Economic Complexity Index and Economic Development Level under Globalization: An Empirical Study*

Zhuqing Mao

DST/NRF South African Research Chair in Industrial Development, College of Business and Economics, University of Johannesburg, South Africa

Qinrui An[†]

Rinascita College of Liberal Arts and Science, Shinhan University, South Korea

Abstract

Purpose – This paper empirically investigates the relationship between the Economic Complexity Index (ECI) and the level of development. Moreover, this research attempts to discover the determinants of ECI in the globalization wave.

Design/methodology – Our empirical model considers the relationship between ECI and the level of development in middle- and high-income economies from 1995 to 2010 by using systemic qualitative analysis, including OLS, fixed-effects, and system GMM. Next, this research used OLS regression to find the determinants of ECI. In particular, we compared the effects of different factors on ECI in the different development stages.

Findings – Our main findings can be summarized as follows: 1. If the ECI increases by 1, it could lead to an increase of about 30% in the level of development in middle- and high-income economies. 2. Human capital plays an important role in the development of and increase in ECI. 3. GVC participation and outflow FDI enhance an increase in ECI, in particular in middle-income economies. 4. The development of manufacturing industries is helpful to increase ECI; however, middle-income economies should pay more attention to their comparative advantage industries. 5. R&D has positive effects on the ECI.

Originality/value – To the best of our knowledge, this is the first paper that uses systemic qualitative analysis to investigate the relationship between ECI and the level of development. The paper provides suggestions for policy makers to increase ECI under the current wave of globalization, in particular in middle-income economies.

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Keywords: Economic Complexity Index, Development, Globalization, Global Value Chains, Economic Structure

JEL Classifications: F00, F14 O10

1. Introduction

Globalization offers the opportunity to transfer knowledge, to exploit the capability of the local economy and to achieve development. Scholars have started to pay attention to studies on globalization and development, in particular to find ways to develop under the new waves of globalization as the internet and communication technology have shortened the distance

between people and increased international cooperation. The technological process requires us to consider development and globalization as one system. Such research is valuable to link the development of economics and the geography of economics.

Against the background of rapid globalization, a measure of the accumulation of know-how in trade has been developed (Hausmann et al., 2014). The knowledge intensity index is the economic complexity index (ECI), which indicates the productive capability of an economy using information of the products exported. The ECI is useful to predict the income level and helpful to understand economic development (Dar et al. 2020).

Because the ECI plays an important role in development, it is worthwhile discovering the relative factors that affect ECI. The accumulation of knowledge is associated with external influences and internal capabilities. The external influence works through trade, foreign direct investment (FDI), and global value chains (GVCs). The internal capabilities are improved through education, innovation systems, and the economic structure.

This paper uses various quantitative methods to investigate the relationship between the economic complexity index (ECI) and the level of development, and attempts to find the determinants of ECI under the wave of globalization. The ECI is a new indicator of the latest wave of globalization, and was developed by Hidalgo and Hausmann in 2009. The ECI has been found to have a positive relationship with development and could be used to predict long-term growth (Hausmann et al., 2014; Mealy, Farmer and Teytelboym, 2018). However, a systematic empirical study investigating the relationship between ECI and the level of development cross countries is lacking. This research fills the gap. Moreover, this research uses the GVC indicator to analyze the determinants of ECI under globalization. GVCs are another aspect of new content developed due to globalization. This research analyzes the determinants of ECI in GVCs, which – to the best of our knowledge – is an original study.

This research compares the effects of different factors of the ECI at the different development stages and provided suggestions for policy makers to increase the ECI under the current wave of globalization, in particular for middle-income economies to escape from the middle-income trap. This paper also makes proposals for linking GVC indicators and the ECI for further research.

In this research, we undertake an empirical study to investigate the relationship between ECI and development, among others to establish the determinants of the ECI. The structure of the paper is as follows: section one is the introduction; section two reviews the literature on development and the ECI; in the third section we show the relationship between development and the ECI; while in the fourth section the determinants of ECI are set out. The conclusion and discussion are contained in the last section.

2. Literature Review

Globalization has complicated economic development and the international situation (Mao and Kim, 2019). Countries use technical barriers to enhance export growth and sustainable economic development (Bhyuan and Oh, 2020). In this process, global value chains (GVCs) play an important role. Sonea and Kob (2020) point out that Korea achieved more value added from GVCs in the auto industry and ship-building industry than other industries. In other words, a suitable economic structure helps to obtain more benefits for economic growth (Gu and Park 2020).

Sustainable and inclusive development can be contributed to by continuous technological innovation and industrial upgrading (Lin, 2011). The process of continuous technological and industrial innovation is associated with knowledge transfer. The accumulation of know-

how can be measured by the Economic Complexity Index (ECI) (Hausmann et al., 2014). The index contains information about the given economy's productive capabilities by calculating relative comparative matrixes across its export baskets (Hidalgo and Hausmann, 2009). In particular, the ECI can explain the differences in development across countries (Mealy et al., 2018). However, the relationship between development and the ECI is only reported through a simple linear graph in Hausmann et al. (2014). A systemic empirical analysis to examine the relationship between development and the ECI is lacking.

Not only the ECI, but also human capital (Benos and Zotou, 2014; Goldin, 2016), population (Aisen and Veiga, 2013; Dreher, 2006), investment (Aisen and Veiga, 2013; Aixalá and Fabro, 2009; Barro, 1991; Benhabib and Spiegel, 1994) and government consumption (Afonso and Jalles, 2014; Barro, 1991; Levine and Renelt, 1992; Moral-Benito, 2012) affect development. Moreover, as globalization increases, the openness has a significant effect on the development of economies (Mottaleb, 2007).

ECI indicates the accumulation of know-how through trade, which represents the productive structure by calculating the relative comparativeness through the trade data. International trade includes items of imports and exports in an economy (Helpman, 1999). FDI involves knowledge assets and plays a significant role in the diffusion of knowledge between the host economy and the source economy (Fan, Li and Pan, 2019; Hymer,1960). The effects of inflow FDI and outflow FDI on knowledge diffusion are different (Lall, 1980; Lin, Liu and Zhang, 2009). Human capital increases productivity through improving the quality of labor (Bodman and Le, 2013; Mankiw, Romer and Weil, 1992), while human capital also promotes the absorption capacity (Nelson and Phelps, 1966). R&D enhances innovation and the technological process (Bodman and Le, 2013; Benhabib and Spiegel, 1994; Romer,1990). For an economy to have a large domestic market is a condition to own the competitive advantage in the global economy (Porter, 1990).

Global value chains offer the opportunity to engage in the global production network with specialization in specific activities (Baldwin, 2018; Criscuolo, Timmis and Johnstone, 2016). Moreover, participation in the GVC provides a greater variety and better quality of foreign inputs for local producers, which increase the diversity of the product (Amiti and Konings 2007; Bas and Strauss-Kahn, 2015; Topalova and Khandelwal, 2011). The high specialization and greater diversity mean a high ECI (Hausmann et al., 2014).

The economic structure should differ based on the different endowments at different development stages (Lin, 2011), the so-called comparative advantage-following. In order to capture its competitive position in the domestic and world markets, an economy should follow its comparative advantage (Jones and Romer, 2010). The nature resource-based economies are different from the most developed economies, where the comparative advantage is the manufacturing industry.

3. Relationship between Development and the ECI

It is valuable to find out how to develop effectively. There is already a lot of research that has been done on development and economic growth (Aisen and Veiga, 2013; Barro, 1991; Barro and Lee, 1994; Teixeira and Queirós, 2016). This research focuses on investigating the relationship between the level of development and the ECI.

3.1. Economic Development

The development situation in the world from 1960 to 2008 is depicted in Fig. 1. Most economies are stuck in the middle box. These economies were middle-income economies in

1960 and still middle-income economies in 2008, although 50 years have passed. This phenomenon is the so-called middle-income trap (World Bank, 2010). It is notable that some economies, including South Korea, Japan, Greece, Singapore, Portugal, Spain, Ireland and Israel, successfully developed from middle-income economies to high-income economies, although the number of these successful catch-up economies is small. The successful catch-up economies are noted in Fig. 1. It is not easy to catch up with other economies.

Fig. 1. Middle-Income Trap
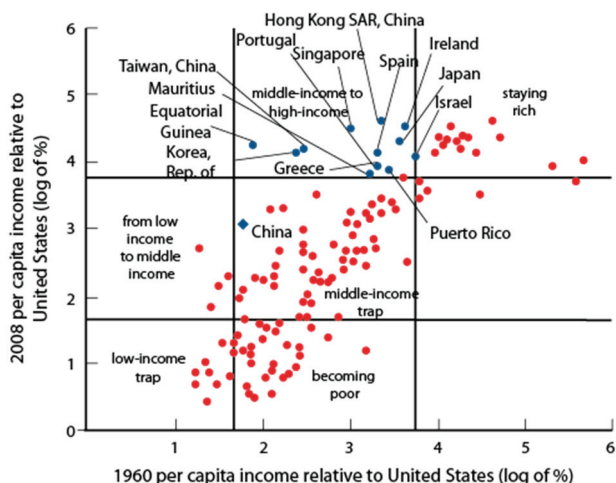
Source: World Bank (2010).

3.2. ECI

ECI is an index developed by Hidalgo and Hausmann to indicate the productive structure of an economy. This index represents information about the diversity of an economy's comparative advantage and the uniqueness of a given product (Hidalgo and Hausmann, 2009). A high ECI indicates that the economy is diverse and sophisticated, and exports products with low ubiquity.

ECI is calculated using the revealed comparative advantages (RCA) matrix (Hidalgo and Hausmann, 2009). The RCA of an economy is:

$$RCA_{cp} = \frac{X_{cp}}{\Sigma_p X_{cp}} / \frac{\Sigma_c X_{cp}}{\Sigma_{cp} X_{cp}}, \qquad (1)$$

where c is the country; p is the product; and X_{cp} is the total exports of product p from country c.

If the country has a revealed comparative advantage in product p, we let $RCA_{cp} = 1$, otherwise $RCA_{cp} = 0$.

We then can obtain an RCA matrix, which can be denoted as M_{cp}. This matrix can be used to define the productive structure of an economy, which is the diversity of an economy and the uniqueness of a product. The sum of each row of the matrix is the number of products that are exported by an economy with the comparative advantage, which is called diversity. The sum of each column of the matrix is the number of economies that export a product with

comparative advantage, which indicates the ubiquity of the exported product.

$$Diversity = k_{c0} = \Sigma_p M_{cp}$$
$$Ubiquity = k_{p0} = \Sigma_c M_{cp}$$

The ECI is defined as:

$$ECI_c = \frac{K_c - \langle K \rangle}{std(K)}, \tag{2}$$

where K_c is the eigenvector of $\widetilde{M}_{cc'} = \frac{1}{k_{c0}} \Sigma_p \frac{M_{cp} M_{c'p}}{k_{p0}}$ associated with the second largest eigenvalue, and the vector associated with the largest eigenvalue is a vector of ones (Hausmann et al., 2014; Kemp-Benedict, 2014).

The ECI represents the capability of one economy to engage in globalization. If the economy owns more capabilities it implies that the development of the economy should be high in terms of the accumulation of know-how (Hausmann et al., 2014)

Fig. 2 and Fig. 3 show a clear positive relationship between per capita GDP and ECI in 1995 and 2011. The countries noted in Fig. 2 and Fig. 3 are successful catch-up economies. These successful catch-up economies have moved to a high level of ECI and to high-level development. ECI and the level of development have a positive relationship in these two figures.
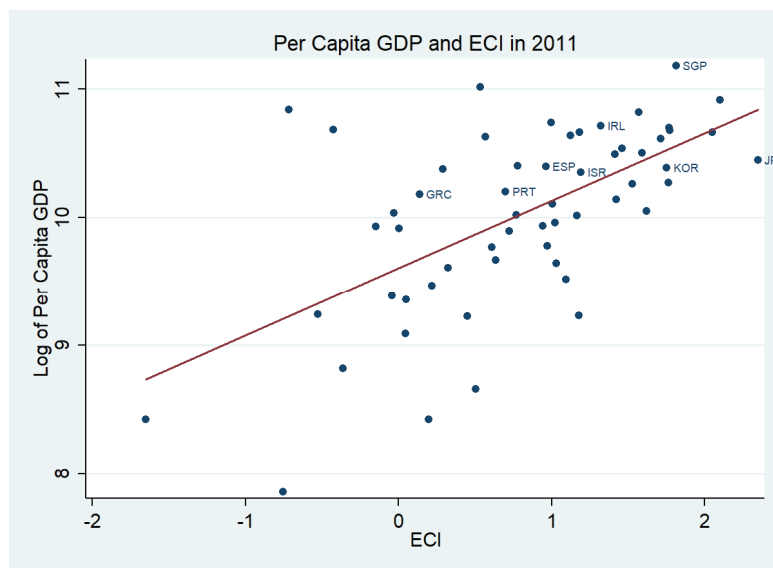
H1: ECI positively influences per capita GDP.

Fig. 2. Relationship between per capita GDP and ECI in 1995
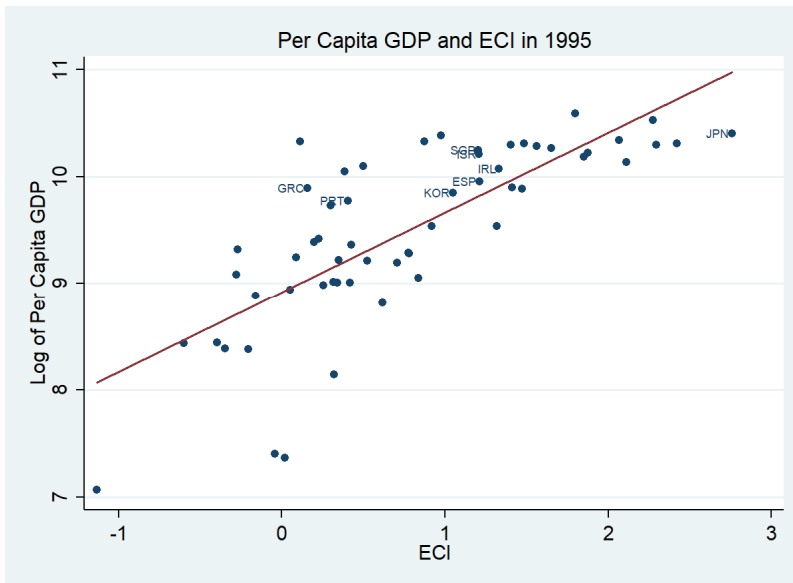
Source: Authors' creation.

Fig. 3. Relationship between per capita GDP and ECI in 2011

3.3. Methodology of and Variable for Development and ECI

This study used the equation below to examine the relationship between the level of development and ECI.

$$Per\ Capita\ GDP_{ct} = \beta_1 ECI_{ct} + Z_{ct}^T \theta_1 + \nu_i + \tau_t + \varepsilon_{it}, \qquad (3)$$

where c indexes country and t indexes time; per capita GDP is the log of per capita GDP, which is calculated using data from the Penn World Table database; ECI is the economic complexity index, which is from the growth lab at Harvard University; Z indicates the control variables; ν represents a country-specific effect and τ represents a period-specific effect; and ε is the error term.

This research selects the log of population, investment in GDP, human capital, openness, and the share of government consumption in GDP as the control variables. Population and human capital are from the Penn World Table database. Openness is the sum of the share of export and import in GDP. The share of export in GDP, the share of import in GDP, the share of investment in GDP and the share of government consumption are from the World Bank database.

GDP per capita is defined as one economy's GDP divided by the total population. The constitution of the GDP of an economy includes consumption, investments and trade. Therefore, in this research we selected the share of government consumption, the share of investment in GDP, and openness as the control variables. Furthermore, human capital positively affects development (Barro and Lee, 1994). Population affects the GDP per capita, based on the definition of GDP per capita. Human capital and population are considered as the control variables in this regression model.

This research uses panel data covering 57 countries and 12 years (1995 to 2011). The country list is in Table C in the Appendix. This paper uses the pooled OLS, fixed effects and system GMM to do the regression to examine the relationship between level of development and ECI. It should be noted that this research does not check the effects of ECI on economic growth, because the relevant literature emphasizes the relationship between ECI and the level of per capita GDP, and not the growth in per capita GDP (Hausmann et al., 2014).

3.4. Regression Results of Development and ECI

The regression results are reported in Table 1. The coefficients of ECI are positive in all models in the table, and they are significant in the OLS and system GMM results. The result of ECI shows that the per capita GDP would increase by about 30% when ECI increases by one unit. The level of development could be raised by increasing ECI. Therefore, it is valuable to know how to increase the ECI in globalization.

The results of Table 1 also show the significant and positive effects of human capital on the level of development. The results show the importance of education for development.

Table 1. Relationship between per capita GDP and ECI

	(1) OLS	(2) OLS	(3) FE	(4) FE	(5) GMM	(6) GMM
ECI	0.395*** (14.23)	0.259*** (9.27)	0.0512 (0.84)	0.0539 (0.90)	0.379*** (4.41)	0.278** (2.99)
Population (log)	-0.105*** (-10.87)	-0.0292* (-2.31)	0.115 (0.39)	0.237 (0.80)	-0.106** (-2.63)	-0.0299 (-0.60)
Investment per GDP	-0.00647* (-2.28)	-0.00569* (-2.08)	0.0159*** (5.10)	0.0148*** (4.58)	-0.00744 (-0.90)	-0.00535 (-0.62)
Human capital	0.701*** (15.77)	0.659*** (16.47)	1.391*** (9.95)	1.308*** (9.05)	0.757*** (4.72)	0.648*** (4.51)
Openness		0.00260*** (9.66)		0.000716 (1.31)		0.00255*** (3.56)
Government C		0.0371*** (10.64)		-0.00820 (-1.14)		0.0350** (3.15)
Constant	7.901*** (51.15)	7.066*** (42.17)	5.033*** (7.16)	5.008*** (7.54)	7.785*** (14.09)	7.117*** (11.71)
Observations	969	969	969	969	969	969
r^2	0.700	0.743	0.712	0.719		
AR_2_test					0.500	0.718

Notes: 1. t statistics in parentheses
2. $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

4. Determinants of ECI

According to the determinants of ECI, we hope to know the factors that influence the accumulation of knowledge, which are from the external influences and internal capabilities.

This knowledge can be transferred through trade, particularly through GVCs (Lee, Szapiro and Mao, 2018; Lema, Rabellotti and Sampath, 2018). Furthermore, the GVCs could improve the absorbing ability of the knowledge (Cummings and Teng, 2003).

> **H2:** *GVC participation positively influences ECI.*

Manufacturing drives economic development. The manufacturing sector in particular provides opportunities for enhancing the technological process (Cornwall, 1982). The shift in capital goods from technologically less sophisticated goods (low uniqueness) to technologically more advantaged goods takes place through the development of manufacturing (Szirmai, Naudé and Goedhuys, 2011). Moreover, the linkage and knowledge spillover effects are stronger in the manufacturing sector and agriculture and mining sectors (Cornwall, 1982; Hirschman and Sirkin, 1958; Szirmai et al., 2011).

> **H3:** *The appropriate industrial structure can positively influence ECI.*

Effective GVC participation in development should be non-linear (Lee et al., 2018; Mao, 2021). At the different development stages, each economy captures a different position in GVCs. The effects of GVC participation should differ in absorbing the knowledge and technology at different development stages.

> **H4:** *At the different development stages, the effects of GVC participation on ECI are different.*

The new structural economic framework emphasizes that the optimal industrial structure of a given economy should differ at different levels of development, according to the different endowment structures (Lin, 2011).

> **H5:** *At the different development stages, the effects of industrial structure are different on ECI.*

4.1. Methodology and Variables of the Determinants of ECI

In order to discover the determinants of the ECI, this research uses the equation below to do the regression.

$$ECI_{ct} = \beta_1 GVC_{ct} + \beta_2 Structure_{ct} + Z_{ct}^T \theta_1 + v_i + \tau_t + \varepsilon_{it}, \tag{4}$$

where c indexes country and t indexes time; ECI is the economic complexity index, which is from Growth Lab at Harvard University; and GVC represents GVC participation. Here we selected the share of foreign value-added in exports as GVC participation. The share of foreign value-added is from the OECD-TiVA database. Structure represents the economic structure. In this paper, the economic structure index is the manufacture value added to the output, which is from the WTO database. Z indicates the control variables; ν represents a country-specific effect, τ represents a period-specific effect; and ε is the error term.

The control variables are human capital, inflow FDI,[1] outflow FDI,[2] the share of exports in GDP, the share of imports in GDP, the share of research and development expenditure in GDP, and the real GDP.[3] The human capital index and real GDP are from the Penn World Table database, and other control variables are from World bank database.

An economy joins global trade through foreign direct investments (FDI) and trade in goods and services. The inflow FDI and outflow FDI have information on FDI, and the share of exports in GDP and the share of imports in GDP represent the trade in goods. Therefore, inflow FDI, outflow FDI, exports and imports are selected as control variables. According to the endogenous factors in the competitiveness of one economy, the share of manufacturing in output, human capital, and R&D expenditure are considered as control variables in this research. Finally, we use the real GDP to control the domestic market. If the domestic market was bigger, the economy would have more opportunity to improve the capability to achieve more competitiveness in the global market.

In this research, we attempted to discover the globalization and economic structural effect of ECI by using pooled OLS regression analysis. This study investigated how different factors affect ECI at different development stages. If the per capita GDP of an economy is bigger than 20,000 US dollars, then the economy is denoted as a high-income economy. Otherwise, the economy is denoted as a middle-income economy. The research does not include low-income economies.

4.2. Regression Results of the Determinants of ECI

The determinants of ECI are reported in the Table 2. The results of the foreign value added (FVA) term are positive and significant. More global value chain (GVCs) participation is useful for increasing ECI. The development of the manufacturing industry is also helpful to increase ECI. It is notable that human capital is the main factor that affects ECI the most. R&D also has positive and large effects on ECI. Outflow FDI has positive effects, while inflow FDI has negative effects on ECI.

Based on the results reported in Table 2, policy makers should pay more attention to engaging in GVCs and developing manufacturing industries for higher ECI. Moreover, improving the education system to enhance human capital would considerably increase ECI. R&D could promote innovative performance, which would be helpful to raise ECI. The government should encourage outflow FDI and be careful about attracting inflow FDI. Instead of the amount of inflow FDI, the quality and industry of inflow FDI would be more important.

This research investigated the different effects of variables on ECI at different development stages. GVCs are more helpful for increasing ECI in middle-income economies than in high-income economies. Manufacturing industries contribute more in high-income economies. The new structural economics theory suggests that an economy could develop a competitive advantage for industries with natural endowments. Most resource-based countries, like Brazil, South Africa, Russia and others, are middle-income countries, which should first develop their competitive industries, such as mining, rather than manufacturing industries. Furthermore, human capital is more important for middle-income countries than high-income countries. The effects of outflow FDI are bigger on ECI in middle-income countries. Therefore, globalization provides more opportunities for middle-income countries than for high-income countries to increase ECI.

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[1] Inflow FDI is the net inflows in the reporting economy from foreign investors.
[2] Outflow FDI is the net outflows of investment from the reporting economy to the rest of the world.
[3] The constant year is 2010

Table 2. Determinants of ECI

	(1) ECI	(2) ECI	(3) ECI	(4) ECI	(5) ECI	(6) ECI
FVA		0.0178***	0.0167***			0.00936***
		(7.47)	(7.63)			(4.36)
Structure				0.0926***	0.0984***	0.0880***
				(9.89)	(10.75)	(9.22)
Human capital	0.820***	0.785***	0.380***	0.891***	0.484***	0.459***
	(25.52)	(23.37)	(9.03)	(30.15)	(12.62)	(11.53)
Inflow FDI	-0.0449***	-0.0461***	-0.0188***	-0.0446***	-0.0193***	-0.0197***
	(-7.11)	(-7.69)	(-4.08)	(-7.59)	(-4.57)	(-4.79)
Outflow FDI	0.0449***	0.0459***	0.0195***	0.0466***	0.0221***	0.0222***
	(7.52)	(8.07)	(4.36)	(8.33)	(5.17)	(5.28)
Exports	0.0100***	0.0149***	0.00375	0.00670**	-0.00420	-0.00137
	(3.61)	(5.62)	(1.56)	(2.75)	(-1.76)	(-0.59)
Imports	-0.00475	-0.0147***	-0.00267	-0.00120	0.0101***	0.00475
	(-1.44)	(-4.58)	(-0.95)	(-0.41)	(3.60)	(1.71)
R&D			0.349***		0.341***	0.340***
			(11.99)		(12.42)	(12.51)
Real GDP	7.37e-08***	7.46e-08***	4.55e-08***	6.95e-08***	3.96e-08***	4.16e-08***
	(7.77)	(8.36)	(5.96)	(8.87)	(6.33)	(6.50)
Constant	-1.753***	-1.887***	-1.125***	-2.814***	-2.073***	-2.044***
	(-20.19)	(-22.04)	(-11.57)	(-22.15)	(-15.82)	(-15.58)
Observations	943	943	740	943	740	740
r^2	0.531	0.557	0.609	0.587	0.655	0.663

Notes: 1. t statistics in parentheses
2. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Table 3. Determinants of ECI at Different Development Stages

	(1) Middle	(2) Middle	(3) Middle	(4) High	(5) High	(6) High
FVA	0.0289***		0.0272***	0.0217***		0.00204
	(8.45)		(8.62)	(4.76)		(0.53)
Structure		0.0563***	0.0400***		0.170***	0.167***
		(4.18)	(3.41)		(14.86)	(13.90)
Human capital	0.411***	0.449***	0.421***	0.131	0.168**	0.161*
	(6.65)	(7.29)	(6.98)	(1.72)	(2.78)	(2.53)
Inflow FDI	-0.0263***	-0.0140*	-0.0246***	-0.0155**	-0.0166***	-0.0166***
	(-4.66)	(-2.51)	(-4.24)	(-2.67)	(-3.66)	(-3.65)
Outflow FDI	0.0264***	0.0213***	0.0255***	0.0152**	0.0187***	0.0186***
	(4.33)	(3.38)	(4.26)	(2.76)	(4.10)	(4.09)
Exports	-0.00221	-0.00607*	-0.00503	0.00644	-0.00756*	-0.00669
	(-0.86)	(-2.23)	(-1.93)	(1.49)	(-2.10)	(-1.73)
Imports	-0.00633	0.0110***	-0.00302	-0.00663	0.0126**	0.0113*
	(-1.93)	(3.54)	(-1.03)	(-1.31)	(3.04)	(2.43)

Table 3. (Continued)

	(1) Middle	(2) Middle	(3) Middle	(4) High	(5) High	(6) High
R&D	0.286***	0.375***	0.390***	0.312***	0.224***	0.225***
	(3.50)	(3.85)	(4.20)	(9.05)	(7.76)	(7.81)
Real GDP	2.74e-09	4.41e-08***	-7.75e-09	6.80e-08***	5.10e-08***	5.31e-08***
	(0.21)	(3.67)	(-0.55)	(5.22)	(7.16)	(6.13)
Constant	-1.130***	-1.695***	-1.581***	-0.317	-1.348***	-1.341***
	(-8.19)	(-8.40)	(-8.19)	(-1.49)	(-7.01)	(-7.02)
Observations	318	318	318	422	422	422
r^2	0.513	0.405	0.532	0.417	0.638	0.638

Notes: 1. t statistics in parentheses
2. $^*\,p < 0.05$, $^{**}\,p < 0.01$, $^{***}\,p < 0.001$

5. Discussion and Conclusion

This research links the development of economics and geographical economics to discuss development and globalization by investigating the relationship between the level of development and ECI. This research matched the World Bank database, the Penn World Table database and the OECD database to undertake a systemic empirical analysis. The ECI positively influences per capita GDP, which increases by about 30% when ECI increases by one unit in middle- and high-income economies. It is important to know how to increase ECI for a higher level of development. Therefore, in this paper we attempted to investigate the determinants of ECIs. It is notable that the effects of human capital are large in relation to development.

The ECI indicates the capability of the productive structure, which implies the accumulation of knowledge through exports. The technology (knowledge) comes from external influences and internal capabilities. GVC participation, FDI, and trade are the external influences on the ECI. The GVC and outflow FDI are positive for ECI, while the inflow FDI is negative. These results suggest that the given economy should engage in GVCs and try to invest in foreign economies to enhance the ECI. The economic structure, human capital, R&D expenditure, and domestic market size (real GDP) affect the ECI as the internal capabilities. The development of the manufacturing industry is helpful to increase the ECI, while human capital and R&D positively influence the ECI and a bigger domestic market would enhance the ECI. In order to increase the ECI, government should adjust the economy structure and develop the manufacturing industry. The education system is important for producing high-quality human capital to enhance the ECI. We should pay attention to innovation through R&D expenditure. Obviously, the domestic market provides opportunities to increase the comparativeness of the given economy.

Policy makers should consider the development stage for increasing the ECI. We found that GVCs are of greater help to middle-income economies than high-income economies. The manufacturing industry is more helpful to high-income economies for increasing the ECI. The given economy should develop comparative industries based on the economy's structure of factor endowments. It should be noted that the effects of human capital are more important to middle-income economies than high-income economies. Middle-income economies should pay more attention to improving the education system to ensure strong competitiveness.

Appendices

Table A. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Per capita GDP (log)	969	9.742	.827	7.001	11.182
ECI	969	.807	.804	-1.649	2.895
Population (log)	969	3.028	1.548	-.43	7.207
Investment per GDP	969	23.345	5.017	5.388	44.991
Human capital	969	2.84	.543	1.429	3.711
Openness	969	71.319	58.578	7.543	609.062
Government C	969	17	4.789	3.46	28.196
FVA	969	24.846	10.151	3.31	51.5
Inflow FDI	961	4.506	9.099	-43.463	198.074
Outflow FDI	950	3.068	9.734	-58.809	208.019
Share of exports	969	42.246	28.617	6.73	231.194
Share of imports	969	41.572	25.7	7.708	210.409
R&D	751	1.304	.952	.042	4.405
Structure	969	9.147	2.117	3.618	15.238

Table B1. Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Per capita GDP (log)	1.000						
(2) ECI	0.700	1.000					
(3) Population (log)	-0.363	-0.064	1.000				
(4) Investment per GDP	-0.056	0.055	0.094	1.000			
(5) Human Capital	0.776	0.663	-0.302	-0.042	1.000		
(6) Openness	0.479	0.410	-0.464	0.167	0.323	1.000	
(7) Government C	0.564	0.390	-0.341	-0.199	0.459	0.148	1.000

Table B2. Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) ECI	1.000								
(2) FVA	0.208	1.000							
(3) Structure	0.121	0.119	1.000						
(4) Human Capital	0.663	0.104	-0.173	1.000					
(5) Inflow FDI	0.037	0.188	-0.109	0.031	1.000				
(6) Outflow FDI	0.180	0.110	-0.113	0.125	0.919	1.000			
(7) Share of exports	0.175	0.616	-0.018	0.081	0.281	0.215	1.000		
(8) Share of imports	0.112	0.685	-0.049	0.036	0.280	0.187	0.966	1.000	
(9) R&D	0.698	-0.001	-0.043	0.589	-0.019	0.105	0.059	-0.005	1.000

Table C. List of countries

Argentina	Croatia	Ireland	Peru	Spain
Australia	Cyprus	Israel	Philippines	Sweden
Austria	Czechia	Italy	Poland	Switzerland
Belgium	Denmark	Japan	Portugal	Thailand
Brazil	Estonia	Latvia	Romania	Tunisia
Bulgaria	Finland	Lithuania	Russia	Turkey
Cambodia	France	Malaysia	Saudi Arabia	United Kingdom
Canada	Germany	Mexico	Singapore	United States
Chile	Greece	Morocco	Slovakia	Venezuela
China	Hungary	Netherlands	Slovenia	
Colombia	India	New Zealand	South Africa	
Costa Rica	Indonesia	Norway	South Korea	

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