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Economic growth, through education, employment, innovation, exports, and imports, in Mexico as in the emerging countries of the BRICS 2007-2017

Crecimiento económico, a través de la educación, el empleo, la innovación, las exportaciones y las importaciones, en México como en los países emergentes de los BRICS 2007-2017

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Abstract
This research identifies the relationship between the factors of education, employment, innovation, imports, and exports with the economic growth of Mexico and the BRICS (Brazil, Russia, India, China, and South Africa), distinguishing the weight of each element during the period 2007- 2017. Developing an econometric model of panel data, estimated by the Panel Corrected Standard Errors (PCSE) method. The results conclude that actions in certain areas of the mentioned variables have favorable repercussions on the increase in Real GDP.
Keywords: economic growth, competitiveness, the BRICS, Mexico.

Resumen
Esta investigación identifica la relación de los factores educación, empleo, innovación, importaciones y exportaciones con el crecimiento económico de México y los BRICS (Brasil, Rusia, India, China y Sudáfrica), distinguiendo el peso de cada elemento durante el período 2007- 2017. Desarrollo de un modelo econométrico de datos de panel, estimados por el método Panel Corrected Standard Errors (PCSE). Los resultados concluyen que acciones en ciertas áreas de las variables mencionadas repercuten favorablemente en el incremento del PIB Real**.**
Palabras clave: crecimiento económico, competitividad, los BRICS, México

1. Introduction

How is it that some countries, like the BRICS, as emerging economies, generated wealth? According to the World Bank (WB, 2008), some of them are the result of countless elections and relationships between companies, families, and governments. Some are the consequence of evolution, but not of a project. The reality is that it is not the result of any direct policy, but it is necessary to determine to what extent this is true (Ito Cerón, 2021).

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About this sustained and high growth, some countries that form the BRICS, have quickly incorporated the know-how, technology, and knowledge from the rest of the world. This knowledge did not need to be created by them, but what they should have done was assimilate it quickly, as we understand perfectly (BRICS Think Tanks Council, 2015). There are a lot of things that we do not understand about how they did it, and how the causes of these policies hastened this development so that they could later provide their innovations, using human capital, creating an ever-more flexible labor market, and utilizing talent most efficiently, production processes more efficient, making them more competitive at the same time, creating the need to enter the international market through exports, without being possible all of the above without imports of various types or forms, to ultimately reach high growth levels (WB, 2008)

But it is important to be competitive in certain areas since a competitive country is a nation that creates wealth, in addition to offering a favorable business climate, that results in more and higher jobs, in this way, a better standard of living for the people (Medeiros et al., 2019; WEF, 2016)

Mexico through the years has presented relatively low levels of competitiveness, according to the Global Competitiveness Report (GCR, 2017) in pillars such as macroeconomic stability and those related to the development of human capital, namely, education, innovation, and employment. An increase in competitiveness would mean an increase in prosperity. Mexico, in comparison with the emerging BRICS countries, has shown a trend in both competitiveness and growth low as we will see throughout this research.

During this work, we will try to show the problem around this topic and how some of these nations managed to obtain wealth by paying more attention to developing certain areas of competitiveness and, demonstrate how this is important to grow economically for countries like Mexico.

1.1. Problem statement

Throughout the history of Mexico and the BRICS, similarities have been found in their economic processes, ranging from political and armed conflicts, as well as the processes towards industrialization and even the commercial opening or economic liberation that each of these countries performed at their own pace from the 40s to the 90s (Anguiano, 2001; Dos Santos, 1972; Pressiani, 2013; Sánchez Andrés, 2002; Zorrilla Salgador, 2004).

Although it is true that the BRICS economies that are completely different in many aspects, have something in common that Mexico does not have, and that is, that together they have a growth rate of real GDP higher than the average growth rates in the world (WB, 2008), in addition, a better competitive position. The following table shows the competitive behavior of the countries under analysis:

Table 1
Competitive Position of Mexico and the BRICS at ICG.

Countries	Year	México	India	Brazil	Russia	China	South Africa
125	2006-2007	58	43	66	59	34	35
134	2007-2088	52	48	72	58	34	44
134	2008-2009	60	50	64	53	30	45
133	2009-2010	60	49	56	63	29	45
139	2010-2011	66	51	58	63	27	54
142	2011-2012	58	56	53	66	26	50
144	2012-2013	53	59	48	67	29	52
148	2013-2014	55	60	56	64	29	53

Countries	Year	México	India	Brazil	Russia	China	South Africa
144	2014-2015	61	71	57	53	28	56
140	2015-2016	57	55	75	45	28	49
138	2016-2017	51	39	81	43	28	47
137	2017-2018	51	40	80	38	27	61

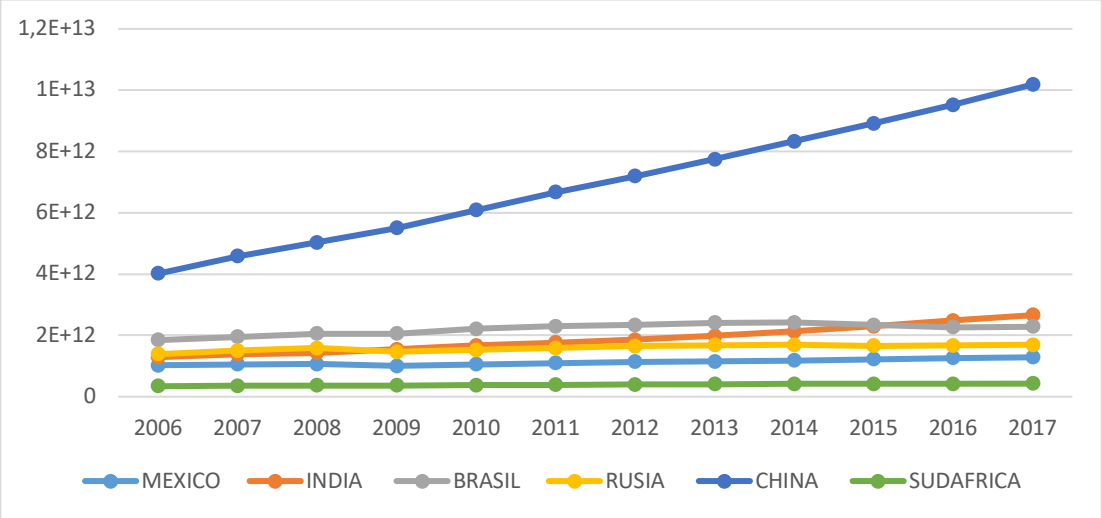
Source: Own elaboration with data from the GCI (2006-2017)

Beyond that, these nations are indeed different but the same in some aspects, but as a group has an RGDP rate higher than the average development rates of the entire world (Giaccaglia, 2019). And some of these countries show a very remarkable development in the publication of scientific research articles, such as the situation in China, Brazil, and India (Sáinz & Calcagno, 1999; Vdovina et al., 2019; WB, 2008).

The reasons why Mexico and the BRICS opted for economic liberalization are very similar (economic crisis). However, what is attractive is not only understanding what prompted each country to carry out liberal economic reforms but also understanding what economic and social resources these countries have taken to obtain a better competitive position than Mexico(Cabello et al., 2021), at the same time that an increase in GDP was achieved at constant prices, as shown in the following graph:

Graph 1

Gross Domestic Product at 2010 Constant Prices for Mexico and the BRICS Countries.



Source: own elaboration, with data from the World Bank (2020).

What this graph show is a relationship that could be positive between the increase in the Global Competitiveness Index and the increase in Real GDP in some cases, such as China and India, economies that the literature tells us, have greater economic growth (Cabello et al., 2021; Parikh et al., 2016).

Something that Mexico must learn, observe and evaluate is the BRICS promotion of scientific and technological creation as a key element for long-term economic growth (Sardana, 2016); As well, it has opted to invest in topics to raise its levels of development, such as high-quality education and training in specific areas, and in the same way to be more efficient in the use of talent and labor flexibility (Arulraj David & Motala, 2017; MUHR & Neves de AZEVEDO, 2019; Velázquez et al., 2002).

This is where questions arise such as: how economic growth is influenced by increased competitiveness in education, employment, innovation, exports (EXPO), and imports (IMPO) in Mexico and the BRICS 2007-2017?

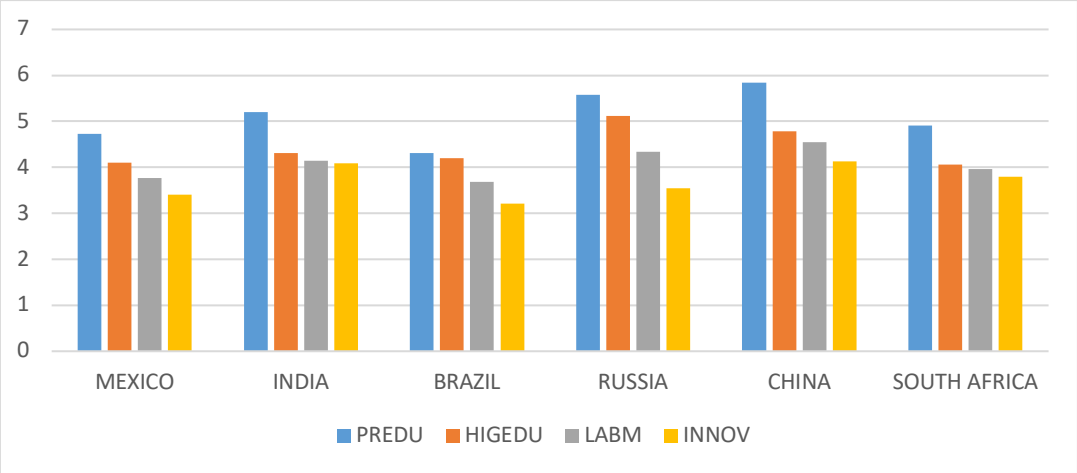
According to the above, it is interesting to be able to analyze the global competitiveness score, as well as its underlying variables in education, innovation, and employment. In the following table we show where Mexico and the BRICS are in the variables mentioned in advance:

Table 2
Competitiveness Score in Education, Innovation, and Employment.

GCI Year 2017-2018	Primary education	Higher education and training	Labor market efficiency	Innovation
India	**69**	**75**	**75**	**29**
México	91	80	105	56
Brazil	112	79	114	85
Russia	**47**	**32**	**60**	49
China	**28**	**47**	**38**	**28**
South Africa	82	85	93	39

Source: Own elaboration (2020) with data from the ICG

Graph 2
Value in Primary Education, Higher Education and Training, Innovation and the Labor Market in the Global Competitiveness Index (2017).



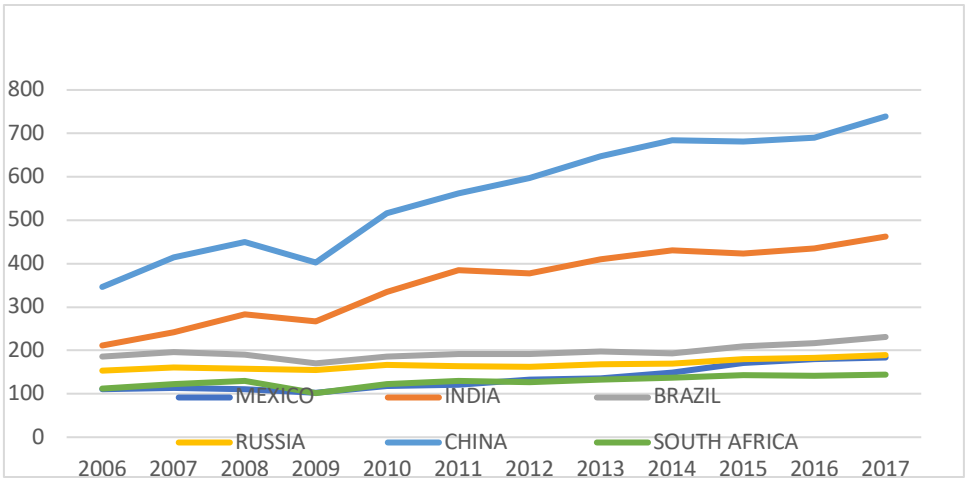
Source: Own elaboration (2020) based on ICG data prepared by the World Economic Forum.
<The best score or value is 7 and the worst is 1>

In graph 2, it is easy to see that China, Russia, and India perform well in the primary education pillar (PREDU), as well as in higher education and training (HIGEDU), at the same time in the labor market (LABM), except for innovation (INNOV) where only China and India are more significant compared to the other economies.

However, in the GCI (Global Competitiveness Index) the first three variables are subdivided. Then, if actions were taken in specific areas: how economic growth is benefited by quantity (QTTYED), quality in higher education (QLTYED), government acquisition of advanced technology products (GTECP as Innovation variable), as well as the use of talent (USFTA as a Labor variable), in Mexico and the BRICS 2007-2017?

Graph 3

Export Volume Index (2000 = 100) of Mexico and the BRICS**.**

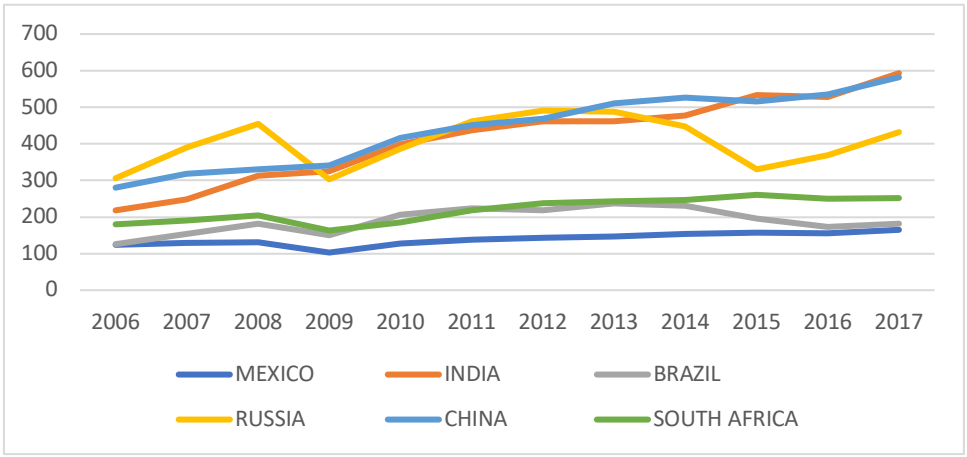


Source: Own elaboration, based on data obtained by BM (2020).

It is observed that China, India, and Brazil have the best position in graph 3, with Russia, Mexico, and South Africa in the last places(Dollar et al., 2021). In this context, it becomes vital to understand the volume of imports from these countries as a unit of analysis to figure out how much knowledge is imported to the countries less developed, as we can see in the next graph:

Graph 4

Import Volume Index (2000 = 100) of Mexico and the BRICS.



Source: Own elaboration, based on World Bank data (2020).

Finding a positive relationship with the previous analogies, in the preliminary graph it is observed that China, India, and Russia have a high level of imports, therefore we could attribute their growth to imports for the reasons discussed previously. It is interesting to see that Mexico has the lowest level in the import volume index.

However, and continuing with today's globalization initiative, experience with other geographic areas is increasingly useful to understand configurations that can be adjusted within our economy. Hence, it is not accidental to return to the experience of the BRICS as successful economies (Raghuramapatruni, 2021).

It is therefore convenient to explore the areas of competitiveness, education, innovation, employment, exports, and imports to know how much they impact economic growth and development.

1.2. Theoretical framework

This section refers to the main theoretical references formulated around economic growth. The concept that is used to define economic growth is the one proposed by Romer (1986), who argues that long-term economic growth is a function of wealth or the accumulation of an intangible capital asset, which is knowledge. Recognizing that the effectiveness of productivity depends on knowledge and this tends to rise infinitely and manifest benefits on a large scale (Kamble & Wankhade, 2017).

In the context of the above, Nelson and Phelps (1965), suggest that people with better education will be able to better distinguish between bad and good ideas, that is, they will be able to make better decisions, remedy difficulties, and face entrepreneurial actions more easily, inducing to encourage innovation in companies also assimilate technologies from abroad faster (Cañibano, 2005; Sánchez Trujillo et al., 2020).

As we have observed, in this era of globalization, technological advances have made machines a fundamental part of the productive structure, which would require more and more skilled workers who will not need to be supervised or controlled through an indefinite contract, but rather according to the novel productivity claims of companies (Blanchard & Wolfers, 1999; Brynjolfsson & McAfee, 2014; Pollert, 1994; Trehan, 2003).

As Krugman (1991, p. 19), says “Productivity is not everything, but in the long term it is almost everything. The ability of a country to improve its standard of living over time depends almost entirely on its ability to increase its output per worker”(Davenport & Kirby, 2016). It is then that being competitive in certain areas is also important. It is necessary to establish that competitiveness and productivity are different, but it is complemented since for competitiveness to exist, productivity is required in an economy (Suárez, 2005).

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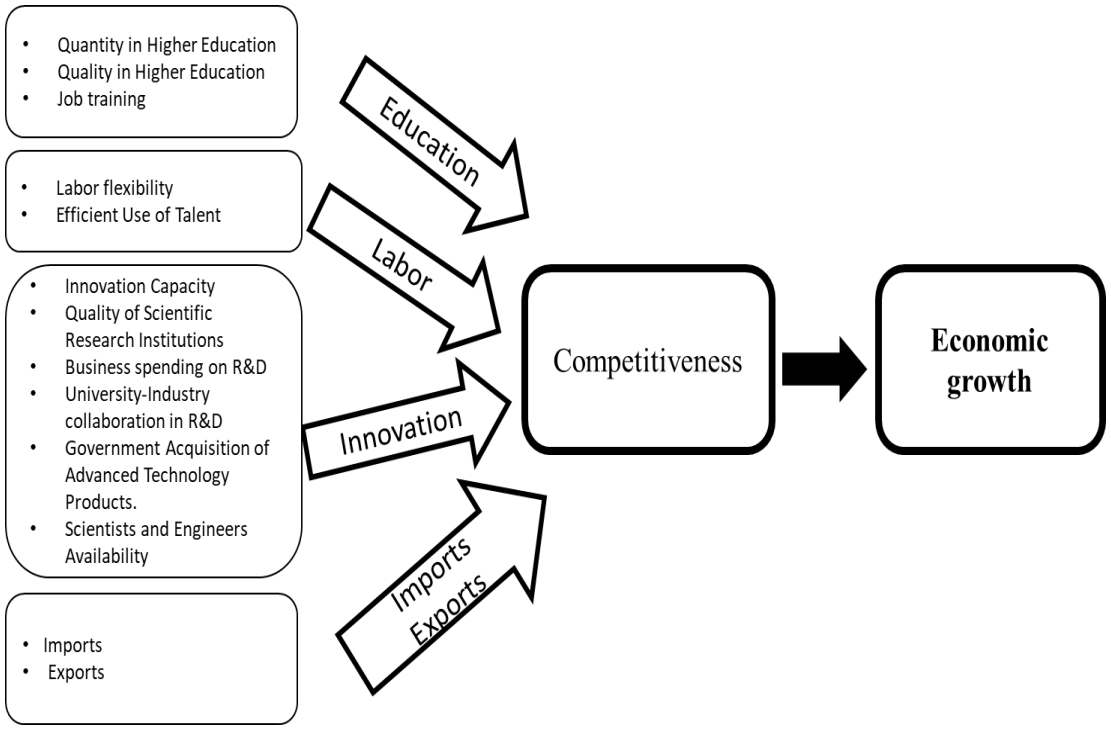
But to achieve a development of wealth in any economy, trade has been transcendental (Krizanic et al., 2021); Many authors talk about nations that focus on international sales as sellers of manufactures or as sellers of high content in technology, these are requested on a large scale (Dixon & Thirlwall, 1975; Kaldor, 1970; Meneses Mendoza, 2021).

Speaking about importation, authors such as Eaton & Kortum (1994), Keller (2001), and Li et al. (2003), affirm the perspective that buying and selling around the world facilitates the increase in the wealth of nations, thanks to the fact that imports bring new and better technological advances to nations where it is impossible to obtain them, these being an elemental piece of differentiation in income and productive efficiency in the countries (Gómez & Ramírez, 2017; Miller & Wunsch-Vincent, 2021). These contributions are related to the theory of catching up, that is, that developing countries have the possibility of raising total factor productivity (TFP) to the levels of developed countries since it is much cheaper, to copy than create (Chen & Wang, 2022; Maudos et al., 1998).

In reality, all the previous theories point to the presence of direct links that are represented simply in the following figure:

Figure 1
Diagram of variables



Source: Own elaboration (2020)

2. Methodology

In this section, the econometric estimation is carried out about the variables that are studied and their impact on economic growth, taking into account the GCI (analyzing the subdivisions of the said index) and the volume index of imports and exports given by the Bank World.

To execute the above, a series of steps were carried out through a longitudinal section study from 2007 to 2017 using panel data. "In the panel data, there is the dimension of space and time" (Gujarati & Porter, 2015, p. 591) The data obtained were processed through Stata 16 and E-views10 software.

The objective of this model is to determine how individually these sub-indices also explain higher education, labor, innovation, imports, and exports can influence Real GDP.

$$\text{Real GDP}_{it} = \beta_{1i} + \beta_2 \text{ PRIMEDU}_{it} + \beta_3 \text{ QTTYED}_{it} + \beta_4 \text{ QLTYED}_{it} + \beta_5 \text{ JTRAIN}_{it} + \beta_6 \text{ LFLEX}_{it} + \beta_7 \text{ USFTA}_{it} + \beta_8 \text{ CAPINNO}_{it} + \beta_9 \text{ QLSCRE}_{it} + \beta_{10} \text{ BUSPR}_{it} + \beta_{11} \text{ UICOR\&D}_{it} + \beta_{12} \text{ GTECP}_{it} + \beta_{13} \text{ VAC\&I}_{it} + \beta_{14} \text{ EXPIN}_{it} + \beta_{15} \text{ IMPOIN}_{it} + \varepsilon_{it}$$

$i = 1,2,3\ldots6.$

$t = 1,2,3\ldots11$

Where real GDP= economic growth; PRIMEDU = primary education score; QTTYED= amount of higher education; QLTYED = quality of higher education; JTRAIN = job training; LFLEX = labor flexibility; USFTA= efficient use of talent

; CAPINNO= capacity for innovation; QLSCREW= quality of scientific research institutions; BUSPR= business spending on r & d; UICOR&D= university-industry collaboration in R&D; GTECP= government acquisition of advanced technology products; VAC&E= the availability of scientists and engineers; EXPIN= export volume index; and IMPOEN= import volume index.

Different tests were carried out such as the test of normality, multicollinearity, unit root, and cointegration; To later try to solve the problems of unobservable heterogeneity, a pooled regression (pooled), fixed effects regression, the F test of significance of the fixed effects, random effects regression, Lagrange Multiplier test for Random Effects of Breusch & Pagan, and to decide which one between random and fixed effect is optimal we use the Hausman test:

Table 3
Hausman test

Test: Ho: Difference in coefficient not systematic
Chi2(14) = (b-B)´[(V_b-V-B)^(-1)] (b_B)
= 1846.31
Prob>chi2= 0.0000
(V_b-V_B is not positive definite)

Source: Own elaboration (2021).

This test tells us that fixed effects are more efficient than random effects (Miller et al., 2021), But this estimation has some limitations like biased coefficients and imprecise standard errors to mention someone and that is the reason we have to take some precautions about it (Hill et al., 2020).

Consecutively, another estimation was carried out to determine if it was necessary to evaluate the countries over time, in which the p-value of the F test indicates that we reject the Ho, so it is possible to affirm that the temporary dichotomous variables are jointly significant and belong to the model.

Table 4
Test for temporary effects
Testparm_Iyear*

_Iyear_2007= 0
_Iyear_2008= 0
_Iyear_2009= 0
_Iyear_2010= 0
_Iyear_2011= 0
_Iyear_2012= 0
_Iyear_2013= 0
_Iyear_2014= 0
_Iyear_2015= 0
_Iyear_2016= 0
_Iyear_2017= 0
F (11 41) =4.01
PROF > F =0.0005

Source: Own elaboration with results
from the Stata 16 program (2021)

We also make the autocorrelation test, Heteroscedasticity, and Contemporary Correlation as we see in the following tables:

Table 5
Wooldridge test for autocorrelation in panel data

H0: no first-order autocorrelation
F (1, 5) = 32.449
Prob > = 0.0023

Source: Own elaboration with results from the Stata 16 program (2021)

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Table 6
Prueba de Heterocedasticidad

Modified Wald test for GroupWise heteroskedasticity in the fixed effect regression model
H0: sigma (i)^2 = sigma^2 for all i
Chi2 (6) = 18.14
Prob>chi2 = 0.0059

Source: Own elaboration with results from the Stata 16 program (2021)

_____

Table 7
Prueba de correlación contemporánea

Correlation matrix of residual						
_e1	1.0000					
_e2	0.1251	1.0000				
_e3	0.1817	0.5412	1.0000			
_e4	0.5458	0.1536	0.5008	1.0000		
_e5	0.5358	0.3519	0.3072	0.0053	1.0000	
_e6	0.2958	0.5168	0.1556	0.3154	0.6731	1.0000
Preusch-Pagan ML test of independence: chi2(15)=27.181 Pr= 0.0237						
Based on 12 observations over pane						
l units.						

Source: Own elaboration with results from the Stata 16 program (2021).

Carrying out all these tests to the model resulted in problems of autocorrelation, heteroscedasticity, and contemporary correlation as we can observe, and to solve them, the estimators of Panel Corrected Standard Errors (PCSE) were used; since Beck and Katz (1995) demonstrated in their study that PCSEs are more accurate to correct the problems described above, and that's why is used for many researchers to solve out this issues (Aparicio & Márquez, 2005; Beck, 2001; Kongkuah et al., 2021; Kumari et al., 2021; Nathaniel et al., 2020) as we show with the following results:

Table 8
Results of the PCSE Regression.

Prais-Winsten regression, correlated panels corrected standard errors (PCSEs)

Group variable: country1 — Number of obs = 72
Time variable: year — Number of groups = 6
Panels: correlated (balanced) — Obs per group:
Autocorrelation: common AR(1) — min = 12
avg = 12
max = 12

Estimated covariances = 21 — R-squared = 0.9997
Estimated autocorrelations = 1 — Wald chi2(19) = 42567.67
Estimated coefficients = 31 — Prob > chi2 = 0.0000

Real	Coef.	Std.	Err.	Z	[95% Conf.	Interval]
PRIMEDU	-0.1510701	0.1156023	-1.31	0.191	-0.3776464	0.0755062
QTTYED	0.3604228	0.0869252	4.15	0.000	0.1900524	0.5307931
QLTYED	0.4107299	0.2094608	1.96	0.050	0.0001944	0.8212655
JTRAIN	0.027244	0.1603675	0.17	0.865	-0.2870705	0.3415585
LFLEX	-0.3441133	0.2110566	-1.63	0.103	-0.7577765	0.06955
USFTA	0.3031298	0.1503947	2.02	0.044	0.0083616	0.5978979
CAPINNO	-0.1483218	0.0763794	-1.94	0.052	-0.2980226	0.001379
QLSCRE	-0.0961916	0.1799106	-0.53	0.593	-0.44881	0.2564267
BUSPR	0.086396	0.1885503	0.46	0.647	-0.2831557	0.4559478
UICOR&D	-0.2565156	0.1538084	-1.67	0.095	-0.5579745	0.0449434
GTECP	0.3954034	0.1384136	2.86	0.004	0.1241177	0.6666892
VAC&I	-0.0866857	0.1213237	-0.71	0.475	-0.3244758	0.1511043
EXPIN	0.5323182	0.0866767	6.14	0.000	0.3624351	0.7022014
IMPOIN	0.3246254	0.0483679	6.71	0.000	0.2298262	0.4194247
_Icountry1_2	-0.1397706	0.0461651	-3.03	0.002	-0.2302525	-0.0492887
_Icountry1_3	0.1036957	0.0295508	3.51	0.000	0.0457773	0.1616141
_Icountry1_4	-0.1427454	0.0337792	-4.23	0.000	-0.2089514	-0.0765394
_Icountry1_5	0.2115359	0.0630596	3.35	0.001	0.0879413	0.3351305
_Icountry1_6	-0.5108387	0.0236753	-21.58	0.000	-0.5572413	-0.464436
_Iyear_2007	-0.0031431	0.0140608	-0.22	0.823	-0.0307018	0.0244156
_Iyear_2008	-0.0108524	0.0154115	-0.7	0.481	-0.0410583	0.0193535
_Iyear_2009	0.0458419	0.0148593	3.09	0.002	0.0167182	0.0749655
_Iyear_2010	0.0005442	0.0167471	0.03	0.974	-0.0322796	0.033368
_Iyear_2011	-0.0123289	0.0188071	-0.66	0.512	-0.0491901	0.0245323
_Iyear_2012	-0.0032279	0.0205326	-0.16	0.875	-0.0434711	0.0370152
_Iyear_2013	0.0164688	0.0209287	0.79	0.431	-0.0245507	0.0574884
_Iyear_2014	0.0112049	0.0211622	0.53	0.596	-0.0302723	0.052682
_Iyear_2015	0.0339527	0.0211637	1.6	0.109	-0.0075273	0.0754328
_Iyear_2016	0.0256374	0.0214403	1.2	0.232	-0.0163847	0.0676595
_Iyear_2017	0.008959	0.0222344	0.4	0.687	-0.0346196	0.0525377
_cons	9.982904	0.1835727	54.38	0.000	9.623108	10.3427
Rho	0.249538					

Source: Own elaboration with results from the Stata 16 program (2021).

3. Results and analysis

Thus, the estimation of the model with PCSE was carried out with the series in logarithms, the interpretation of the results obtained must be made in terms of elasticities, and in this sense, the regression analysis allows make the following predictions:

A rise of 1% in QTTYED, QLTYED, USFT, GTECP, IEXPO and IMPO would result in an increase in real GDP of 0.36%, 0.41%, 0.30%, 0.14%, 0.53%, and 0.32%, on average, respectively.

What it means is that QTTYED and QLTYED, USFT, TECP, EXPO, and IMPO have a positive influence on the economic growth of the countries under study.

The year 2009 was also significant, according to economic history, since, in 2008, the world registered an economic crisis that began with the bankruptcy of the financial giant Lehmann Brothers, with the problem of US subprime mortgages affecting not only the economy of that country but also to those of other nations, mainly members of the European Union. However, although initially emerging economies were not affected by this crisis, over time, the financial and real consequences of it reached some more than others (Juárez et al., 2015).

4. Conclusions

After conducting the research, we can confirm the 5 variables of our general hypothesis since economic growth is determined by competitiveness in quantity and quality in higher education, the efficient use of talent (employment), the acquisition of products of advanced technology (innovation), exports and imports, in Mexico and the BRICS countries during 2007-2017.

This analysis shows both the strengths and weaknesses of these countries, in the different study variables. In this sense, Mexico showed that has a poor performance in higher education compared with most of the BRICS countries and, it is necessary to boost the competitiveness of this variable, quantity, and quality of higher education and thus obtain greater economic growth.

Betting on education is undoubtedly a safe step to generate value in production processes and international competitiveness, and is key to economic prosperity.

Therefore, the educational system is where the foundations of innovation are formed and people are the core of it, it is there where the ideas, motivations, and ambitions give rise to innovation.

In this sense, the efficient use of human talent in the era of the knowledge society, becomes a fundamental element of successful companies, since are the people the ones who achieve competitive advantages in companies or countries, through reaching greater efficiency in production processes.

As we have observed, imports are also significant, the acquisition of cutting-edge technologies since these have the potential to improve human well-being. By expanding production volume and creating completely new business models and industries, although these technologies or innovations bring new opportunities, they also bring challenges, such as investing in education, infrastructure, computer, broadband connection networks, improving R&D capacity to reproduce, improvise and disseminate appropriate technologies, or where appropriate even improve them.

And this is how it can be seen in knowledge, a way to improve efficiency and thus increase productivity to later commercialize it since trade plays a prominent role in that sense because surplus production finds in external demand a route through exports to expand economic growth.

And if we tried to follow a recipe, it would be that of China and India as examples of emerging countries that have invested in education, acquiring innovation, enhancing their intellectual capital, and learning in the process; at the same time that they strengthened their economy.

But we must not forget, that these countries also underwent a process, a change in the way of thinking on the part of their society and their government throughout history; that is why we can say that not only the significant variables of this model intervened in the development of their wealth, but also the historical and geographical context, good economic planning, the current world situation of those years and the position that was played within the world political-economic system, in addition to its demographic endowment; and to say otherwise would be considered somewhat reductionist.

However, the most optimistic, business, academic, political, and social sectors see in China and India the opportunity to get on the "prosperity train" without dimensioning and questioning the extent to which it is viable not only economically but also socially and environmentally. It will be necessary to take into consideration many aspects of Mexico and takes only what is beneficial without these generating setbacks on issues where there is some progress.

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