirim and Tosuner \(2014\)](#) found no relationship between FDI stock and the level of education. Yet, the negative impact of FDI inflows on human capital development was evident in the study by [Bayar and Gunduz \(2020\)](#) for 11 European transition countries in the 1995–2018 period.

The impact of trade openness on human capital has also captured attention in empirical studies. [Blanchard and Olney \(2017\)](#) studied 102 countries from 1965 to 2010 to assess how the composition of a country's exports affects educational attainment. They found that the average educational attainment increases with the growth in skilled manufactured exports and decreases with the growth in agricultural and low-skill-intensive manufactured exports. A study by [Atkin \(2016\)](#) for Mexico in the years of 1986–2000 showed that expansions in less-skilled export-manufacturing industries increase school dropout rates. [Li et al. \(2019\)](#) found a similar result when they claimed that, in the period from 1990 to 2010, rapid trade liberalization in China led to the expansion of job creation in relatively low-skilled and labor-intensive sectors. This negatively affects human capital, displayed as a reduction in the number of completed schooling years and the likelihood of attending high school and college for young people. Using a panel data for 11 European transition countries in the 1995–2018 period, [Bayar and Gunduz \(2020\)](#) concluded that trade liberalization has a positive effect on human capital development.

Openness captures the degree to which a country is open to the rest of the world. This includes openness to international flows of goods and services: international trade; openness to international flows of capital: foreign direct investment; and openness to international coordination in policy making: international cooperation. Therefore, our hypothesis is presented below.

H3. *Openness has a positive impact on human capital. Specifically:*

H3.1. *The variable of FDI is positively associated with the variable of human capital.*

H3.2. *The variable of international trade is positively associated with the variable of human capital.*

H3.3. *The variable of international cooperation is positively associated with the variable of human capital.*

3. Methods

3.1. Econometric Model

Based on the literature review (theoretical framework) and the proposed hypothesis, an empirical model was developed and its equation is written as:

$$HMC_{i,t} = c + \beta_1 GDP_{i,t} + \beta_2 ESR_{i,t} + \beta_3 URB_{i,t} + \beta_4 FDI_{i,t} + \beta_5 EXP_{i,t} + \beta_6 IMP_{i,t} + \beta_7 ICO_{i,t} + \alpha_i + \mu_t + e_{i,t} \quad (1)$$

where the subscript i denotes country and t denotes time in years, α_i is the within-entity error term, μ_t is the unknown coefficient for the time regressor (t), and $e_{i,t}$ is the overall error term of the model for country i in year t .

- Human capital level (HMC): A proxy for this variable is the education index provided in UNDP's Human Development Reports. The education index is the weighted average of adults' mean years of schooling and children's expected years of schooling. The index ranges from 1 to 100 and a higher score indicates a higher human capital level.
- GDP level (GDP): This variable is measured as the natural logarithm of GDP. Data for GDP (in 2011 USD) were taken from the Penn World Table ([Feenstra et al. 2015](#)).
- Economic structure (ESR): This variable is measured as the share of the agricultural sector in the economic structure (% of GDP) or the share of non-agricultural sectors (sum of shares of industry and service sectors) in the economic structure (% of GDP). Data for shares of agriculture, industry and service were taken from World Development Indicators (World Bank).
- Urbanization (URB): A proxy for this variable is the ratio of urban population measured as the percentage of the total population who are living in urban areas. Data for this variable were taken from World Development Indicators (World Bank).

- Foreign direct investment (FDI): This variable measures net inflows of foreign direct investment (% of GDP). Data for net inflows of foreign direct investment were taken from World Development Indicators (World Bank).
- Exports (EXP): This variable measures the volume of exports (% of GDP). Data for export volume were taken from World Development Indicators (World Bank).
- Imports (IMP): This variable measures the volume of imports (% of GDP). Data for import volume were taken from World Development Indicators (World Bank).
- International cooperation (ICO): This variable captures the degree to which governments can cooperate in making policies. A proxy for international cooperation is political globalization index, which was taken from the KOF Globalization Index published by the Swiss Economic Institute (Dreher 2006). Political globalization is measured by the number of embassies, membership of international organizations and the number of international treaties signed. The index has a score ranging from 0 to 100 and a higher score implies a higher degree of political cooperation.
- Stock of capital (CAP): This variable is measured as the natural logarithm of physical capital stock. Data for physical capital stock (in 2011 USD) were taken from the Penn World Table (Feenstra et al. 2015).
- Stock of labor (LAB): This variable is measured as the natural logarithm of quantity of labor. Data for the quantity of labor as measured by the number of employed people who are engaged in production activities were taken from the Penn World Table (Feenstra et al. 2015). Table 1 provides information about variables and their description, measurement and data sources.

Table 1. Summary of the variables.

Variables	Description	Measurement	Mean
Human capital level (HMC)	Stock of knowledge, skills and competency that possessed by the labor force	Education index	Human Development Reports (UNDP)
GDP level (GDP)	Size of the economy's output and domestic spending capability	Natural logarithm of GDP (in 2011 USD)	Penn World Table
Stock of capital (CAP)	Size of the economy's physical capital	Natural logarithm of physical capital stock (in 2011 USD)	Penn World Table
Stock of labor (LAB)	Number of employed people who are engaged in production activities	Natural logarithm of quantity of labor	Penn World Table
Agriculture (AGR)	Share of agriculture sector in economic structure	Agriculture share (% of GDP)	World Governance Indicators (World Bank)
Non-agriculture (NAGR)	Share of industry and service sectors in economic structure	Sum of industry and service shares (% of GDP)	World Governance Indicators (World Bank)
Urbanization (URB)	Rate of urbanization	Ratio of urban population (% of total population)	World Governance Indicators (World Bank)
Foreign direct investment (FDI)	The inflow of foreign direct investment	Net inflows of foreign direct investment (% of GDP)	World Development Indicators (World Bank)
Exports (EXP)	Exports of goods and services	Export volume (% of GDP)	World Governance Indicators (World Bank)
Imports (IMP)	Imports of goods and services	Import volume (% of GDP)	World Governance Indicators (World Bank)
International cooperation (ICO)	Degree of international cooperation in policy making	Political globalization index	KOF Globalization Index (Swiss Economic Institute)

3.2. Data

The study investigating the impact of openness on human capital was conducted with 112 developed and developing countries worldwide. The group of developed countries included 36 countries (Table A1). According to the United Nations' country classification by income level, developing countries are divided into high-income (10 countries), upper-middle-income (26 countries), lower-middle-income (24 countries) and low-income (16 countries) groups. The period of study covered from 2000 to 2019 and was chosen based on two reasons. First, worldwide globalization started to grow strongly in 1990. According to the available data provided by the KOF Globalization Index, the world globalization only grew at the average annual rate of 0.62% in the 1970–1989 period, but the growth rate jumped to its double to 1.24% per annum in the 1990–2019 period. Due to the availability of data consistency for all countries, the starting period was 2000. Second, the COVID-19 pandemic has badly damaged the world economy since 2020 and its impact strongly disrupted many aggregate macroeconomic variables; however, data for the variables of GDP, stock of capital and stock of labor from Penn World Table (Feenstra et al. 2015) are unavailable from 2020 onwards. Therefore, the end period of the study was chosen to be 2019 for all variables.

3.3. Model Validation

Regression estimation is conducted for all country groups. In the regression equation, the agriculture variable or non-agriculture variable can be used interchangeably as they can describe economic structural transformation. For this reason, the estimation model for each group of countries, agriculture variable or non-agriculture variable was considered to choose the most appropriate one. In our model, there is a potential endogeneity problem, so an instrumental variable two-stage least square fixed-effect model was chosen for the estimation. To be specific, the GDP level was treated as the instrumental variable. Two variables were included in the model to account for their effect on GDP level, stock of capital and labor. Because the endogeneity test and the overidentification test of all instruments were passed, the estimated results are valid and accepted. The regression results are presented in the next section. Exceptionally, the result for the high-income developing country group did not pass the tests and, therefore, it is not valid and is not presented.

4. Results and Discussions

The regression results are presented in Table 2. As can be seen from the table, high economic growth has a positive effect on human capital in all groups of countries. As the level of GDP increases, more resource is allocated to education, training and health care activities. The country's level of human capital increases as people acquire more knowledge, enrich their skills and strengthen their physical health. Economic structural transformation had a significant effect on human capital. Declines in the share of the agricultural sector or increases in the shares of non-agricultural sectors favors human capital formation. Expansion in non-agricultural sectors creates more jobs with ever-demanding skills. Higher job opportunities induce people to attain education to acquire the needed skills. A positive relationship between urbanization and human capital is found in developed, lower-middle-income and low-income developing countries. As the rate of urbanization increases, more people can move from rural to urban areas. Living in urban areas, people should attain the needed skills to meet the requirements of the variety of available jobs and, therefore, demand for education increases. On the supply side, better infrastructure in urban areas facilitates education activities. More schools, universities and training centers and institutes are allocated in cities, which provide easier and more affordable access to better education for the urban population. Urbanization induces the accumulation rate of human capital. Other studies also reported this positive effect (Arouri et al. 2014; Bertinelli and Zou 2008).

Table 2. Impact of openness on human capital in developed and developing countries.

	Developed Countries	Developing Countries		
		Upper-Middle Income	Lower-Middle Income	Low Income
Human capital level				
GDP level	11.710 *** (1.061)	16.096 *** (1.288)	11.288 *** (0.673)	7.394 *** (0.882)
Economic structure: Agriculture	−0.421 *** (0.117)	0.010 (0.102)		
Economic structure: Non-agriculture			0.022 * (0.013)	0.038 * (0.021)
Urbanization	0.564 *** (0.049)	−0.058 (0.061)	0.276 *** (0.053)	0.153 * (0.081)
Foreign direct investment	0.004 (0.002)	0.054 (0.055)	0.038 ** (0.018)	−0.082 ** (0.035)
Exports	0.104 *** (0.020)	−0.018 (0.025)	−0.004 (0.014)	−0.092 *** (0.025)
Imports	−0.064 ** (0.025)	0.054 ** (0.024)	0.026 * (0.014)	0.112 *** (0.021)
International cooperation	0.186 *** (0.028)	0.166 *** (0.037)	0.023 (0.030)	0.303 *** (0.033)
GDP level				
Stock of capital	0.4993 *** (0.034)	0.591 *** (0.024)	0.589 *** (0.025)	0.497 *** (0.034)
Stock of labor	0.649 *** (0.045)	0.361 *** (0.033)	0.555 *** (0.064)	0.730 *** (0.099)
Centered R ²	0.710	0.711	0.868	0.818
Endogeneity test: <i>p</i> -value	0.035	0.012	0.017	0.022
Sargan test: <i>p</i> -value	0.297	0.670	0.157	0.107
Number of observations	715	499	473	315

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The impacts of openness on human capital vary greatly among the groups of countries. First, foreign direct investment has an effect on human capital in lower-middle- and low-income developing countries, while in developed and upper-middle-income developing countries, it shows no effect. In lower-middle-income developing countries, there is a positive effect of FDI on human capital. In these countries, FDI acts as an effective channel for foreign technology transfer and an effective source of local labor training. Through its direct and spillover effect, more FDI stimulates the host country's human capital formation. This finding is consistent with those of [Bayar and Gunduz \(2020\)](#), [Naroş \(2019\)](#) and [Van Nguyen et al. \(2020\)](#). In low-income developing countries, the effect of FDI on human capital is negative. It is not a surprising result. Low-income developing countries are also known as the least developed countries with a rather low level of human capital. Foreign firms are not ready to implement high technologies and may prefer to use labor-intensive technologies, which enable them to exploit cheap labor costs. Additionally, there is evidence of natural-resource-seeking FDI in the least developed countries when foreign firms are motivated to undertake investment for the exploitation of natural resources ([Dao 2023](#)). As more FDI firms opt to allocate their business in lower-skill industries that employ low-skilled workers, more demand for low-skilled workers results in higher wages for these workers. Higher low-skilled workers' wages discourage people from attaining education, which leads to a reduction in human capital. In upper-middle-income developing and developed countries, FDI has no effect on human capital. Developed countries have a similarly high level of human capital and they generally possess an advanced level of technology. Because of this, there is no room for the achievement of gains from FDI technology transfer. There is a clear dependency upon the country's level of

development on the effect of FDI on human capital. As the country's level of development increases, the FDI impact on human capital turns from negative to positive and eventually becomes saturated.

Second, as expected, trade liberalization impacts human capital, although the patterns of the impacts are different in different country groups. Exports have a positive effect in developed countries, while in low-income developing countries, the effect is negative. Developed countries are endowed with a high-skilled labor force and possess a high level of technology. They have a comparative advantage in high-tech and high skill-intensive products, whereas the least developed countries are characterized with an abundance of low-skilled labor and a poor level of technology. These countries have a comparative advantage in low-skilled-intensive products, mainly agricultural and primary goods. Trade openness allows countries to specialize in producing and exporting goods on which they have a comparative advantage. When countries are involved more freely in international trade, developed countries gain a higher relative price of high-skilled-intensive goods, while in the least developed countries, the relative price of low-skilled-intensive goods rises. As a result, the demand for high-skilled workers in developed countries increases, which increases high-skilled workers' wages and thus higher returns to skills. In the least developed countries, the increase in demand for low-skilled workers raises their wages and thus increases the cost of attaining education. Higher returns to skills induce people in developed countries to invest more in higher education, which enriches their human capital level. Meanwhile, in the least developed countries, a higher cost of attaining education decreases educational attainment, which lowers their level of human capital. This finding strongly supports the theoretical view proposed by [Findlay and Kierzkowski \(1983\)](#) that the skill composition of the country's exports decides the effect of trade on educational attainment.

In developing countries, imports stimulate human capital formation as they demonstrate a positive sign effect. Developing countries have large differences in the level of development. There exist vast gaps in technology level among countries and with developed countries. More freedom in international trade enables these countries to import high-tech machines or a way of purchasing foreign advanced technology. The application of advanced technology in production increases labor productivity and thus returns to education. Higher returns to education induce people to invest more in education to acquire modern skills, which endow them with absorptive capacity for incoming new advanced foreign technology. Additionally, trade openness facilitates the importation of foreign education and health services, which directly improve human capital formation. Students from developing countries have more opportunities to seek advanced education and training in developed countries and higher level developing countries.

Third, international cooperation demonstrates a positive effect on human capital in developed, upper-middle-income and low-income developing countries, while it has no effect in lower-middle-income developing countries. International cooperation is characterized by a diffusion of cooperative government policies. Developed countries have similar backgrounds in economic as well as human development level. They are all high-income countries with a high level of human development. A consensus on policy making to pursue common goals is thus easier to reach. In developed countries, especially those in the European Union, there is more freedom in labor movement across nations as workers in one country can search for employment opportunities in other countries. International cooperation in education sets the goal of improving the entire higher education system in those countries to ensure that a person that obtained training from any higher education institution can acquire the needed skills that qualify them to work in other countries. University degree awards are commonly recognized in the member countries. This encourages universities to engage in international cooperation in curricular settings and teaching courses, which then offer learners that enroll in one university various options to take courses in different universities and thus gain more experience in a foreign environment, which prepares them for future overseas working. A higher degree of international cooperation in education offers more benefits and the possibility of lowering costs for people to acquire

knowledge and skills. As a result, they are induced to invest in higher education, which fosters human capital formation. In international cooperation programs in education with developing countries, developed countries often provide Official Development Assistance (ODA) to finance scholarships for students from those countries to undertake studies in developed countries. However, some of these students, once they complete their training, decide to stay and work in developed countries and, therefore, this “brain gain” adds to the increase in human capital stock in these countries.

Developing countries due to the large differences in their level of development have incompatible education systems. International cooperative policies in higher education seek to achieve improvement in the quality of local universities. To become a partner with foreign universities in countries with a higher level of development, local universities should continuously increase their quality to meet accredited quality standards. However, improvement in quality requires an increase in costs and higher tuition fees. In upper-middle-income developing countries, higher tuition fees may not be a considerable problem, but in lower-middle-income developing countries, it may become a great barrier for local people. The access to higher education for people in these countries is limited, which leads to the reduction in human capital formation. From another perspective, international cooperative programs in education offer more opportunities to study abroad for local people. With more access to foreign education, domestic students can acquire more knowledge and skills, which enhances the development of human capital. While international cooperation in education results in a higher human capital level in upper-middle-income developing countries, the positive and negative effects of international cooperation in education may offset one another, leading to having no impact on the human capital level in lower-middle-income developing countries. Low-income developing countries have the largest impact of international cooperation on human capital. A more intense international cooperation provides more opportunities for the governments of these countries to receive ODA from foreign governments to finance education programs at home or scholarships for sending students to study abroad.

Our study offered a set of methodological, theoretical and practical contributions. This paper adopted an appropriate approach to the topic of human-capital-based economic growth. To be specific, the instrumental variable two-stage least square fixed-effect model was shown to be a powerful tool when dealing with endogeneity and analyzing the panel data. Another attribute of the study is the method of grouping countries by the level of development, which helps to capture further details about the estimated results of the model. It should be noted that the panel data will grow over time, necessitating much more empirical investigation to gain insights into related themes. In this regard, the approach and/or method utilized in this study could be replicated for future studies. Second, the study advanced the relationship of human capital and openness. According to economic principles, trade can assist every country in improving its economic situation. Hence, by delving deeply into the impact of openness on human capital, this study provided many insights into the underlying causes of economic growth. Third, the study offered policy implications on economic development for both developing and developed countries. For example, enhancing the quality of human capital is critical for rich countries’ future innovation and development, whereas attracting FDI and increasing imports should be LDCs’ major priorities. This study not only confirmed the right pathway for many nations through increased FDI inflows, strong international cooperation and broad international trade at present, but also suggests a roadmap for many countries by learning and harnessing openness for long-term development in years to come.

The study has some limitations. The first concern is with the data. This study relied largely on secondary data, which are subject to critique for being of low quality, limiting the quality of the conclusions derived to some extent. While we fully acknowledge this unavoidable limitation, we mitigated this concern to the best of our abilities by using well-vetted data from reliable sources. It should be noted that many well-known organizations, for example, the World Bank and OECD, currently publish country-scale secondary data,

which are widely used in many research projects. In addition, the data for some variables (i.e., GDP growth, labor stock and capital stock) were unavailable beyond 2019. This means that the model cannot account for the potential effects of the COVID-19 epidemic on human capital accumulation. This limitation, however, may be overcome when the data become available in coming years. The instrumental variable two-stage least square fixed-effect model provided a high level of accuracy and reassurance, but its restriction on variable selection can result in potential limitations. Human capital is a complicated variable because it might be reflected in another variable, for example, employment linked to types of jobs. While education shows the input quality of human resources relatively, employment associated with different jobs in the formal and non-formal economic sectors may reflect the country's human resource quality to some degree. As a result, the use of the study's conclusions should be approached with caution. Furthermore, we did not account for geographical aspects when developing the model, which could limit the understanding of the topic to some degree.

5. Conclusions and Policy Implications

Least developed countries (LDCs) have a strong incentive to prioritize and expedite economic growth. This is because rapid economic growth can help to raise people's living standards and close the development gap with developed nations. This research aimed to advance the understanding of the factors that influence human capital, with a particular emphasis on openness. Utilizing an two-stage least square fixed-effect model with instrumental variables with a dataset of 112 nations from 2000 to 2019, we found several valuable findings. First, the top human capital variables are FDI, exports, international cooperation, economic growth, urbanization and economic structural transformation in favor of non-agricultural industries. FDI was found to be a strong driver of developing nations' human capital development, suggesting that further attracting as well as leveraging FDI should be among these countries' strategic priority. Second, while exports have been the engine of growth in rich countries, they have been ineffective in developing human capital in many least developed countries, implying that LDCs should exercise caution in their export-based economic development policies. Third, international cooperation emerged as an important driver in supporting multifaceted development, not just human capital accumulation, suggesting that LDCs and emerging nations should actively participate in diplomatic and economic cooperation. This increases the chances of low-resource countries achieving quick economic growth and sustainable development in an unpredictable and/or changing world. In light of mindsponge–mindspongeconomics (Khuc 2022; Vuong 2023) and the SM3D knowledge management system (Nguyen et al. 2023; Vuong et al. 2022), FDI, international trade and international cooperation are driving forces that facilitate the special advanced information-processing system that not only helps to reduce costs (Vuong 2018), but create a new generation of labor force with better knowledge and innovation, and build valuable disciplines that are essential and/or required for high-demanding industries. Additionally, urbanization has become a prevalent trend in many nations, and the development of sound policies and advanced infrastructure to enable this process is critical. We hope that the findings of this study can help to underpin the human-capital-based economic growth model (Mathur 1999) that has been in place for the last two decades and serve as a useful reference for LDCs and emerging countries to grow and catch up with wealthy countries in years to come.

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Appendix A

Table A1. List of 112 countries by the level of development.

Country Group	Country Name
(a) Developed countries (36)	Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States
(b) Developing countries (76)	(i) High-income countries (10): Brunei Darussalam, Chile, Hong Kong, Israel, Korea (Republic of), Oman, Saudi Arabia, Singapore, United Arab Emirates, Uruguay
	(ii) Upper-middle-income countries (26): Algeria, Argentina, Belize, Botswana, Brazil, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Fiji, Gabon, Guatemala, Iran, Iraq, Jamaica, Jordan, Malaysia, Mauritius, Mexico, Namibia, Paraguay, Peru, South Africa, Thailand, Turkey
	(iii) Lower-middle-income countries (24): Bangladesh, Bolivia, Cabo Verde, Cambodia, Cameroon, Congo, Côte d'Ivoire, Egypt, El Salvador, Ghana, Honduras, India, Indonesia, Kenya, Lao, Mongolia, Morocco, Nicaragua, Nigeria, Pakistan, Philippines, Sri Lanka, Tunisia, Viet Nam
	(iv) Low-income countries (16): Burkina Faso, Burundi, Chad, Gambia, Guinea, Guinea-Bissau, Madagascar, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Sudan, Togo, Uganda, Zambia

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