Financial inclusion in Puebla, Mexico: a socioeconomic and spatial econometric analysis

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Abstract
This study examines financial inclusion in 217 municipalities in the state of Puebla, Mexico, using statistical analysis and the Moran Index to assess geographic and socioeconomic factors. It was found that 124 municipalities had at least one financial institution, and a cluster of five municipalities showed a high density of these services. In contrast, 93 municipalities lacked financial institutions, and eight of them were in areas with high financial exclusion. The results reveal that municipalities with a higher economically active population and a lower educational lag have better financial inclusion. No significant differences were observed in the poverty levels between municipalities with and without financial inclusion. These findings underscore the need for specific public policies and emphasize the importance of considering the geographic dimension in planning financial inclusion.

Keywords: economic development; financial exclusion; financial institutions; Mexican municipalities; poverty.

Inclusión financiera en Puebla, México: un análisis socioeconómico y econométrico espacial

Resumen
Este estudio examina la inclusión financiera en 217 municipios del estado de Puebla, México, utilizando análisis estadísticos y el índice de Moran para evaluar factores geográficos y socioeconómicos. Se identificó que 124 municipios tienen al menos un establecimiento financiero, y un clúster de cinco municipios mostró una alta densidad de estos servicios. En contraste, 93 municipios carecen de instituciones financieras, y ocho de ellos se encuentran en áreas de alta exclusión financiera. Los resultados revelan que los municipios con una mayor población económicamente activa y menores niveles de rezago educativo tienden a tener mejor inclusión financiera. No se observaron diferencias significativas en los niveles de pobreza entre los municipios con y sin inclusión financiera. Estos hallazgos subrayan la necesidad de políticas públicas específicas y enfatizan la importancia de considerar la dimensión geográfica en la planificación de la inclusión financiera.

Palabras clave: desarrollo económico; exclusión financiera; instituciones financieras; municipios mexicanos; pobreza.

1   Introduction

Financial inclusion is defined as affordable and useful access to a wide range of financial services that cater to a variety of needs, from transactions and payments to savings and credit for both individuals and businesses [1]. Financial inclusion has emerged as a critical factor for economic and social development, particularly in developing countries. This is a multidimensional concept that encompasses access, use, and quality of financial services. These aspects are critical for developing effective public policies that can overcome various barriers to financial inclusion [2]. Regarding access, variables such as financial service availability and accessibility are studied [3]. This approach can be divided into demographic and geographic variables, such as the distance to the nearest bank branch or the number

of bank branches per capita [4]. Internationally, about half of adults in developing countries have a bank account. However, significant disparities in access to financial services persist [5]. In Latin America, countries such as Brazil, Chile, and Uruguay have made considerable progress, but Mexico continues to face significant obstacles in financial inclusion. Specifically, Mexico is grouped with Argentina, Colombia, and Peru as nations with low levels of financial inclusion, characterized by a high proportion of individuals outside the formal financial system [6]. According to data from the National Survey of Financial Inclusion (ENIF) of 2021 [7], 67.8% of the Mexican population has at least one formal financial product. The study of financial inclusion has garnered interest at the subnational level to understand regional disparities in access to and use of financial services. For instance, in countries like India and South Africa, district or provincial-level data have been used to examine financial inclusion [8,9]. In Latin America, subnational research has explored how variations in economic and social development between regions can influence financial inclusion. Studies conducted in Brazil and Colombia have used state and municipal level data to investigate the correlation between financial inclusion and variables, such as income, education, and employment [10]. In Mexico, the 2023 study by [4] highlights the variability in financial inclusion levels among different municipalities, emphasizing the need for public policies that adapt to the particular characteristics of each area. This challenge remains despite implementing the National Financial Inclusion Policy 2020-2024, which addresses multiple key dimensions of financial inclusion: enhancing access to the financial system, effective use of financial services, development of financial skills, and user empowerment [11]. This longitudinal study uses a quantitative approach to examine financial inclusion in the municipalities of the state of Puebla. The research is descriptive and comparative, focusing on three key aspects: the classification of municipalities by their level of financial inclusion, the variation and spatial distribution of the density of financial institutions between 2021 and 2023, and their correlation with socio-economic variables, such as population, employment, poverty, and education. It is noteworthy that the method employed in this study differs from prior approaches by incorporating a spatial component in the analysis, which is often missing in research using multivariate techniques [4,12]. The findings could provide a solid foundation for designing future public policies, particularly in areas with limited or no financial infrastructure.

2 Materials and methods

2.1 Study area

Puebla State is situated in the central-eastern region of Mexico, divided administratively into 217 municipalities and covering an area of 34,306 square kilometers. With its high population density and developed transportation infrastructure, Puebla is among the top eleven states in the country conducive to economic activity. It has 10,127 kilometers of roads, 1,057.2 kilometers of railways, a national and international airport, and five airstrips. These infrastructure elements facilitate the movement of people and goods, essential for economic development and financial inclusion.

2.2 Acquisition and categorization of information on financial institutions

We examined the 217 municipalities in the state of Puebla and divided them into two groups: municipalities with financial inclusion and municipalities with financial exclusion. This classification was made based on the presence or absence of financial institutions in each municipality, using data from the National Statistical Directory of Economic Units of Mexico for the year 2021 [13]. A municipality was deemed to have financial exclusion if it lacked any financial institution from development banks, credit auxiliary organizations, insurance and finance institutions, or credit institutions. On the other hand, a municipality was classified as financially included if it had at least one type of financial institution, including at least one ATM. This classification enables a geographical assessment of access to financial services at the municipal level. It provides a geospatial framework for analyzing the relationship between financial inclusion and other key socioeconomic variables in the state of Puebla.

2.3 Data analysis

Initially, a descriptive analysis was conducted focusing on five socioeconomic variables corresponding to the year 2020 at the municipal level. The variables analyzed include the total population per municipality, the Economically Active Population (EAP), and the percentage of the population with educational lag [14]; the percentage of the population in poverty conditions [15]; and the degree of marginalization [16]. Additionally, a 'Density' variable was created to quantify per capita access to financial services in each municipality, using data from the National Statistical Directory of Economic Units [13]. This variable was calculated for the years 2021 and 2023 and was generated by the ratio between the number of existing financial institutions and the total population in each municipality (Table 1). The approach used provides a fair comparison regarding the availability of financial services among different municipalities. This metric was used to examine how the presence of financial institutions in 2021 relates to the socioeconomic variables of 2020. It is important to note that no comparisons of socioeconomic data with the density of financial institutions were made for the year 2023. The main reason for this omission is the lack of updated socioeconomic data that would allow for accurate comparison of that year. For the statistical analysis, version 2023.06.0 of RStudio was used.

2.4 Normality test

To determine whether the data for each variable were normally distributed, a Shapiro-Wilk test was conducted for each variable in each group. The Shapiro-Wilk test is a statistical test used to test the null hypothesis that a sample is from a normal distribution. It was decided that if the p-value of the Shapiro-Wilk test was greater than 0.05, the data would be considered normally distributed.

Table 1.
Definition of Socioeconomic Variables

Variable	Measurement Scale (Value)	Description
Population	Total population per municipality	Individuals over 18 years old per municipality
Economically Active Population (EAP)	Number of Economically Active Population per municipality	Individuals over 12 years old who have or are seeking employment
Education	Percentage of the population with educational lag	Individuals 15 years and older who cannot read or write
Poverty	Percentage of the population in poverty per municipality	Individuals suffering from at least one social deprivation (access to services, education, food, healthcare, housing) and having a monthly income below the poverty line (approximately 76.41 USD at 2020 prices).
Marginalization	Classified into five categories: Very Low (1), Low (2), Medium (3), High (4), or Very High (5)	A measure of the deprivations suffered by the population, resulting from lack of access to education, residence in inadequate housing, insufficient monetary income
Financial Institutions in 2021 and 2023	Number of financial institutions per municipality in 2021 and 2023	Physical establishments of Credit Auxiliary Organizations, Credit Institutions, Insurance and Finance Institutions, and Development Banks.
Density	Density of financial institutions per 1,000 inhabitants in 2021 and 2023	Number of financial institutions per 1,000 residents calculated by dividing total number financial establishments by total population multiplying result by1000

Source: own elaboration based on information from INEGI (2020, 2023) [13,14], CONEVAL (2021) [15] and CONAPO (2023) [16].

2.5   Comparison tests between groups

To compare the differences between the two groups of municipalities, comparison tests were performed for each variable. For variables that are normally distributed, a student's t-Test was used. For variables that are not normally distributed, a Mann-Whitney U test was used. The student's t-Test is a parametric test that compares the means of two independent groups to determine if they are significantly different. The Mann-Whitney U test is a nonparametric test that compares the distributions of two independent groups to determine if they are significantly different. A 95% confidence level was used for all tests, so we reject the null hypothesis (that there is no difference between the groups) if the p-value is less than 0.05. This analysis provides a detailed insight into the differences between municipalities with financial inclusion and those with financial exclusion in terms of EAP, Poverty Level, Educational Lag, and Degree of Marginalization.

2.6   Distribution of financial institutions between 2021 and 2023

Besides comparing municipalities with financial inclusion and exclusion, the study also analyzed the distribution of the Density of Financial Institutions per 1,000 inhabitants in 2021 and 2023. For 2023, new branches of Banco Bienestar, categorized under Development Banking, were added to the database. This addition is relevant because of Banco Bienestar's role in Mexican government policy aimed at improving the accessibility and conditions of banking services. To assess the data distribution, a Shapiro-Wilk normality test was conducted for each variable. Since the data were not normally distributed, a Wilcoxon test for related samples was used instead of a student's t-Test to compare the density of Financial Institutions in 2021 and 2023. This analysis allowed us to determine whether there are significant differences in the density of these establishments between the two years.

2.7   Spatial econometric analysis

In addition to the descriptive and comparative analyses, a geostatistical analysis of the spatial distribution of Financial Institutions for the years 2021 and 2023 was also conducted. This analysis aimed to identify spatial patterns and areas of high and low density of Financial Institutions. For this purpose, the Moran Index was used, a measure that evaluates spatial autocorrelation in the data. The Moran Index can range between -1 and +1, where a value close to +1 shows strong positive spatial correlation (i.e., nearby areas have similar values), a value close to -1 indicates strong negative spatial correlation (i.e., nearby areas have different values), and a value close to 0 indicates no spatial correlation. The calculation of the Moran Index was performed using the variables 'Density of Financial Institutions for the year 2021 and the year 2023.' The results of the Moran Index provide a quantitative measure of the spatial distribution of Financial Institutions and can help identify areas of interest for future interventions to improve financial inclusion. Geostatistical analyses were performed using GeoDa software version 1.16 [17]. The results of this comparison provide a dynamic view of how financial inclusion in Puebla has changed over a two-year period, which is crucial for understanding the trends and patterns of financial inclusion in the state.

3   Results and discussion

3.1   Spatial distribution of financial inclusion in Puebla

The state of Puebla is comprised of 217 municipalities, which were classified in terms of financial inclusion and exclusion. A total of 124 municipalities were identified with financial inclusion, defined as those with at least one type of financial establishment available to their residents. In contrast, 93 municipalities were identified as falling into the category of financial exclusion, characterized by the total absence of financial institutions by 2021. With the integration of Mexican government development banking in 2023, this was reduced to 85 municipalities without financial services (Fig. 1-a, b).
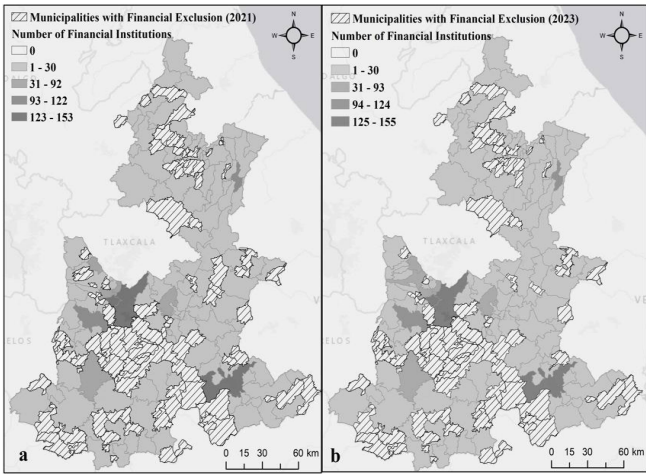
Figure 1. Classification of municipalities in the state of Puebla by financial inclusion and exclusion in 2021 (a) and 2023 (b).
Source: own elaboration based on information from INEGI (2023) [13].

density of financial institutions. Specifically, the average density increased from 0.19 in 2021 to 0.22 in 2023 (Fig. 3), suggesting that there is one financial institution for every 4,545 inhabitants. These findings are consistent with previous research that emphasizes the importance of physical access to financial institutions in reducing financial exclusion [5,18,19]. However, it should be noted that an increase in establishment density does not automatically ensure improved financial inclusion [20]. In fact, financial inclusion is a multifaceted phenomenon that can also be influenced by the adoption of financial technologies [21,22]. Therefore, although the increase in the density of banking establishments represents a positive step forward, additional strategies are needed to address other factors affecting financial inclusion.
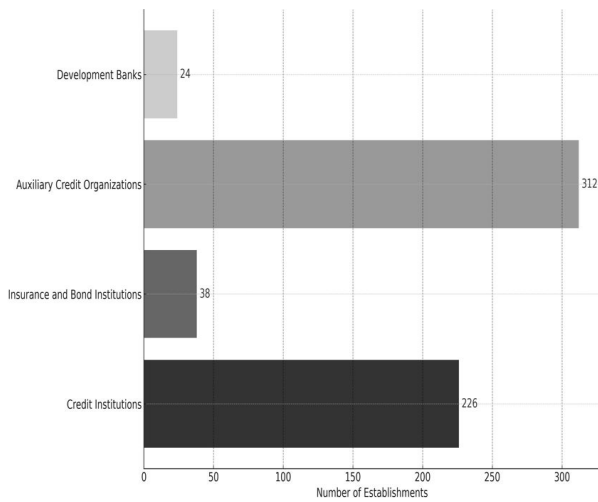

Figure 2. Type and number of financial institutions found in the 124 municipalities with financial inclusion in 2021.
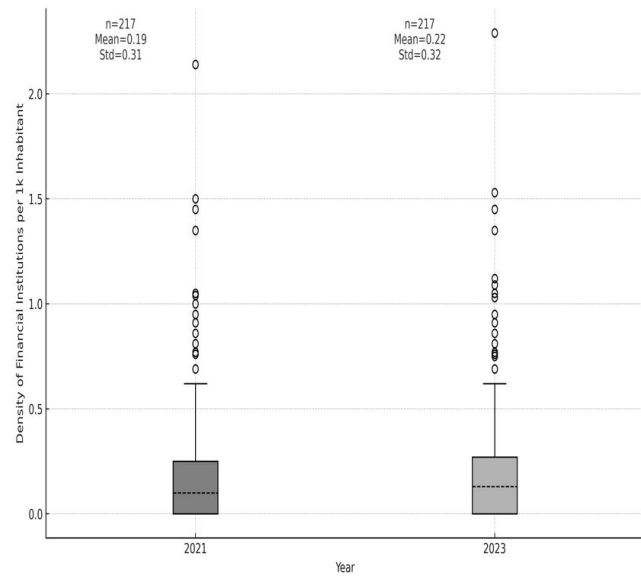Source: own elaboration based on information from INEGI (2023) [13].

Figure 2. Statistically significant difference in the average density of financial institutions between 2021 and 2023, based on a Wilcoxon test for related samples with a confidence level of 95% (p = 2.37×10^{-9}).
Source: own creation using R software.

Municipalities with financial inclusion have financial services where credit auxiliary organizations predominate. These include general deposit warehouses, financial leasing companies, financial factoring companies, and savings and loan societies. In second place are credit institutions, which are dedicated to receiving public deposits and granting loans to individuals or companies, charging an interest rate for the use of money. Some examples are private banks, multiple-purpose financial companies, and credit unions [11]. Insurance and finance institutions, as well as Development Banking, are present in third and fourth place, respectively (Fig. 2).

3.2 Changes in the density and spatial distribution of financial institutions (2021-2023)

Between 2021 and 2023, the municipalities studied experienced a statistically significant change in the average

The analysis using the Moran Index for the density of financial institutions per thousand inhabitants in 2021 yielded a value of 0.109. This indicates a relatively weak but statistically significant spatial correlation, confirmed by a z-value of 2.6367 at a 95% confidence level. This value suggests a trend toward the clustering of financial institutions in five municipalities, with high-high density values (Fig. 4-A). Specifically, a notable concentration was observed in the municipalities of Coronango, next to the state capital, as well as in San José Chiapa, Oriental, and Rafael Lara Grajales, which are part of the region hosting a significant industrial conglomerate in the automotive sector. In contrast, a cluster of eight municipalities with high financial exclusion was identified, with low-low density values (Fig. 4-a). This means that there are no financial institutions within these eight municipalities or in their surrounding areas. In 2023, the Moran Index registered a value of 0.111, signifying a statistically significant but weak spatial correlation, as
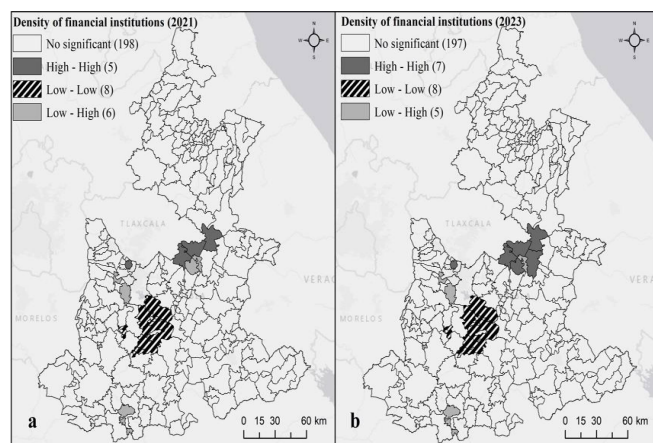
Figure 4. Spatial distribution of the density of financial institutions in the State of Puebla for the years 2021 and 2023. The Moran Index of 0.109 and Z-value of 2.6367 show a significant spatial clustering of financial institutions at a 95% confidence level.
Source: own creation using R software.

Table 3.
Comparison of socioeconomic characteristics between municipalities with Financial Inclusion and Financial Exclusion in 2021: means (x), standard deviations (σ) and results of Mann-Whitney U and Student's t-Tests.

Variable	Financial Inclusion (n=124)	Financial Exclusion (n=93)	Statistical Test	p-value
Population	x = 32106.97; σ= 112832.18	x = 4817.29; σ= 4514.54	Mann-Whitney U Test	7.82×10^{-19}*
Economically Active Population (EAP)	x= 23378.20; σ= 79833.61	x= 3217.43; σ= 3479.96	Mann-Whitney U Test	1.76×10^{-18}*
Education	x= 26.72; σ= 8.14	x= 30.68; σ =7.55	T-Test	3.20×10^{-04}*
Degree of Marginalization	x= 2.82; σ=1.12	x= 3.34; σ=0.94	Mann-Whitney U Test	3.67×10^{-04}*
Poverty	x=75.21; σ = 11.19	x= 77.61; σ = 10.14	Mann-Whitney U Test	0.13

Note: * indicates statistical significance at the $\alpha = 0.05$ level.
Source: own creation using R software.

confirmed by a z-value of 2.6982 at a 95% confidence level. This data suggests an expanded clustering of seven municipalities with high-high density values, notably incorporating San Salvador el Seco and Soltepec because of their closeness to other high-density areas (Fig. 4-b). Conversely, the cluster of eight municipalities characterized by high financial exclusion remained unchanged. Although the average density of financial institutions rose between 2021 and 2023, the spatial analysis reveals a persistent clustering pattern that favors financially inclusive municipalities while disadvantaging those with financial exclusion. These observations align with prior studies linking urbanization and economic development to increased financial inclusion [2,23].

3.3 Socioeconomic analysis of financial inclusion at the municipal level

The results of the Shapiro-Wilk test for each variable in municipalities with financial inclusion and municipalities with financial exclusion indicate that most of the variables do not follow a normal distribution. The exception is the "Education" variable, which follows a normal distribution in both groups (Table 2).

Table 2.
Normality tests for the socioeconomic variables for the year 2020

Variable	Financial Inclusion (p-value)	Financial Exclusion (p-value)
Population	5.20×10^{-56}	1.32×10^{-10}
Economically Active Population (EAP)	5.27×10^{-23}	3.17×10^{-11}
Education	0.491	0.449
Poverty	4.54×10^{-04}	0.024
Degree of Marginalization	3.70×10^{-07}	5.93×10^{-08}

Note: p-values are from the Shapiro-Wilk normality test. P-values less than 0.05 indicate a rejection of the null hypothesis that the data are normally distributed.
Source: own creation using R software.

3.4 Socioeconomic variables and financial inclusion at the municipal level

The findings of this study underscore significant differences in the levels of financial inclusion between municipalities in relation to the Economically Active Population (EAP) and Educational Gap. Specifically, municipalities with better financial inclusion demonstrated higher EAP, lower Educational Gap and a lower degree of marginalization. These results were corroborated using the Mann-Whitney U test for EAP and Student's t-Test for Educational Gap (Table 3).

These findings are consistent with previous research that underscores the importance of educational level in financial inclusion. Martinez et al. [24] found that individuals with secondary or tertiary educational levels are more likely to use financial instruments compared to those who only have primary education. This correlation between educational level and financial inclusion has also been documented in international contexts, such as in China [25], and across a diverse set of countries [2]. Our study expands on this literature by providing empirical evidence that these trends hold at the municipal level. Municipalities with lower educational lag tend to have better financial inclusion, suggesting that policies aimed at improving educational levels could have a positive collateral impact on financial inclusion. Furthermore, the positive correlation found between the Economically Active Population (EAP) and financial inclusion highlights the importance of employment and economic activity in promoting financial inclusion. This relationship is consistent with previous research suggesting that an increase in individual income is associated with a higher likelihood of using financial instruments [24]. Contrary to what might be expected, this study found no statistically significant differences in the level of poverty between municipalities with financial inclusion and those with financial exclusion, according to the results of the Mann-Whitney test (Table 3). This result is interesting because it contrasts with the commonly accepted notion that

poverty is a key determinant of financial exclusion [26]. Other studies emphasize the crucial role of financial inclusion in socioeconomic development and poverty reduction [27,28]. Such studies argue that financial inclusion contributes to poverty reduction by facilitating the distribution of consumption over time, the acquisition of assets, investments, and improvements in income levels. Along these lines, previous studies in other contexts, such as in India [29], have also shown that poverty-related variables are not always reliable predictors of financial inclusion. However, the absence of a statistically significant relationship between poverty and financial inclusion in our findings suggests that there may be other mediating or moderating factors at play, which could vary at the regional or municipal level. In fact, previous research has identified variables such as access to information technology, local infrastructure, and government policies as factors that could have a significant impact on financial inclusion [30,31]. Our results show significant differences in the degree of marginalization between municipalities with financial inclusion and those with financial exclusion (Table 3). This finding suggests that the degree of marginalization could be another key factor affecting financial inclusion at the municipal level. Marginalization, which is often related to limited access to basic services and economic opportunities, could be both a cause and an effect of financial exclusion. Therefore, strategies to improve financial inclusion should consider a multidimensional approach that addresses both marginalization and these other key factors. Thus, while our research does not invalidate the importance of financial inclusion for economic development and poverty reduction, it adds a layer of complexity to the debate. The need for additional research examining these potential mediating or moderating factors at the local level to provide a more complete understanding of how and when financial inclusion effectively contributes to poverty reduction becomes apparent.

3.5 Implications for areas of financial exclusion

We identified eight municipalities with notable financial exclusion. This result is worrisome, but is consistent with previous studies showing a positive correlation between the level of development and access to financial services [32]. It is evident that the inhabitants of these municipalities face significant challenges in terms of access to financial services. These areas often experience a vicious cycle: the absence of financial services can hinder economic development, subsequently reducing the demand for such services and discouraging new providers. [33]. Residents of these municipalities may face significant challenges in accessing basic financial services. The importance of the spatial dimension in the study of financial inclusion has also been highlighted in the literature [4,34]. The results suggest specific policies may be necessary to address these areas of financial exclusion, as a one-size-fits-all solution is unlikely to be effective given the diversity of factors influencing financial inclusion [35].

4 Conclusion

The central aim of this study was to analyze the state of financial inclusion in the municipalities of the state of Puebla, Mexico, during the period from 2021 to 2023. Among the most significant findings is that municipalities with higher levels of Economically Active Population (EAP) and lower levels of Educational Lag tend to have better financial inclusion. It is noteworthy that no significant differences were found in poverty levels between municipalities with and without financial inclusion.

Likewise, a significant increase in the per capita density of financial institutions was identified for 2023. However, our spatial analysis, supported by the Moran Index, revealed a weak but statistically significant spatial correlation in the density of financial institutions for both 2021 and 2023. This pattern suggests a concentration of financial services in municipalities that already have financial services, while others continue to face high financial exclusion. These findings are consistent with previous research and underscore the importance of considering geography in financial inclusion strategies.

The outcomes regarding concentration and financial exclusion emphasize the need for nuanced and specific policy approaches for different geographical areas. Given that financial exclusion persists, despite the overall increase in the density of financial institutions, it is evident that these areas of financial exclusion may require specific policies to increase the availability of financial services.

Moreover, these results highlight the importance of considering the spatial dimension in the study of financial inclusion. The lack of financial institutions in a municipality, especially if it is surrounded by areas with low density, can limit economic development and, consequently, decrease the demand for these services, discouraging the entry of financial service providers into the market.

These results have important implications for public policy and banking practice in the country. For example, mapping municipalities according to their degree of financial inclusion could serve as a valuable tool for resource allocation and the formulation of government policies. The relationship between the EAP and financial inclusion underscores the need for policies that encourage employment and economic activity to improve access to financial services. However, it is crucial to recognize some limitations of the study. First, the research focuses on a single state in Mexico, which could limit the generalizability of the findings. Second, although the longitudinal nature of the study provides the basis for exploring causal relationships, the presence of unobserved or uncontrolled variables may limit the ability to establish these relationships definitively. Third, the absence of a significant correlation between poverty and financial inclusion could be because of factors not examined in this study, suggesting the need for future research to explore these aspects.

In this regard, it is recommended that future studies

expand the geographical scope of the research, employ longitudinal designs, and explore other potential factors that may influence financial inclusion. This study contributes to the existing literature by offering new perspectives and data that may be useful for researchers, practitioners, and decision-makers in financial inclusion. Additionally, it raises new questions and challenges that could be the focus of future research in this field.

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