Latin America: complexity and economic development, 1995-2018

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Abstract

This article analyzes the behavior of the Economic Fitness indicator as a measure of the international competitiveness of Latin American economies, as well as an indicator of their relationship with per capita income gaps and the Human Development Index (HDI). Positive correlations were found between per capita income gaps and the stagnation of the international competitiveness of Latin American economies, as well as between human development levels and the productive structure, suggesting a causal relationship between human development and competitiveness. This article also finds that the Economic Fitness indicator fluctuates significantly when estimated using exports in domestic value-added, suggesting that the original estimate may over- or underestimate competitiveness.

Keywords: development; trade; input-output models; Latin America.

1. INTRODUCTION

One of the most widely accepted ideas in economic theory is that the division of labor and the productive specialization of individuals lead to higher levels of efficiency and welfare. Conventional theories of international trade reproduce these arguments and extrapolate the benefits of specialization and trade at the country level, predicting higher rates of economic growth and levels of development. However, some theoretical arguments have been developed over the past 10 years that counter this idea and concepts such as "economic complexity," "product complexity," and, recently, Economic Fitness (EF hereafter) emerged (Hidalgo and Hausmann, 2009; Tacchella *et al*., 2012). The empirical evidence regarding these concepts suggests that economic development is more closely related to the diversification of production and the capacity to produce "unique" or "complex" goods than it is to the specialization predicted by trade theories based on the analysis of comparative advantages. Informed by this evidence, developed countries tend to export goods that are not produced by other countries, as part of a much more diversified basket of goods. The evidence regarding the low specialization of production in developed countries is so consistent that Felipe *et al*. (2012, p. 36) concluded that: "Development is a process that transforms the economic structure of a country towards the production and export of more complex products"; in other words, economic development can be understood as the set of capabilities that enable production in greater quantities and variety. Therefore, the causal relationship would not go from trade to specialization and then to growth and development, but rather from economic development to diversification and from trade (under more competitive conditions) to profits and growth. Or, more simply, one can say that development is not a consequence of specialization derived from trade.

On the other hand, the classical trade theories focused their attention on the benefits derived from the exchange of products, ignoring the possibility that productive processes can be fragmented into different stages or phases, or that this fragmentation could lead to some of these processes relocating to places where costs are lower. In other words, if the exchange is of wine for cloth, as in the Ricardian example, technological advances and reduced transportation costs could lead to countries trading grapes, cotton, yarn, cloth, glass, bottles, wine, paper, wood, etc. To test the hypothesis that the comparative advantages of trade are due to a developed productive structure, analysis must factor in that when Portugal exports wine to England it could be exporting back English bottles, and when England exports cloth to Portugal it could be exporting cotton previously imported from India, for example.

This article sets out to a) analyze the evolution of the international competitiveness of Latin American economies, measured through the EF indicator in a context in which most countries in the region adopt development policies based on market liberalization. Analysis will be based on estimates compiled by the authors following the original method proposed by Tacchella *et al*. (2012), and data from the UN Comtrade Database (2020);

b) present an estimate of EF by calculating the revealed comparative advantages (RCA) from the domestic value-added contained in exports, following Koopman *et al*. (2014); and c) demonstrate that the development of a country's productive structure can be attributed to its human development and that, therefore, economic growth is an effect, rather than a cause of economic development.

In addition to this introduction, the rest of the article is organized as follows: the second section offers a brief review of the literature on the EF of countries and the relationship between trade and economic development. The third section goes on to describe the method developed by Tacchella *et al*. (2012) and the proposal developed to perform the value-added analysis. The fourth section then presents an analysis of the estimation results, followed by some conclusions in the fifth section.

2. TRADE AND DEVELOPMENT: FROM SPECIALIZATION TO DIVERSIFICATION

The positive correlation between productivity and exports is one of the most robust results that have been found concerning international trade (Bombardini *et al*., 2012). At the industry level, this correlation demonstrates that the Ricardian model affords sound explanations of the advantages of international trade, namely, that it is differences in relative productivity which determine trade patterns: producers tend to increase their volume of exports as they achieve higher relative productivity levels in certain industries (MacDougall, 1951 and 1952; Stern, 1962; Harrigan, 1997; Eaton and Kortum, 2002; Kerr, 2009; Costinot *et al*., 2012). At the business level, meanwhile, it can be argued that exporting success occurs when some companies are sufficiently productivized to overcome the cost of exporting (Bernard *et al*., 2003; Melitz, 2003; Melitz and Ottaviano, 2008).

Thus, if the model assumes goods produced competitively from a single factor of production (labor), with constant returns to scale, but various forms of production between countries and between goods, then countries will export their products at a relatively lower cost. A country enjoys a comparative advantage in the production of a good if the opportunity cost of producing it is lower than it would be if it were produced in another country. Equilibrium may occur either when both countries specialize completely and benefit from trade, or when only one country produces both goods and neither gains nor loses through trade (Ricardo, 1817). Therefore, at the level of business, industries, and nations, higher competitivity derives from exploiting comparative advantages in the production of (relatively) cheaper goods and thus obtaining a greater market share.

However, combining the analysis of comparative advantages derived from the Ricardian model with the study of the complexity of products and economic systems reveals that the countries with the highest economic performance tend to have more diversified production and export baskets (Hidalgo and Hausmann, 2009; Tacchella *et al*., 2012). If the main conclusion from the theory of comparative advantages is that their exploitation is what defines a country’s level of competitiveness, and that trade would generate patterns of specialization in production and trade that result in greater economic benefits for all, more recent empirical studies show the following: i) open economies do not show a pattern towards specialization in production; and, ii) economies with better performance, measured by their levels of development or growth rates, produce a greater variety of goods and services. Similar evidence had already been found in works such as Imbs and Wacziarg (2003); Klinger and Lederman (2006), and Bustos *et al*. (2012), which show that the level of diversification observed in the productive structure of nations is directly related to their levels of economic development. Thus, developed countries tend to compete with a wide range of products, some with high added-value and only produced by some of them, while in less developed countries diversification is much lower and production will be more limited to less sophisticated goods among which there is a lot of competition.

Comparative analyses such as Akamatsu (1962), Kuznets and Murphy (1966), and Lall (2000), focusing on a range of economic systems, show that developing countries embark on a path of sustained growth when there have been profound changes in their productive structure. However, such transformations are neither explained nor considered in neoclassical theories of economic growth. Development economists such as Rosenstein-Rodan (1943), Prebisch (1950), and Hirschman (1958), evolutionists such as Nelson (1982) and Alcouffe and Kuhn (2004), and post-Keynesians such as Pasinetti (1983) and Thirlwall (2002), have incorporated these transformations and their implications for economic growth into their analyses. According to these authors, a nation's productive diversity is associated with its local capabilities, so much so that economic development must be conceived as a process in which capabilities are created and adapted. In other words, growth depends on the expansion of tacit productive knowledge via the dynamics of learning (Castañeda and Romero-Padilla, 2018). Such productive capabilities can be human (know-how), physical (infrastructure), and institutional,[1] and are a form of knowledge that is difficult to transfer through the acquisition of patents, imitation, foreign investment, or imports (Dell'Erba *et al*., 2013). In other words, this set of capabilities cannot be traded internationally.

Recently, these ideas have been further developed through new concepts and methodologies which have produced strong empirical evidence (Bahar *et al*., 2012; Tacchella *et al*., 2012). The methodological alternatives focus on the intensive use of data and network tools. Moreover, these new approaches propose a vision that describes competitiveness as a property which emerges from a system with interacting productive units. One particularly noteworthy study is Hidalgo and Hausmann (2009) which, without making an explicit reference to the conditions that determine the capacity to produce, or the aggregate production function, establishes that if the division of labor increases productive efficiency, then a network of interdependent market relations can be built to achieve higher levels of efficiency and production. Using the authors’ analogy of building blocks, it follows that the smaller the building blocks, the greater the variety of items that can be produced. Thus, there is an apparent paradox between specialization and diversification, because the finer the division of labor, the greater the specialization that enables production of a greater variety of goods; in other words, specialization is necessary for diversification. However, specialization could be of the capabilities and specialized knowledge of individuals rather than the specialization of production itself. For example, developing information, computer, and communication technologies requires specialized and sophisticated knowledge in the fields of mathematics, physics, and engineering, to name a few. The complexity of the system, continuing with the example, implies that mathematical language is a necessary condition for designing the computer and computational programs, and that knowledge of electrical and electronic physics and engineering (both) is a necessary condition for designing and building the machine necessary for computation. Furthermore, in these design and production processes the supply chain is not linear, but rather a network of multiple interactions, with processes that feedback directly and indirectly. Understood in this way, at the level of economic systems, the division of labor implies a certain level of specialization in the tasks, skills, and knowledge that each person has and that make up the building blocks which allow the design and production of a greater variety of goods and services, as a result of a more-highly refined specialization of tasks. The concept of EF, therefore, is a product of using complex systems to define competitiveness (Tacchella *et al*., 2012).

Methodologically, the proposal adopts a nonlinear and iterative approach that can efficiently capture the intrinsic relationship between the export baskets of different nations and their industrial competitiveness. This international competitiveness indicator recognizes the complexity of the global economic system and that measures of product quality and (relative) capacity of production systems are mutually determined. A product is relatively complex in terms of the number of countries that manufacture and export it, while a country is relatively competitive in terms of the variety and quality of products it is capable of exporting. Therefore, based on a non-linear relationship between products and countries, defining product complexity in terms of the fitness of the countries that produce them, it can be argued that the fact that a product is produced by a developed country reveals little about the complexity of the product itself, given that this type of country exports almost all products. On the other hand, when a developing country is capable of exporting a product, it is very likely to be one that requires a low level of sophistication to produce; moreover, the export basket will likely be less diversified than in developed countries.

The concept of EF has not been analyzed systematically or deeply, and the literature on the subject is still limited. Morrison *et al*. (2017) conclude that more work is needed to find and identify reliable and stable measures of fitness and complexity. Specifically, the authors provide theoretical and empirical evidence on the intrinsic instability of the algorithm definition behind the fitness concept. However, Servedio *et al.* (2018) present an adjusted and stable metric of EF and complexity using a nonlinear and non-homogeneous map applied to the available information on country exports. According to the authors, non-homogeneous estimates guarantee convergence and stability.

Zaccaria *et al*. (2018), for their part, expand the concept to include trade in services and achieve a universal matrix that allows for a more complete analysis of global competitiveness. By applying two algorithms to the universal trade in goods and services matrix, to contrast country-level competitiveness and changes in complexity and diversification when services are included in the goods matrix, the results show that the competitiveness of many countries was over- or underestimated and that services tend to cluster together with complex manufacturing, suggesting a similar capability structure. The authors conclude that complex services complement the diversification strategy of developing countries.

In an application of the concept and metrics, Vinci and Benzi (2018) study the causal relationship between Fitness and Gross Domestic Product (GDP) per capita. Both authors show that there is sufficient evidence for a causal relationship between per-capita GDP and a nation's EF, especially in high-income countries, and the opposite is true for low-income countries where this relationship is absent.

Roster *et al*. (2018) describe in their article an application of the EF they call Country Opportunity Spotlight, which assesses a nation's current capabilities and demonstrates which industries have the potential to diversify, given those capabilities. This adds to the explanatory and predictive power of the EF. The empirical application is estimated for Mexico and Brazil and they conclude that the use of this indicator is a unique contribution to the literature on economic development and trade, as it provides a quantitative perspective on who is good at doing what and how they became so. According to the authors, the methodology makes it possible to understand a nation's past development path and to make predictions about future paths. The following section describes the method originally developed by Tacchella *et al.* (2012), and adds to their proposal the consideration of measuring exports in value-added rather than in gross values, given that the complete or partial relocation of productive processes causes developing countries to export complex products, but with a high content of imported inputs. Understood in this way, therefore, the participation of some developing economies in the global market could be overestimated.

3. METHOD

Following the original proposal by Tacchella *et al*. (2012)[2] for obtaining EF indicators, this section merely rewrites their equations in matrix notation to illustrate another way in which a country's EF of nations is defined from the interaction between the level of diversification of a country's exports with the quality or complexity of existing products:

$$\begin{cases} \tilde{F}_c^{(n)} = MQ_p^{(n-1)} \\ \tilde{Q}_p^{(n)} = \left(\frac{1}{(1/\tilde{F}_c^{(n-1)})M}\right) \end{cases} \rightarrow \begin{cases} F_c^{(n)} = \frac{\tilde{F}_c^{(n)}}{\langle \tilde{F}_c^{(n)} \rangle_c} \\ Q_p^{(n)} = \frac{\tilde{Q}_{p,t}^{(n)}}{\langle \tilde{Q}_p^{(n)} \rangle_p} \end{cases} \quad (1)$$

Where M is a binary matrix of relevant exports, by country and by type of product, with elements $m_{c,p}$ equal to one if country c exports product p, and equal to zero otherwise. $Q_p^{(n-1)}$ is a column vector with elements $q_p^{(n-1)}$, which indicate the level of complexity of each product; thus, the matrix multiplication $\tilde{F}_c^{(n)}$ results in a column vector with elements that indicate the level of competitiveness of each country. In $\tilde{Q}_p^{(n)}$, in the expression $(1/\tilde{F}_c^{(n-1)})$, the operator "/" indicates that the reciprocals of each country's level of EF are estimated as an element of the vector $\tilde{F}_c^{(n-1)}$. The vector of products by level of complexity is obtained by multiplying the row vector $\tilde{F}_c^{(n-1)}$ by the export matrix and estimating their reciprocals. The variable n represents the number of iterations, which are obtained from the column and row sums of the matrix M when the unit vectors $Q_p^{(0)}$ and $F_c^{(0)}$, $Q_p^{(1)}$ and $F_c^{(1)}$, are taken as initial conditions. The estimates of $F_c^{(1)}$ and $\tilde{F}_c^{(n)}$ are normalized to take values between zero and one at each iteration and are expected to converge to a fixed point.[3] The elements of matrix M are obtained by estimating the RCA defined as:

$$RCA_{c,p} = \frac{\frac{x_{c,p}}{X_p}}{\frac{X_c}{X_w}} \quad (2)$$

Where, $x_{c,p}$ represents the total exports of product p, from country c; X_c is the total exports of product p; X_c represents the total exports of country c and X_w the overall volume of exports. If $RCA_{c,p} > 1$, then it is considered that country c has a comparative advantage in the production (and export) of product p.

On the other hand, the objective is to present an estimate of the EF by calculating the RCA using as a reference the value of exports in domestic value-added, using a similar methodology as Koopman *et al*. (2014). This is because current trade patterns reveal that, in addition to not tending towards specialization of production, international trade in the 21st century predominantly consists of intermediate inputs combined with direct and indirect trade in services not previously considered tradable; in other words, trade in tasks (Escaith, 2014). Using data from the World Input-Output Database (WIOD, Release 2016) that records transactions from 43 countries, from the rest of the world for 56 industrial sectors, RCAs will be measured more accurately by considering only the domestic value-added contained in the exported goods. The domestic value added from equation (2) is modified as follows:

$$RCA_{c,p} = \frac{\frac{vx_{c,p}}{VX_p}}{\frac{VX_c}{VX_w}} \quad (3)$$

Where, $vx_{c,\,p}$ represents the domestic value-added contained in the exports of product *p* from country *c*. That is, the value of imported inputs that are incorporated in the exports of good *p*, plus net taxes and international transport margins, are deducted. VX_p measures total exports of good *p* in value-added at the global level only. VX_c, therefore, is the total exports of country *c* in domestic value-added, while VX_w represents the total exports in global value-added, in this case only net taxes and international transport margins are deducted. As this date is not available at the product level, in the exercise presented here, *p* is replaced by the industrial sector *i* in which value-added is generated, both by the direct export of its products and by the indirect export of its inputs, that is, through the export of goods from other industrial sectors *j*. The main advantage of analyzing at the industry level is that, as will be seen below, doing so makes it possible to incorporate into the analysis of countries' competitiveness the capacity to generate domestic supply chains that provide intermediate inputs to the directly exporting sectors. Therefore, the value-added of the direct and indirect exports of industrial sector *i* is integrated as follows:

$$vx_{c,i} = vxi_{c,i} + vxf_{c,i} \quad (4)$$

Where $vxi_{c,\,i}$ is the domestic value-added generated by the direct and indirect export of intermediate inputs from industry i, country c to satisfy the global demand for final goods; and *vxfc, i* is the value-added generated by the direct export of final goods. Each value of $vxi_{c,\,i}$ is obtained from the sum of all the elements that represent a direct or indirect export of intermediate inputs from the matrix of value-added generated by:

$$VA_t = \hat{V}_t(I - B_t)^{-1}\hat{F}_t \quad (5)$$

Where B_t is a square matrix of technical coefficients representing the volume of inputs required from industry *I* in country *c* to produce one unit of output of industry *j*, country *q*; $(I - B_t)^{-1}$ is the matrix of total requirements — the well-known Leontief Inverse —, which quantifies the total of inputs that are directly or indirectly demanded and supplied at the inter- and intra-industry level; $\hat{V}_t$ is a diagonal matrix of value-added coefficients; all of dimension *nc*, where *n* represents the number of industries (56 for the exercise in this article); and *c* the number of countries (43 individual countries plus the rest of the world). *t,* meanwhile, represents the variable for the year in which a certain volume of final and intermediate goods is demanded, which with the available information varies from 2000 to 2014. The elements $b_{i,j,t}^{c,q}$ in B_t and the elements $v_{j,t}^{q}$ in $\hat{V}_t$ are defined as the proportion of intermediate inputs provided by sector *i* to sector *j* from country *c* to country *q*, per unit of output (in current dollars); and as the proportion of direct inputs, measured as compensation to labor and capital over the final value of output of sector *j*, in country *q*; respectively. Thus, if $i = j$ is the case of intra-industry trade and if $c = q$ is domestic transactions, then, in other words, the volume of inter-industry and international transactions is measured. $\hat{F}_t$ is a diagonal matrix of global final demand, whose elements represent the volume of production in sector *i*, country *c*, to satisfy the final demand of the period, independently of its use and final destination. Therefore, in VA_t we have a total value-added matrix which, by rows, decomposes the value-added generated in a sector and country, according to the final destination of its products, as well as sector and country. By columns, the value-added of a finished product is broken down according to the sector and country where the input factors (capital and labor) are located. Each $va_{i,j,t}^{c,q}$ element in VA_t quantifies the income that is generated in sector *i* in country *c* directly or indirectly depending on the volume of final demand in sector *j*, in country *q*.

Therefore, for each $va_{i,j,t}^{c,q}$ in which $c \neq q$, the total value added generated by the direct or indirect export of intermediate inputs from country *c* to country *q* is accounted for. Meanwhile, direct exports of final goods are accounted for in value added, $vxf_{c,i}$ the corresponding value-added matrix is estimated in equation 4:

$$VAX_t = \hat{V}_t(I - B_t)^{-1}\hat{X}_t \quad (6)$$

Where $\hat{X}_t$ is a diagonal matrix of final goods exports, by industry and country of origin. In VAX_t for each element $vax_{i,j,t}^{c,q}$ in which the domestic value added in final goods exports is accounted for, which includes direct and indirect intermediate inputs.

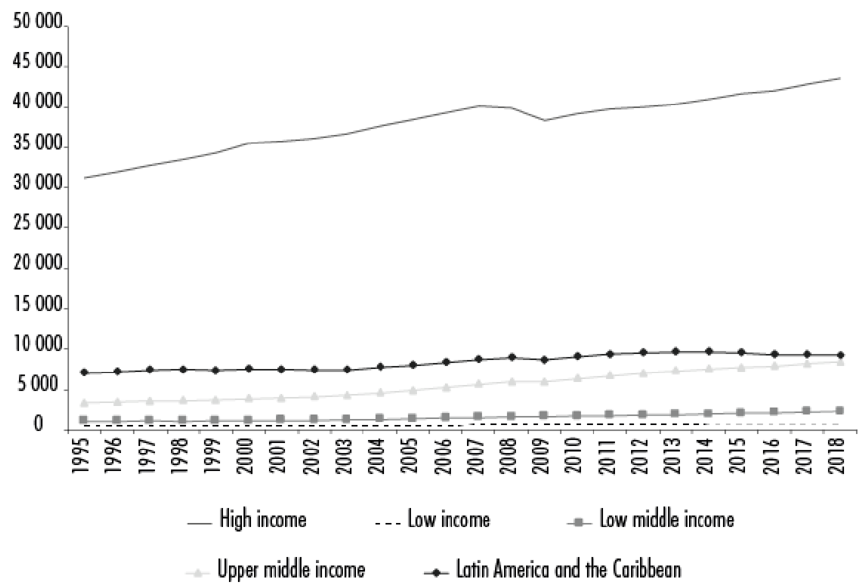
Given the size of the global input-output matrices available for estimating exports in domestic value-added, for the purposes of this exercise, it was decided that for a country to have a revealed comparative advantage in value-added, the value of $VCRV_{c,\,p}$ has to be greater than 1.5.

The following section presents two estimation results: in the first, the EF is assessed using UNCTAD data for the period 1995 to 2018, UN Comtrade Database (2020), highlighting that with this database the number of exported products is reduced, although the period of analysis and the number of countries are extended, compared to exercises presented in previous empirical works and the estimate published by the World Bank (2020). Next, the estimation is presented using the comparative advantage criterion revealed from the volume of exports in domestic value-added, with the main disadvantage that estimates can only be made for 55 industrial sectors and 43 countries,[4] but which serves to illustrate how the comparative advantage revealed in value-added does modify the dynamics and levels of competitiveness of the countries. Finally, the results of estimating a linear panel model that relates the EF estimation results with the Human Development Index (HDI) and dichotomous variables for groups of countries are presented, to show how the relationship between development and competitiveness remains close throughout the period analyzed and that there are certain structural problems in Latin American countries that keep them lagging behind in their levels of competition.

4. EVOLUTION OF THE COMPETITIVENESS OF LATIN AMERICAN ECONOMIES

One of the main challenges that the world economy continues to face is the enormous inequality in average income levels between nations. Despite the fact that between 1995 and 2018 the ratio of average income between high-income and low-income countries fell from US$66.4 to US$58.9, the income gap remains very high. As can be seen in Figure 1, in constant 2010 dollars the average income in rich countries went from just over US$31 thousand in 1995 to just over US$45 thousand per person in 2018; while the average income in the poorest countries had an increase of US$269 per person, from US$470 to 740.

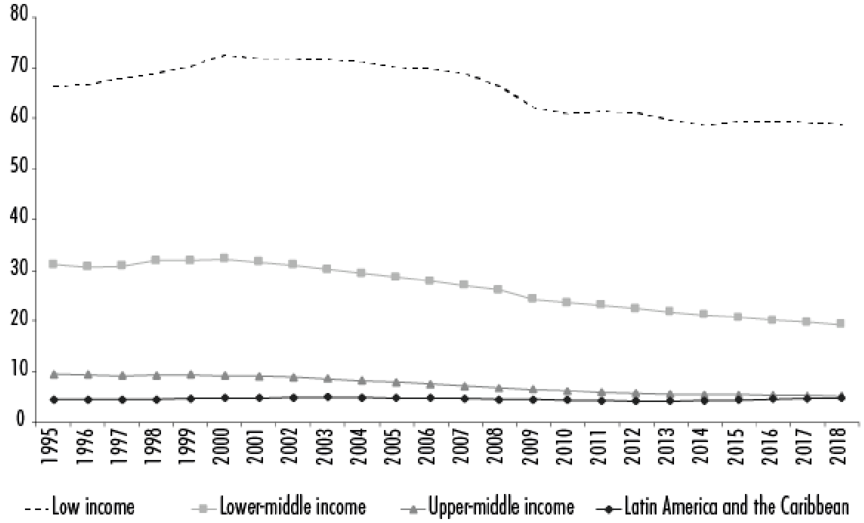
Figure 1. Per capita income by country group, 1995-2018 (constant 2010 dollars



Source: Compiled by the authors using data from the World Bank (2020).

In the case of Latin America and the Caribbean, there was a slight increase in the income gap during the period, as the average income of the richest countries went from being 4.45 to 4.72 times higher than the income of the countries of the region between 1995 and 2018 (Figure 2). The average income in the rich countries increased by just over US$12,300, while the average income in Latin America and the Caribbean increased by just under US$2,200.

Figure 2. Per capita income gaps between high-income and middle- and low-income countries, 1995-2018



Source: Compiled by the authors using data from the World Bank (2020).

This article argues that this slow convergence in income levels between the poorest and richest groups of countries is a result of the set of productive capacities, rather than explaining the development of a country's productive structure with reference to the relative endowment of factors that interact within an economic system.

Based on these estimates, using data for 224 countries and 255 products, Table 1 and Figure 3 show the evolution of the competitiveness of the countries of the region in comparison with the performance of the rest of the world. First, it can be observed that between 1995 and 2018, Germany occupied the first position as the most competitive economy with an EF index equal to one in all years except 2009, 2015, and 2017 (in these years Japan occupied the first place as the most competitive country). Of the countries that as of 2018 obtained the top 10 places, the cases of China and Poland stand out, which at the beginning of the period presented an index below 0.50 (0.38 in the case of China and 0.34 in the case of Poland), while by 2018 their distance from Germany was significantly reduced. The rest of the countries that as of 2018 occupied the first places in competitiveness are the United States, Italy, France, Austria, Belgium, and the Czech Republic. These results also show that the relative size of the economy (and population) are not so important in determining the productive capacity of a country in terms of diversification of production and quality of tradable goods.

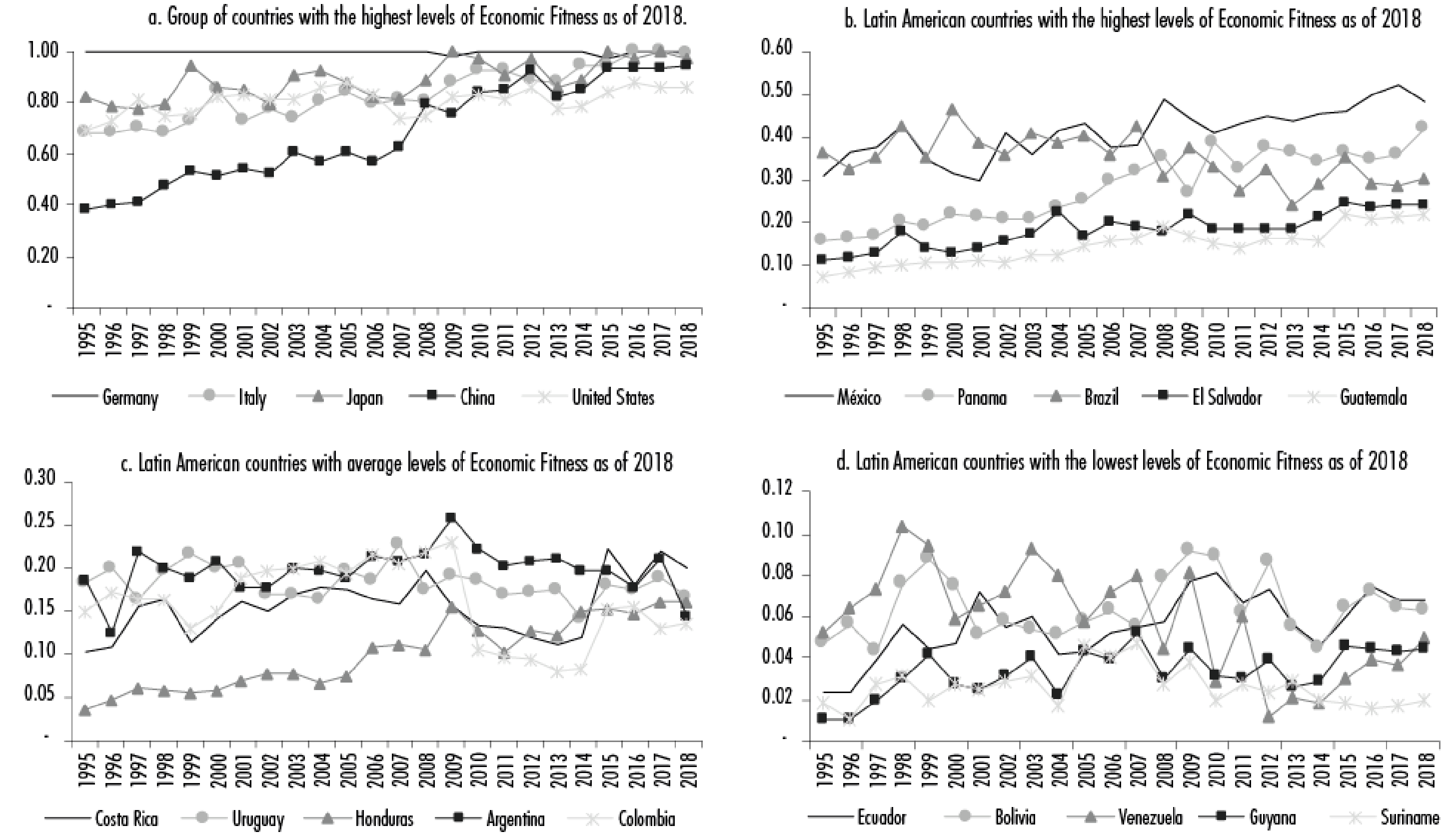
Table 1. Index of international competitiveness (Economic Fitness), 1996-2018

Position	Country	1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018
Top 10													
1	Germany	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Italy	0.68	0.68	0.84	0.77	0.80	0.79	0.81	0.92	0.89	0.94	1.00	0.98
3	Japan	0.78	0.79	0.85	0.79	0.92	0.82	0.88	0.96	0.97	0.89	0.96	0.97
4	China	0.40	0.47	0.51	0.53	0.57	0.57	0.80	0.84	0.92	0.85	0.93	0.94
5	United States	0.72	0.74	0.82	0.81	0.85	0.83	0.74	0.83	0.86	0.78	0.87	0.85
6	Austria	0.69	0.77	0.78	0.72	0.75	0.70	0.79	0.81	0.84	0.80	0.92	0.82
7	Belgium	0.60	0.66	0.64	0.56	0.61	0.56	0.69	0.68	0.69	0.61	0.76	0.80
8	France	0.74	0.77	0.70	0.72	0.74	0.80	0.85	0.79	0.82	0.71	0.75	0.76
9	Poland	0.35	0.46	0.46	0.51	0.57	0.57	0.61	0.62	0.66	0.62	0.74	0.75
10	Czech Republic	0.70	0.79	0.75	0.62	0.69	0.71	0.76	0.72	0.76	0.75	0.76	0.73
Latin America													
31	Mexico	0.36	0.42	0.31	0.41	0.42	0.38	0.48	0.41	0.45	0.45	0.50	0.48
37	Panama	0.16	0.20	0.22	0.21	0.24	0.30	0.35	0.39	0.37	0.34	0.35	0.42
49	Brazil	0.32	0.43	0.46	0.36	0.39	0.36	0.31	0.33	0.33	0.29	0.29	0.31
61	El Salvador	0.12	0.18	0.13	0.16	0.22	0.20	0.18	0.19	0.18	0.21	0.24	0.24
66	Guatemala	0.09	0.10	0.11	0.11	0.12	0.16	0.19	0.15	0.17	0.16	0.21	0.22
77	Costa Rica	0.11	0.16	0.14	0.15	0.18	0.16	0.20	0.13	0.12	0.12	0.18	0.20
87	Uruguay	0.20	0.20	0.20	0.17	0.16	0.18	0.17	0.19	0.17	0.14	0.17	0.17
94	Honduras	0.05	0.06	0.06	0.08	0.06	0.11	0.11	0.13	0.13	0.15	0.15	0.16
101	Montserrat	0.02	0.33	0.34	0.17	0.20	0.15	0.12	0.11	0.14	0.11	0.13	0.14
103	Argentina	0.12	0.20	0.21	0.18	0.20	0.21	0.21	0.22	0.21	0.20	0.18	0.14
107	Colombia	0.17	0.16	0.15	0.20	0.21	0.22	0.22	0.10	0.09	0.08	0.16	0.13
120	Perú	0.10	0.10	0.11	0.08	0.11	0.09	0.12	0.13	0.13	0.13	0.13	0.12
123	Chile	0.08	0.11	0.08	0.13	0.10	0.09	0.10	0.12	0.12	0.10	0.12	0.12
125	Paraguay	0.06	0.07	0.06	0.05	0.05	0.10	0.09	0.09	0.11	0.08	0.08	0.10
138	Nicaragua	0.09	0.07	0.04	0.05	0.07	0.07	0.07	0.08	0.10	0.07	0.08	0.09
145	Belice	0.01	0.04	0.03	0.06	0.03	0.02	0.41	0.02	0.04	0.06	0.09	0.08
159	Ecuador	0.02	0.06	0.05	0.06	0.04	0.05	0.06	0.08	0.07	0.05	0.08	0.07
164	Bolivia	0.06	0.08	0.07	0.06	0.05	0.06	0.08	0.09	0.09	0.04	0.07	0.06
172	Venezuela	0.06	0.10	0.06	0.07	0.08	0.07	0.04	0.03	0.01	0.02	0.04	0.05
175	Guyana	0.01	0.03	0.03	0.03	0.02	0.04	0.03	0.03	0.04	0.03	0.05	0.04
197	Suriname	0.01	0.03	0.03	0.03	0.02	0.04	0.03	0.02	0.02	0.02	0.02	0.02

Note: Detailed results for all years and countries in the sample, including Caribbean countries, are available from the authors on request.

Source: Compiled by the authors using data from UN Comtrade Database (2020).

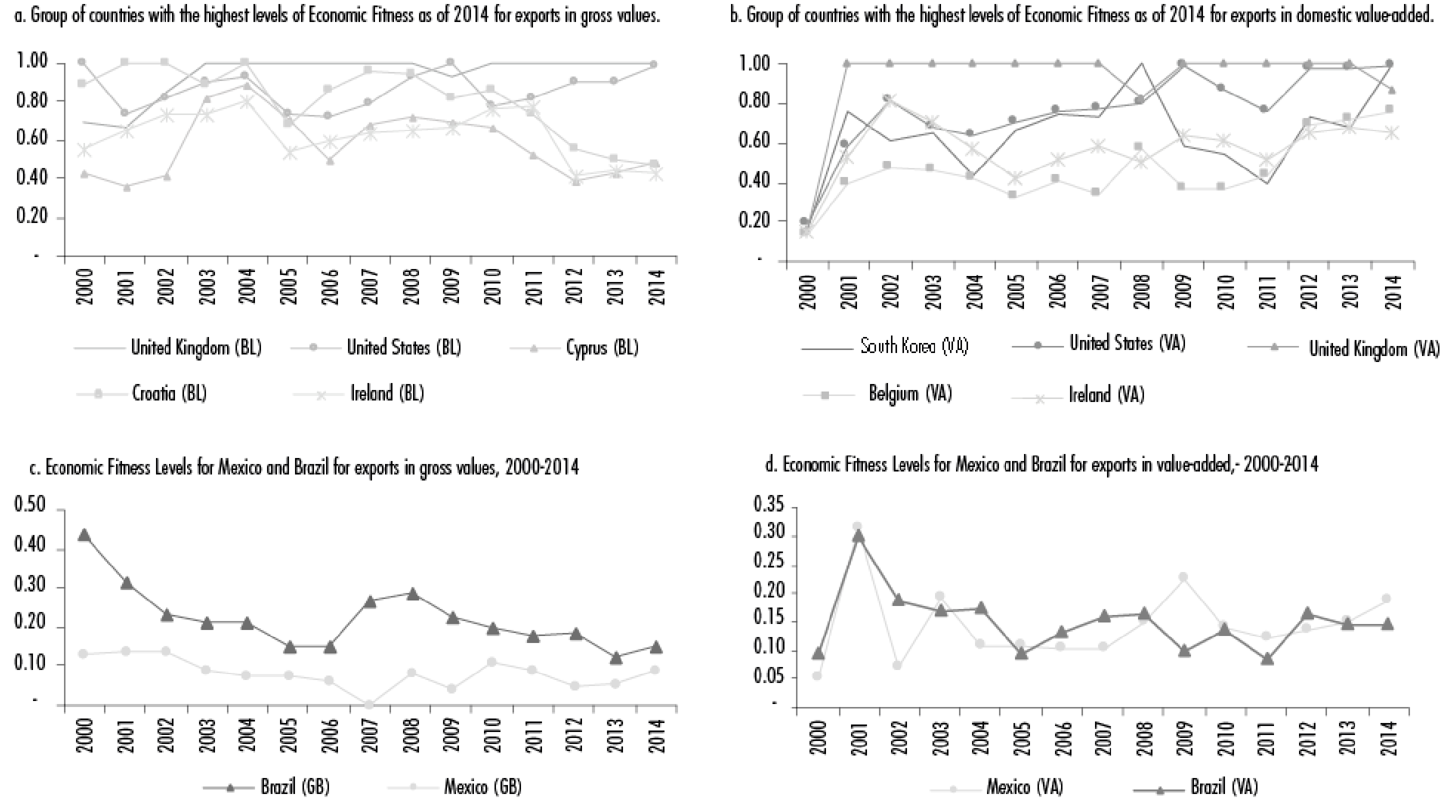
Figure 3. International competitiveness index (Economic Fitness), 1995-2018



Source: Compiled by the authors using data from UN Comtrade Database (2020).

In the case of Latin American economies, Mexico, Panama,[5] and Brazil occupied the top three places in the region in terms of competitiveness as of 2018, followed by El Salvador, Guatemala, and Costa Rica. The least competitive countries, meanwhile, according to the authors' estimates, are Surinam, Guyana, Venezuela, Bolivia, and Ecuador. Regarding the evolution of the countries, Figure 2 shows that the country that improved its relative position the most is Panama, since its indicator went from 0.16 to 0.42 in 1995. Mexico improved its position from 0.31 to 0.48 points, with a more stable growth or variation. On the other hand, Brazil experienced a more volatile behavior, as at the beginning of the period the value of its competitiveness indicator is double that of Panama, so that, if in 1995 Brazil was the most competitive country in the region, in 2018 it occupied third place with a reduction of 0.06 in the value of its EF. Small economies such as Panama, El Salvador, and Guatemala present a more stable growth in their competitiveness indicators. For the rest of the countries, panels c and d of Figure 2 show that Honduras is the country that has made the greatest progress in its competitiveness levels since 1995, while Colombia is one of the countries with the greatest reduction in its competitiveness indicator. The EF estimates calculating the RCA based on the domestic value-added contained in exports finding a significant difference in competitiveness levels, despite the limited nature of the indicator estimated at the industry level and with a significantly smaller sample of countries. Figure 4 shows how the competitiveness rankings change when global market share in terms of domestic value-added contained in exports is factored in. As the analysis incorporates 55 industries, which include all services that are directly or indirectly exported, first, it can be observed that only the United States remains in the group of the most competitive countries according to RCA for exports in gross values; Germany, Japan, China, and Italy would not have a high combination of diversification of their exports with sophistication or complexity of their products (aggregated at the industry level).

Figure 4. Economic Fitness from exports in gross values and exports in domestic value-added, 2000-2014



Source: Compiled by the authors using data from WIOD (Release 2016).

The second important limitation of the estimation of the FE for exports in domestic value-added lies in a significant reduction in the number of countries that can be included in the model, which results in countries such as Japan and Germany having competitiveness indicators that are too low, on the one hand, and on the other, that the behavior of more Latin American economies cannot be observed, since only Mexico and Brazil were included in the database used in this exercise. Nevertheless, panels c and d of Figure 4 show how, when considering domestic linkages at the industry level, Brazil is more competitive than Mexico for its exports in gross values, while Mexico is more competitive than Brazil in 2014 for its exports in domestic value-added.

These results are consistent with the estimates made by Marcato *et al*. (2019), who find that the estimate of RCAs changes significantly when these are estimated from the share of exports measured in domestic value-added.

Finally, with a regression model for panel data, the relationship between HDI and the own estimate of FE was explored; using HDI as an independent variable as a measure that could capture the set of human capabilities that derive from the development of a flexible and competitive productive structure. Table 2 summarizes the results of estimating the parameters of a linear model for panel data, using as regressors the HDI values with a one-year lag, and dichotomous variables for groups of countries by income level and the Latin American region.

Table 2. Estimation results for a panel data model, 1995-2018

	Coefficient	*Standard error*	*t*	*P > | t |*	*95% confidence interval*
Human Development Index_1	0.83	0.0340	24.42	0.000	(0.7645) – (0.8980)
High-income countries	-0.33	0.0288	-11.56	0.000	(-0.3897) – (-0.2767)
Upper middle-income countries	-0.42	0.0243	-17.15	0.000	(-0.4643) – (-0.3690)
Lower middle-income countries	-0.34	0.0190	-18.10	0.000	(-0.3819) – (-0.3073)
Low-income countries	-0.28	0.0156	-18.07	0.000	(-0.3118) – (-0.2507)
Latin America	-0.43	0.0246	-17.45	0.000	(-0.4769) – (-0.3805)

Source: Compiled by the authors using data from the United Nations Development Program (2020) and UN Comtrade Database (2020).

The results show a positive relationship between the HDI and the international competitiveness index, EF, with an estimated parameter equal to 0.83, so that for every 10 decimal points increase in the HDI, next year, an increase of 8.3 decimal points in the EF could be expected. As the estimated coefficient is less than one, it can then be assumed that: i) the HDI does not perfectly capture the whole set of human capabilities necessary to generate competitive economic systems, or ii) the HDI only captures the average of these capabilities individually and the rest of the necessary capabilities would be explained by a set of institutional or cultural factors particular to each country or group of countries.

Moreover, when including the dichotomous variables by country groups, the estimated coefficient for each group is negative, which would confirm that something more than human development is needed to obtain a positive EF value. Furthermore, the parameter estimates by country group indicate that for low-income, high-income, and lower middle-income countries, their starting points in 1995 were more favorable than for upper middle-income and Latin American countries. Thus, if in 1995, to have an EF indicator, a minimum level of human development is required and this requirement is higher for Latin American countries and those classified as upper middle income, it can be argued that there are historical and institutional conditions in these groups of countries that prevent them from advancing at the same rate of competition as the rest of the world.

5. CONCLUSIONS

The relationship between trade and development has been widely studied since the emergence of the field of economics as a discipline that seeks to explain not only the factors that determine the conditions of equilibrium in particular markets, but also how these processes, through which prices and quantities are decided, generate the levels of profitability of investments and the remuneration of the labor force, which in turn have an impact on people's quality of life. Thus, according to the conventional understanding, the causal relationship goes from the division of labor, the formation of markets, and trade to the levels of economic growth and human development. However, it is possible that the causal relationship is not unidirectional and that the division of labor requires certain development conditions that allow for the specialization necessary for the formation of efficient and flexible market structures. The EF estimations in this article demonstrate that: (i) the indicator is fairly consistent even when for the export matrix the number of products is reduced, and less so when the number of countries is reduced; (ii) over a relatively long period, the behavior of this indicator is clearly associated with per capita income gaps between high-income countries and the rest; *iii)* in the case of Latin America, of the largest economies that correspond to the group of upper middle-income countries, only Mexico shows a relative improvement in its international competitiveness indicator, while in the case of Brazil the value of this indicator tends to move away from the maximum possible, and in the rest of the economies there is no significant reduction in the gaps; iv) when the EF indicator is estimated using exports in domestic value added, the results vary significantly in relation to the estimation of RCA based on exports in gross values; v) the HDI as a variable to explain the set of capabilities that exist in the economies to develop internationally competitive production systems is statistically significant; however, the HDI variable is not sufficient to explain why the more developed countries have more diversified export baskets with more sophisticated products.

Methodologies which factor in the complexity of economic systems advance the study of the advantages of trade and its relationship with levels of development, as it is impossible to analyze only some groups of countries or only some types of products or industries. This article, therefore, concludes that it is more efficient to develop a country's productive capacities based on the division of labor. This is because this division of labor represents more sophisticated levels of specialization in tasks and knowledge, while the institutional framework enables the correct interaction between agents for increasing levels of competition via a diversified production basket that contains "unique, sophisticated, or complex" products.

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[1] Institutional capabilities refer not only to the way in which exchanges are carried out in an economy and the way in which contracts are made and enforced, but rather to the entire set of formal and informal rules observed in a society, which can encompass dimensions as broad as gender or race discrimination in the labor market, as well as the form of government and the entire legal system. The authors are grateful to an anonymous reviewer for this observation.

[2] For a more in-depth look at the mathematical properties of the algorithm used to determine countries' product complexity and the EF, see Pugliese *et al*. (2014). Servedio *et al*. (2018), meanwhile, proposes an improved estimator that solves some convergence problems that may arise from the particular characteristics of the export matrices.

[3] In their original version, the authors use as criteria to normalize the conditions that the sum of Fitness of all countries must be equal to the total number of countries, while the sum of complexity of all products must be equal to the total number of products.

[4] For details on the construction of this database, see Timmer *et al*. (2015).

[5] Panama appears in the group of the most competitive countries in Latin America, as do Honduras and El Salvador, which appear to be more competitive than other economies in the region with higher levels of development. These results can be explained by the fact that we worked with a database that classifies exports into 255 types of products, and this reduced classification could be biasing the estimator in favor of these economies. Nevertheless, the authors decided to work with this data as they provide a longer period to evaluate changes over time. The authors would like to thank an anonymous reviewer for this observation.