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Relación de la educación con la economía de un país. El caso de México

The Relationship Between Education and the Economy of a Country: The Case of Mexico

Relação entre educação e economia de um país. O caso do México

Lilia Rodríguez Quintero
Universidad Juárez del Estado de Durango, Durango, México.
liliarq6@gmail.com
https://orcid.org/0000-0001-6470-1613

Resumen

El presente estudio examina la relación entre la educación y el desarrollo económico en México. A través de un análisis descriptivo basado en datos nacionales y estatales, se identifican correlaciones entre indicadores educativos — como la tasa de alfabetización y el acceso a la educación superior — así como en variables económicas, tales como el Producto Interno Bruto (PIB) y las exportaciones. Los resultados destacan que las regiones con mejores indicadores educativos suelen tener un mayor desarrollo económico. En consecuencia, esto resalta la necesidad de implementar estrategias integrales que fortalezcan la educación para potenciar el crecimiento económico regional.

Palabras clave: educación, desarrollo económico, desigualdad regional, correlación, alfabetización, México.

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Abstract

This study examines the relationship between education and economic development in Mexico. Through a descriptive analysis based on national and state-level data, correlations between educational indicators, such as literacy rates and access to higher education, and economic variables, such as Gross Domestic Product (GDP) and exports, are identified. The results highlight that regions with better educational indicators tend to experience higher economic development. This underscores the need to implement comprehensive strategies that strengthen education to enhance regional economic growth.

Keywords: education, economic development, regional inequality, correlation, literacy, Mexico.

Resumo

Este estudo examina a relação entre educação e desenvolvimento econômico no México. Por meio de uma análise descritiva baseada em dados nacionais e estaduais, são identificadas correlações entre indicadores educacionais — como taxa de alfabetização e acesso ao ensino superior — e variáveis econômicas, como Produto Interno Bruto (PIB) e exportações. Os resultados destacam que regiões com melhores indicadores educacionais tendem a ter maior desenvolvimento econômico. Consequentemente, isso destaca a necessidade de implementar estratégias abrangentes que fortaleçam a educação para impulsionar o crescimento econômico regional.

Palavras-chave: educação, desenvolvimento econômico, desigualdade regional, correlação, alfabetização, México.

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Introduction

The link between education and economic and industrial development is a highly relevant issue for any nation. In Mexico, a country with a long history of industrialization and a relatively young and large workforce, this issue takes on a strategic nature. Since the mid-20th century, the country has transitioned through different economic models, from import substitution to integration into global value chains, consolidating its position as a key player in industries such as automotive, aerospace, and electronics. However, this progress

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has not been uniform. The educational and economic gaps between regions highlight structural challenges that limit national development potential.

Education is a fundamental driver of the country's development, generating the human capital needed to meet the demands of a dynamic productive sector, adapt to technological innovation, and strengthen global competitiveness. However, Mexico faces significant challenges in this area, such as low investment in education and research, a lack of effective links between educational institutions and businesses, and regional inequalities that perpetuate economic disparities.

This article examines the relationship between economic and educational variables, with the aim of determining whether they are correlated. It seeks to understand current dynamics and highlight the importance of comprehensively addressing educational and economic issues as part of a synergistic process for the benefit of regional development. To this end, it draws on a review of public data and current indicators to provide a comprehensive overview that contributes to the debate on the role of education as a central pillar of progress in the country.

General objective

To analyze the relationship between educational levels and economic development in the different states of Mexico, in order to identify how improvements in educational indicators can contribute to economic growth and the reduction of regional inequalities.

Specific Objectives

1. Identify the federal entities with the highest and lowest performance values in educational and economic terms.
2. To evaluate the correlations between educational variables, such as literacy, years of schooling, and percentage of students in higher education, and economic variables, such as GDP per capita, exports, and average income, in Mexico's states.

Literature review

Mexico's economic growth

Mexico, like most countries, has gone through different economic stages and experienced a progressive evolution in its main industries and productive activities. According to Lara et al. (2023), during the 1960s in Mexico, stabilizing development policies drove significant economic growth. This industrialization model was based on import substitution and strong state intervention in the economy. However, in the 1970s, this model began to show signs of exhaustion due to the adoption of economic populism during the governments of Luis Echeverría and José López Portillo (1970-1982). As a result, public debt increased significantly, and towards the end of the 1980s, the country faced a severe crisis that included the collapse of oil prices, the external debt crisis, and a deep macroeconomic recession.

Faced with this situation, Mexico implemented structural reforms promoted by international organizations such as the World Bank and the International Monetary Fund, following the principles of the *Washington Consensus* . These reforms were characterized by reducing state participation in the economy, liberalizing markets, making interest and exchange rates more flexible, privatizing public companies, and granting greater autonomy to the central bank. These policies profoundly transformed the country's economic, political, and social structures.

However, these measures also had negative consequences. Domestic industrial capital accumulation declined, resulting in slow economic growth and a specialization in the export of cheap, labor-intensive assembled products (Calderón and Hernández, 2016). Beginning in 1982, Mexico experienced economic stagnation with low growth rates and a deterioration in the population's well-being, attributed to a lack of dynamism in the manufacturing sector and the absence of an active strategic industrial policy (Calderón and Sánchez, 2011).

Calderón and Sánchez (2012) have carried out a broad analysis of the literature in which they point out what other authors, through different analyses and tools, have identified as some of the problems that have caused Mexico to fail to achieve high sustainable growth.

Guillén (2000) points out that neoliberal policies, aligned with the Washington Consensus, were procyclical and counterproductive by not considering the country's particularities. Martínez et al. (2004) acknowledge that liberalization boosted growth, but the lack of structural and credit reforms limited economic progress. Villarreal (2005) observes that the ALPES model, along with restrictive policies, exacerbated external imbalances. Ros

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(2008) and Ibarra (2008) highlight low investment, caused by factors such as declining public investment, an appreciated exchange rate, and a lack of financing, as key factors in the slow growth. De María and Campos et al. (2009) point out that a lack of investment and employment in the productive sector, along with fiscal and trade policies focused on macroeconomic stability, also contributed to the stagnation. Moreno- Brid and Ros (2004) indicate that the poor performance of investment has been one of the main causes of the slowdown in Mexico.

Education, human capital and economic development

So far, many of the factors mentioned are associated with Mexico's relationship with other countries, foreign trade, and monetary policies. However, many of the drivers that can drive growth are also endogenous or internal.

For example, according to Maldonado et al. (2023), in addition to investment, another of the fundamental determinants of growth is the level of qualification of human capital, since it is proposed that the higher the level of education and training, the greater its productivity will be.

Education and knowledge not only represent key factors of economic development, but also constitute pillars of social and productive progress (Rojas, 2024).

According to Goczek et al. (2021), education is one of the most important social institutions and, although it faces difficult tasks, it is widely considered one of the main development mechanisms. Therefore, the relationship between the quality of education and economic performance is always of utmost importance. The conviction that education has a significant impact on economic growth and sustainable development is commonly accepted (Hanushek and Woessmann , 2020; Widarni and Bawono , 2021; Hess, 2016; Rajan, 2020). Pal (2023) argues that education is one of the most important tools for a country's socioeconomic development as it catalyzes increased productivity and promotes technological advancements.

The main idea of the importance of education in the development, perhaps long-term, of a country lies in the fact that it is the main way to create productive human capital with the knowledge necessary for the labor market. This has been argued by various authors in the economic literature.

For example, some authors mention that education is considered an investment in human capital, which improves people's skills, knowledge and productivity, aspects that are

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crucial for economic development and raising the standard of living (Weisbrod , 1962; Shengelia et al., 2021; Schultz, 1960; Riadynska , 2022).

Likewise, Weisbrod (1962) and Fayzullin (2022) mention that investment in education leads to the accumulation of human capital, which is essential to take advantage of technological progress and improve productivity.

For their part, some other authors agree that human capital contributes significantly to economic growth by directly entering the production process and incentivizing the accumulation of inputs. It also facilitates the adoption of new technologies, which is essential for innovation and economic development (Angrist et al., 2021 ; Rossi, 2018 ; Diebolt et al., 2018 ; Mincer , 1981).

In this sense, the relationship between patents and economic growth in national economies is a topic that has been studied for decades (Beltrán-Morales et al., 2018). According to Grossman and Helpman (1991), there is a trend in the global economy where technological innovations have become the decisive factor in economic growth and well-being.

In fact, various classical economic models and theories, such as those proposed by authors such as Gary Becker (human capital theory), Paul Romer (endogenous growth theory), or Robert Solow (Solow growth model), consider human capital as a key factor for the development of a region.

These concepts form a close link because, in practice, as already mentioned, they interact directly and indirectly. Education is a fundamental input for the formation of human capital, improving individuals' knowledge, skills, and innovative capacity. Human capital, defined as the set of competencies and attributes that contribute to productivity, is a determinant of long-term economic performance. In short, investment in education allows for the accumulation of highly qualified human capital, which is crucial for competitiveness, innovation, and sustainable economic growth in a knowledge-based economy .

Hypothesis

A region's educational level is positively correlated with its economic development; therefore, improving educational indicators will significantly contribute to improvements in various economic indicators and, potentially, reduce regional economic inequality in Mexico.

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Methodology

The methodology adopted is quantitative and descriptive. Based on the literature review, various variables used in studies on economic growth and education were identified. However, many of these variables—such as GDP per capita or labor productivity—are not available at the state level with the frequency or coverage required for this study. Therefore, alternative indicators were selected that reflect relevant dimensions of the phenomenon under analysis.

In this regard, given that Mexico has several institutions that generate and publish related data, the data used for this study come from the National Institute of Statistics and Geography (INEGI), the Ministry of Public Education (SEP), and the Mexican Institute of Intellectual Property (IMPI). Based on a review of the main variables that, according to the literature and under the aforementioned conditions, could be useful for the purpose of this study, nine quantitative variables were selected for the analysis to compare and analyze the 32 states:

1. Number of economic units in the federal entity
2. Number of applications for inventions before the IMPI
3. Gross Domestic Product (GDP) in millions of pesos (base 2018)
4. Exports (in millions of dollars)
5. Percentage of undergraduate students in relation to the total population aged 15 to 24
6. Average quarterly income
7. literate population
8. Average number of teachers per school
9. Average years of schooling

Based on the collected data, a national overview is initially presented, followed by a correlation analysis between variables. This analysis allows for the identification of linear relationships, although it is important to note that correlation does not necessarily imply causality, as external or random factors may intervene.

Correlation is essentially a normalized measure of linear association or covariance between two variables. The most commonly used correlation method is Pearson's correlation, denoted by r, and measured as the ratio of the covariance of two variables to the product of their variances, that is:

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$$r = \frac{Cov(x,y)}{S_x S_y}$$

According to Vinuesa (2016), the correlation index $r$can vary between -1 and +1, where both extremes indicate perfect correlations, negative and positive respectively, while a value of r= 0 indicates that there is no linear relationship between the two variables. According to this author, a positive correlation indicates that both variables vary in the same direction, while a negative correlation implies that both variables vary in opposite directions. Furthermore, Vinuesa (2016) highlights that $r$it is, in itself, a measure of the size of the effect that can be interpreted as follows:

- Null correlation: r< |0.1|
- Low correlation: |0.1| < r<= |0.3|
- Median correlation: |0.3| < r<= |0.5|
- Strong or high correlation: r> |0.5|

Likewise, Devore (2008) makes some notes on the most important properties of r:

1. The value of r, does not depend on which of the two variables studied is x and which is y.
2. The value of$r$ It is independent of the units in which xy and y are measured.
3. $r = 1$if and only if all pairs (x_i, y_i) lie on a straight line with positive slope and $r = -1$if and only if the pairs (x_i, y_i) lie on a straight line with negative slope.

Results

Companies

The three states with the largest number of companies are the State of Mexico with 817,094, Mexico City with 458,231, and Jalisco with 399,075 (Figure 1). In contrast, the states with the fewest companies are Baja California Sur (41,237), Colima (41,612), and Campeche (46,923).

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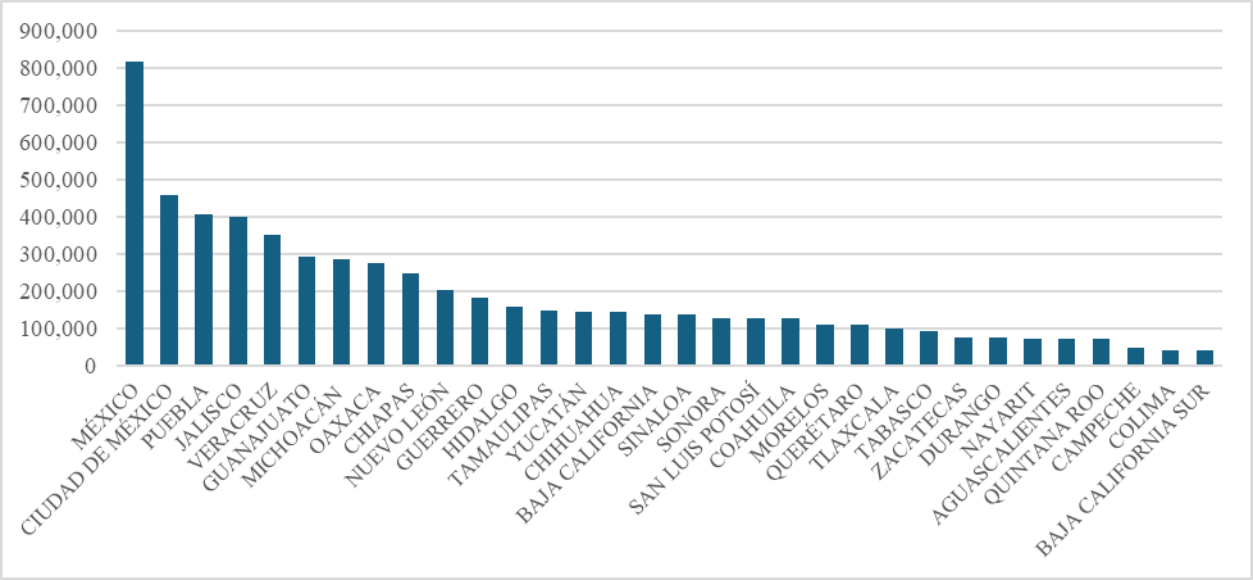
Figure 1. Number of economic units per federal entity, 2023

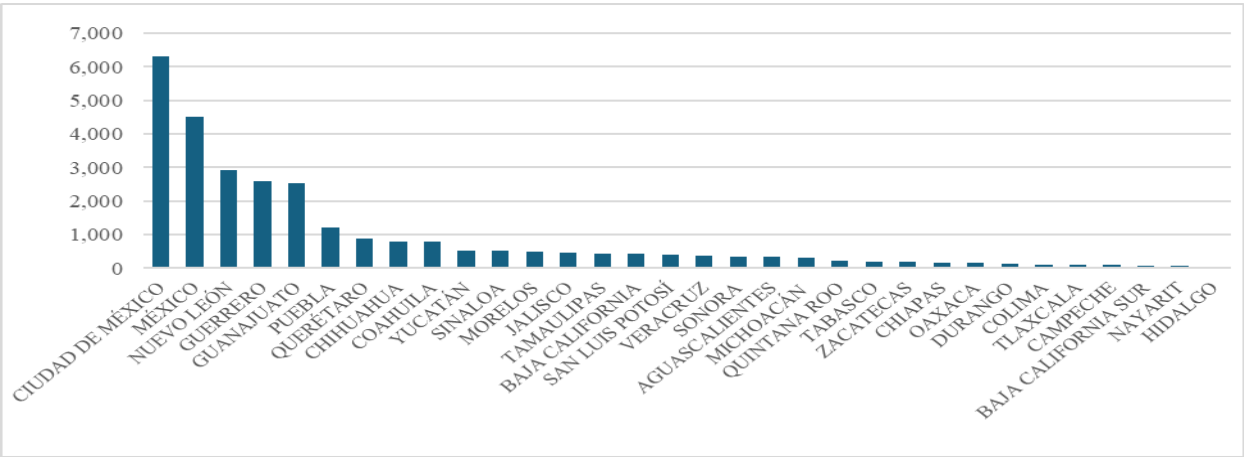


Source: National Statistical Directory of Economic Units, INEGI

Applications for inventions

Regarding invention applications, the leading states are Mexico City with 6,317, the State of Mexico with 4,512, and Nuevo León with 2,432 (Figure 2). On the other hand, the states with the fewest inventions are Hidalgo (53), Baja California Sur (72), and Nayarit (72).

Figure 2. Number of applications for inventions by Mexicans by federal entity 2015 - 2023



Source: IMPI, 2023

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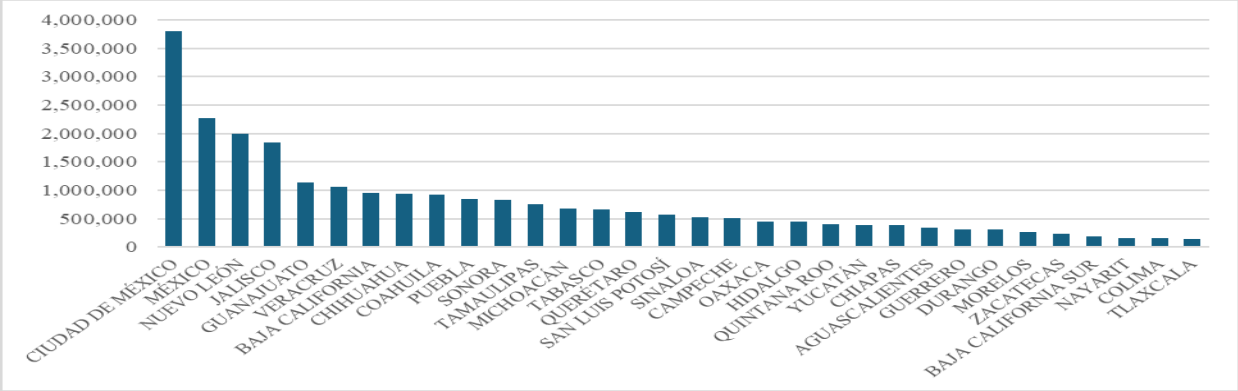
Gross Domestic Product (GDP)

The largest economies, measured by GDP, belong to Mexico City (3,806,083 million pesos), the State of Mexico (2,275,498 million), and Nuevo León (1,995,054 million) (Figure 3). In contrast, the smallest economies are Tlaxcala (148,814 million), Colima (154,500 million), and Nayarit (162,750 million).

Figure 3. Gross Domestic Product by State (GDP), preliminary figures 2023

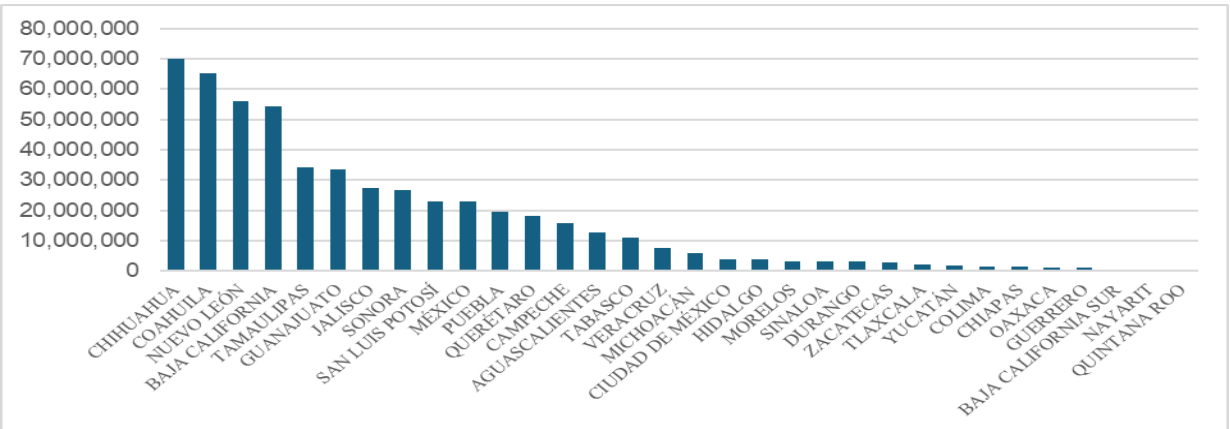


Source : System of National Accounts, PIBE, INEGI (2023a)

Exports

The states with the highest export volumes are Chihuahua (69,923,269 million pesos), Coahuila (65,406,768 million), and Nuevo León (56,016,434 million) (Figure 4). At the other end of the spectrum, those with the lowest export volumes are Quintana Roo (35,416 million), Nayarit (299,158 million), and Baja California Sur (504,424 million).

Figure 4. Exports by federal entity (millions of dollars) preliminary 2023



Source: Quarterly exports by federal entity, INEGI (2023a)

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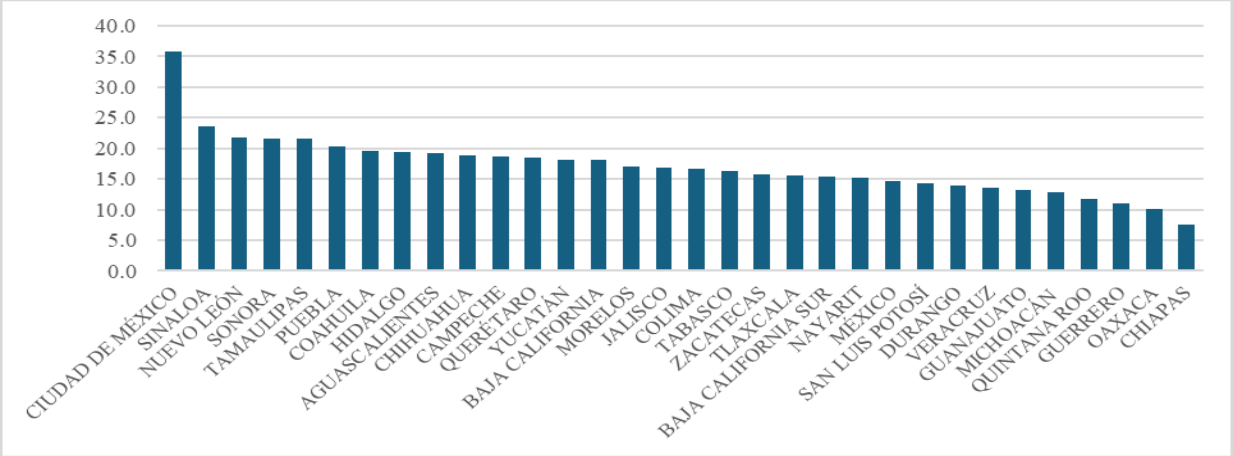
Bachelor's students

The states with the highest percentage of university students are Mexico City (35.8%), Sinaloa (23.6%), and Nuevo León (21.8%) (Figure 5). In contrast, the lowest percentages are found in Chiapas (7.6%), Oaxaca (10.1%), and Guerrero (10.9%).

Figure 5. Percentage of bachelor's degree students in relation to the total population aged 15 to 24, 2020



Source: Prepared by the authors with information from the 2020 Population and Housing Census of INEGI and the Ministry of Public Education.

Average Quarterly Income

The highest average quarterly income is found in Baja California Sur ($91,417.12), Mexico City ($89,310.27), and Baja California ($88,912.22) (Figure 6). The lowest incomes are found in Chiapas ($39,844.83), Guerrero ($41,754.07), and Oaxaca ($43,342.93).

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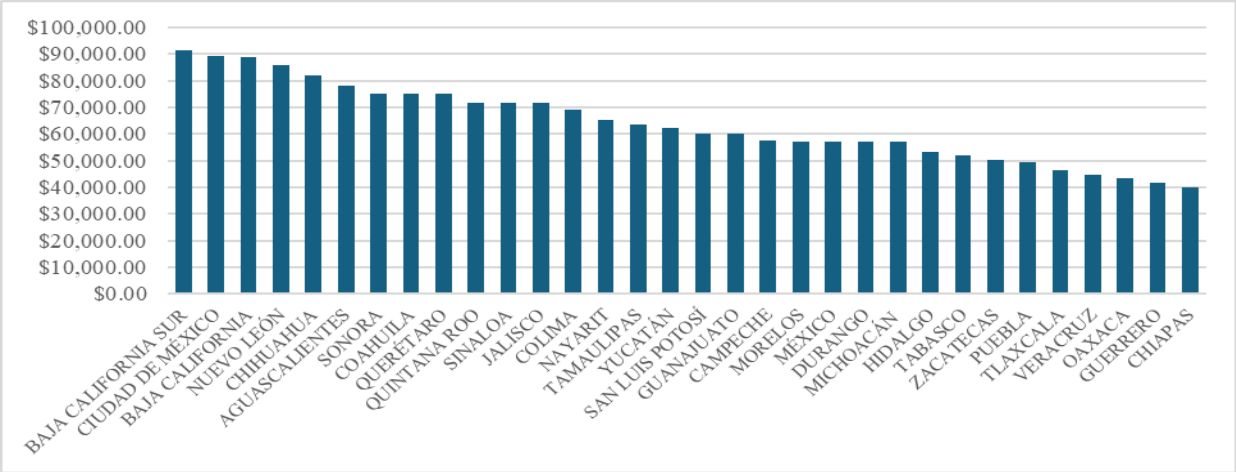
Figure 6. Average quarterly income by federal entity (mxn), 2022

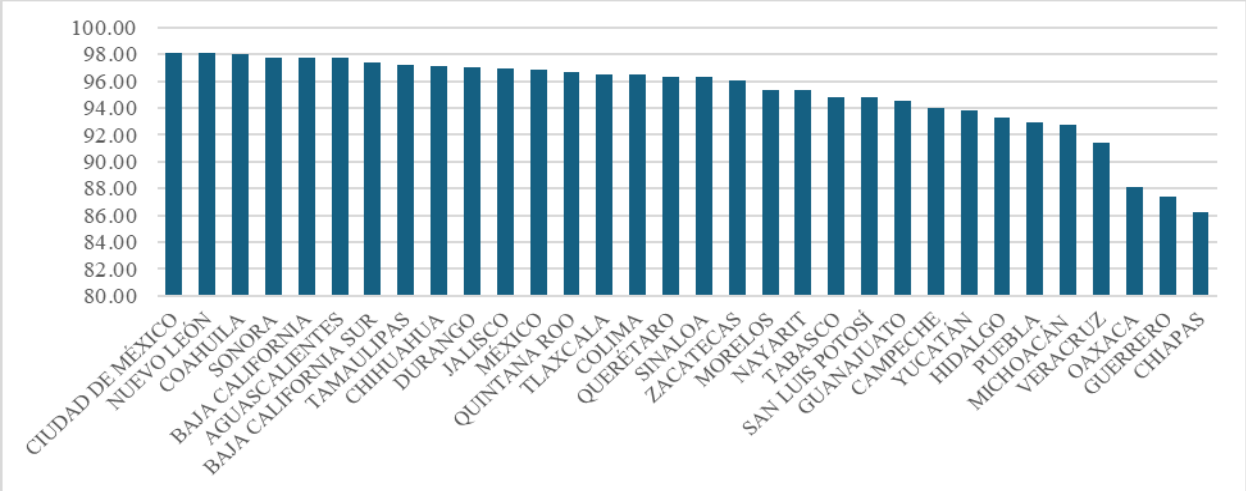


Source: National Survey of Household Income and Expenditure 2022, INEGI

Literacy

The highest literacy rates are found in Mexico City (98.15%), Nuevo León (98.09%), and Coahuila (97.99%) (Figure 7). In contrast, the lowest rates are found in Chiapas (86.22%), Guerrero (87.42%), and Oaxaca (88.09%).

Figure 7. Percentage of literate population by federal entity, 2020



Source: 2020 Population and Housing Census, INEGI

Teachers per School

Finally, the states with the most teachers per school are Mexico City (145.65), Jalisco (82.87), and Querétaro (81.09) (Figure 8). Those with the fewest teachers are Guerrero (29.39), Chiapas (33.65), and Campeche (39.52).

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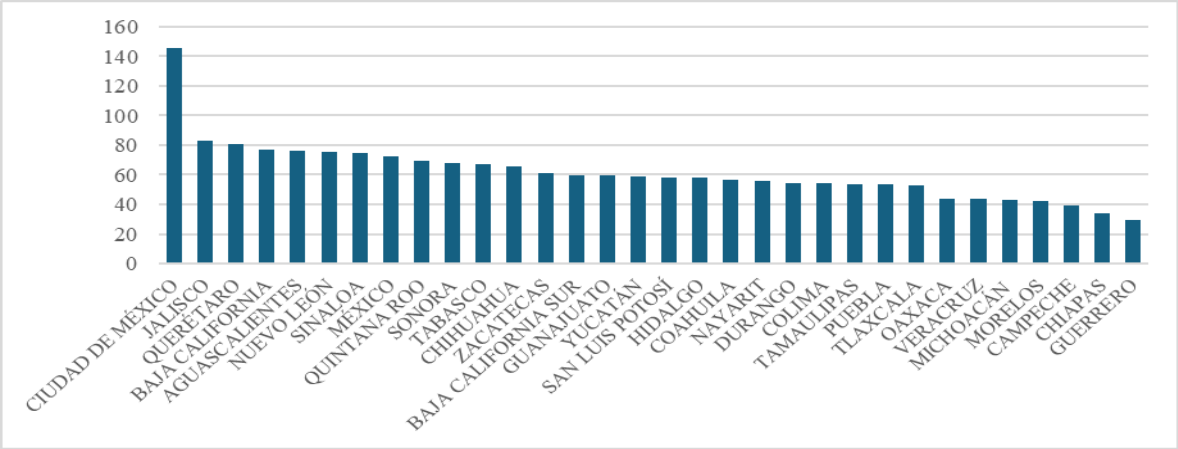
Figure 8. Average number of teachers per higher education school 2023-2024

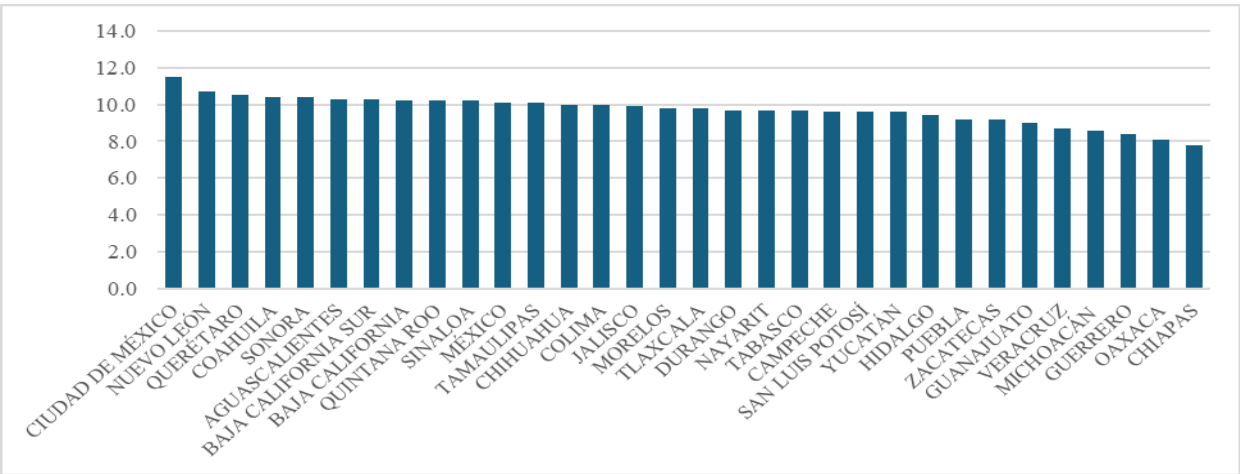


Source: INEGI with data from the Ministry of Public Education

Average years of schooling

The three states with the highest average schooling are Mexico City (11.5 years), followed by Nuevo León (10.7 years) and Querétaro (10.5 years) (Figure 9). On the other hand, the three states with the lowest average schooling are Chiapas (7.8 years), Oaxaca (8.1 years), and Guerrero (8.4 years).

Figure 9. Average years of schooling



Source : 2020 Population and Housing Census, INEGI

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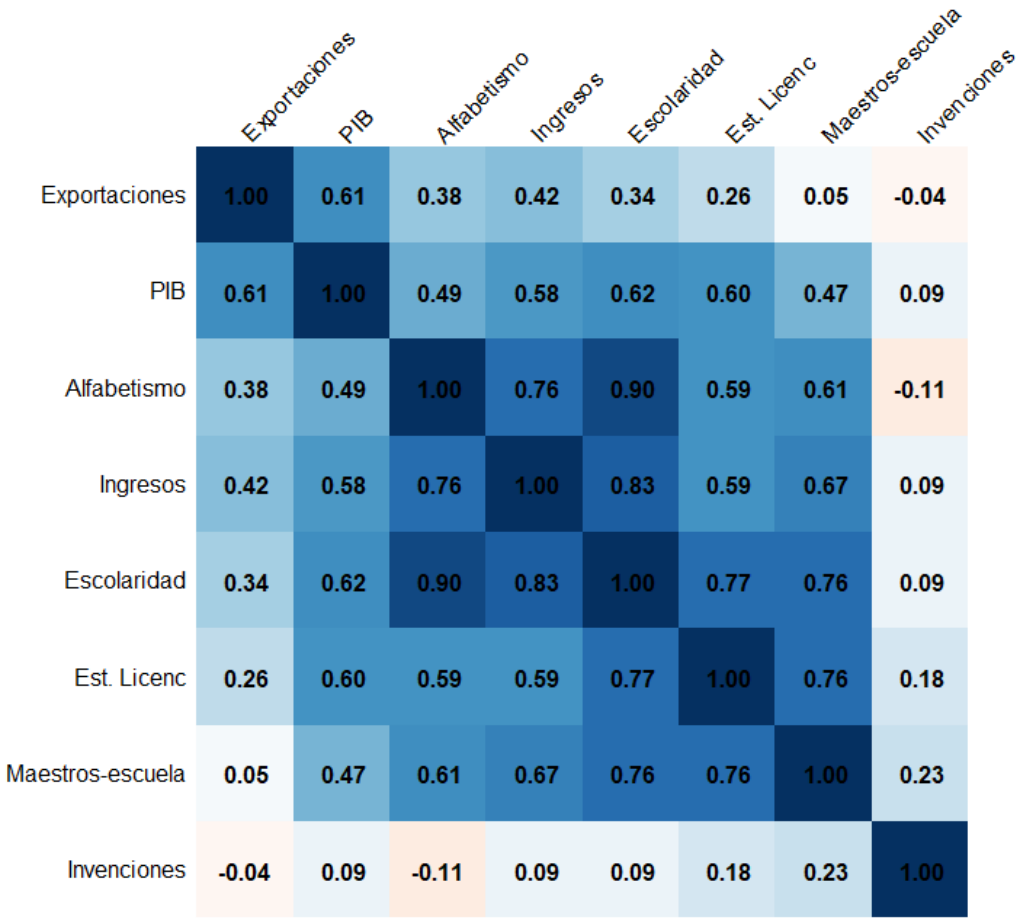
Correlation analysis

To identify any type of relationship, at least numerical, a correlation matrix was constructed to examine the relationship between the selected variables. It is important to mention that the variable of economic units per state was eliminated, given that this variable is presented in absolute values without controlling for population size or sector, and was considered inappropriate for correlational analysis due to its potential to bias the results.

Furthermore, for each variable, the variables were transformed to account for population size to avoid overestimating the results: for invention applications, GDP and exports were obtained as per capita figures; for the number of undergraduate students variable, the population aged 15 to 25 in each state was considered, and the remaining variables were already expressed as rates or averages. The results are shown below (Figure 10):

Figure 10. Correlation matrix between economic and educational variables



Source: Own elaboration

Special emphasis is placed on identifying interdimensional relationships between educational and economic variables. To this end, the color indicates the sign of the correlation

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(blue = positive; red = negative), and its intensity represents the magnitude of the coefficient. Each cell shows the numerical value of the correlation between the corresponding variables.

For example, the exports variable has a positive correlation with the following variables: GDP (.61), literacy rate (.38), average quarterly income (.42), level of schooling (.34), percentage of higher education students (.26), average number of teachers per school (.05), and a negative correlation with the invention applications variable (-.04). This last variable is the only one that has a negative correlation with some other variables; however, it is so low as to be practically zero. Given that an 8-year period was taken, it is possible that extending or reducing the analysis period for invention applications could change this value.

Overall, the results are consistent with the literature: the economic variables are correlated with the education-related variables. Although this is only a correlation analysis, not a causal one—that is, no other tests were performed to reinforce statistical significance—the variables have a certain argumentative logic. Virtually every quadrant of the first seven variables in the correlation matrix, except for the invention filings, as explained above, has a relatively high correlation with these variables: exports, GDP, literacy rate, average quarterly income, percentage of bachelor's students, and average number of teachers per school.

Above all, the most relevant correlations are those between variables from different dimensions, since, in any case, educational variables could be correlated for shared reasons, and the same is true for economic variables. For example, the correlation between average quarterly income and the level of education and literacy rate have the highest values; GDP has a practically equal correlation with the percentage of bachelor's degree students, the level of education, and exports; and the average number of teachers per school has a strong relationship with both the percentage of bachelor's degree students, the level of education, and the average quarterly income.

This, despite being a largely descriptive analysis, shows that the population's economic and educational variables interact relatively closely and directly. While the work conducted does not allow us to discern which variables can cause changes in others—that is, in what sense the relationship exists—a broader literature review could identify how these themes can be combined to generate positive returns across investments, regional wealth, education expenditures, etc.

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Discussion

The analysis reveals a relationship between educational indicators and economic variables in Mexico's states. The results show that regions with higher literacy rates, a higher percentage of bachelor's degree students, and a higher average number of years of schooling have higher values in economic indicators such as GDP, exports, and average income. This association supports the hypothesis that strengthening the education system is a key factor in driving economic development and reducing regional inequalities.

These findings align with those reported in the literature, where authors such as Hanushek and Woessmann (2020) and Pal (2023) have highlighted the impact of human capital on economic growth. Thus, just as previous studies highlight the relevance of investment in education for the accumulation of human capital and the adoption of productivity-enhancing technologies (Schultz, 1960; Mincer , 1981), the present work reinforces the idea that improvements in the quality and access to education can translate into palpable economic benefits at the regional level.

However, it is important to acknowledge certain limitations of the study. First, the methodology based on correlation analysis prevents the establishment of direct causal relationships. There may be external factors or omitted variables that influence both educational and economic performance, suggesting the need to apply more robust statistical methods to control for these variables. Furthermore, the eight-year analysis period may not be sufficient to capture structural changes or the impact of recent educational policies, which limits the generalizability of the results.

On the other hand, the transformation of some variables into per capita figures, while helping to avoid biases derived from population size, may not fully reflect the complexity of the interactions between the different socioeconomic factors present in each state. In this sense, future studies should incorporate a multivariate analysis that allows for a more in-depth exploration of the dynamics between investment in education, human capital development, and economic indicators.

Despite these limitations, the study offers a relevant contribution to the debate on the role of education in Mexico's economic development. The evidence suggests that the implementation of public policies that strengthen both educational quality and coverage can generate a virtuous cycle, in which a better-educated population contributes to greater competitiveness and, consequently, to sustained and equitable economic growth.

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Conclusions

Mexico's economic growth, as well as the performance of its industrial sector and other key indicators, has gone through volatile periods that have hindered its consolidation as an international benchmark. In this regard, one of the variables that takes on significant relevance is the role of education, primarily due to its relationship to human capital development and, in the medium and long term, to regional development. Based on this, the heterogeneity of the states and the inequality in areas such as access to and quality of education mean that the benefits it offers are not widespread throughout the country.

The analysis identified a close correlation between some educational variables and others related to the economic sphere. The results show that states with better economic performance also tend to have better educational indicators.

The findings highlight the importance of ensuring access and improving the quality of education provided in a region to foster positive economic returns. While the study does not present a causal analysis or the direction of the relationship, the literature review suggests that improving education will, among many other things, foster a region's growth. Greater accumulation of knowledge, a skilled workforce, and access to advanced technologies are part of the link between education and such growth.

Future lines of research

This study opens up new lines of analysis that merit exploration in complementary research. First, it suggests incorporating more advanced econometric methodologies to identify causal relationships between educational indicators and economic variables. This would allow for a more precise understanding of how changes in the educational system influence long-term economic development.

Furthermore, it is important to expand the analytical framework by including additional variables that have not currently been addressed, such as investment in educational infrastructure and technology, the quality of teaching, and structural factors of a socioeconomic and cultural nature. Integrating these dimensions could offer a more complete view of the role education plays in shaping human capital and, consequently, in regional growth.

It is also interesting to delve into micro-level case studies that analyze specific contexts within states to identify how local specificities impact the interaction between

education and the economy. The use of qualitative methods or mixed approaches will allow us to capture contextual dynamics not captured by quantitative variables.

Finally, comparative studies with other countries or regions are proposed, which could enrich the academic debate and provide international perspectives that will allow for the identification of replicable good practices. This future research will contribute to better public policymaking aimed at maximizing the impact of education on socioeconomic progress.

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