

Older Adults' Financial Literacy Spatial Analysis in Tlaxcala

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Abstract

This paper maps older adults (OAs) financial literacy in 59 out of 60 municipalities of the Tlaxcala state (Mexico) analyzing the patterns at municipality and voting district level. Through a random sample of 2954 OAs we measure and compare sub-groups financial literacy means versus the state mean. Only 2.33% of all OAs are financial literate, and those with higher dependency score below the state average. Formal education and not having inherited are associated with major knowledge and OAs financial illiteracy is associated with being abused. This results may serve as a baseline for public policy and show specific vulnerabilities for this age group. The main limitation of the research is that neither all municipalities, nor voting district, were surveyed. The originality stems from mapping microdata aggregation that may benefit decision makers and research scholars. In order to spread financial literacy specific actions attached to the national policy need to be taken.

JEL Classification: G53, J18, J19, Y10.

Keywords: Financial literacy, Older adults, Spatial analysis, Tlaxcala.

Análisis Espacial de la Educación Financiera en Adultos Mayores en Tlaxcala

Resumen

Este artículo mapea la educación financiera de las personas adultas mayores (PAM) en 59 de 60 municipios del estado de Tlaxcala (México) analizando los patrones a nivel municipal y distrito electoral. A través de una muestra aleatoria de 2954 PAM, medimos y comparamos las medias de educación financiera de los subgrupos respecto a la media estatal. Sólo el 2,33% de todas las PAM tienen conocimientos financieros, y aquellos con mayor dependencia muestran menores conocimientos respecto a la media estatal. Tener educación formal y no haber heredado se asocian con mejores conocimientos y el analfabetismo financiero se asocia con la violencia hacia las PAM. Estos resultados pueden constituir una línea base para políticas públicas y evidencian las vulnerabilidades específicas de este grupo etario. La principal limitación consiste en no haber alcanzado todos los municipios ni todos los distritos electorales. La originalidad de esta investigación radica en el mapeo de microdatos agregados que puede beneficiar a los tomadores de decisiones y a los investigadores. Para difundir la educación financiera es necesario adoptar medidas específicas y vinculadas a la política nacional en materia.

Clasificación JEL: G53, J18, J19, Y10.

Palabras clave: Adultos mayores, Análisis espacial, Educación financiera, Tlaxcala.

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1. Introduction

The world population is aging and this process is concurrent to a birth rates decrease and higher life expectancy. A larger proportion and a greater number of older adults call for public policies to address the challenges posed by such demographic changes. The retirement age represents a sharp reduction in labor income (Raccanello, Osorio, & Molina, 2015) and, no matter their age, older adults (OAs) still engage in paid activities to compensate low pensions and make ends meet. Notwithstanding, most OAs lack financial literacy (Klapper, Lusardi, & Van Oudheusden, 2015), that may have negative consequences on their quality of life (Lusardi, 2012, 2012a).

Although government agencies require a precise diagnostic to design specific public policies and programs, in Mexico official statistics provide aggregated information at the national level only. Thus, even when data highlights the disadvantages faced by OAs, its representativeness does not allow a proper policy targeting at state level. In order to fill this gap, this paper, stemming from a broader research, provides a spatial analysis of OAs' financial literacy. Following Klapper, Lusardi, and Van Oudheusden (2015), we measure financial literacy through five questions in a sample of 2,954 elderly residents in 59 out of 60 municipalities in the state of Tlaxcala. Then, we map the results at municipal as well as voting district level, and OAs sub-groups mean comparison is performed. The aim is two-fold: 1) to grasp a comprehensive view of the OAs' knowledge and to identify those areas where training efforts should be concentrated to enhance financial literacy and, 2) to compare financial literacy levels among sample sub-groups.

After the introduction, we present the global trends and those factors contributing to population aging, highlighting that this phenomenon will increasingly affect Mexico in the next decades. Then, in the third section, we describe the characteristics of the Mexican OAs, along with the latest data regarding the discrimination and violence they experience. Despite Mexican OAs financial exploitation is not as frequent as in other countries, we review the literature about the importance of financial literacy and numeracy for decision-making, as well as its consequences. The methodology of the survey and the financial literacy mapping technique at the municipal and voting district levels using two different criteria constitute the fourth section. In the results section, we present OAs financial literacy descriptive statistics by gender and age groups, as well as the cartography analysis and the discussion derived by sub-groups mean comparison. Finally, we state the limitations of the research and we suggests some policy recommendations.

2. Background

2.1 World elderly population trend

In November 2022 the world population reached 8 billion people and, according to the most recent projections, it will reach 8.5 billion in 2030 and 9.7 billion in 2050. By 2100, about 10.4 billion people will live on the planet (United Nations, 2022).

Three factors explain the world demographic increase: fertility rate, mortality rate, and, for some countries, migration. The fertility rate has been decreasing since the mid-1960s, a trend that

will continue in the next decades, although the number of births will remain stable. At the same time, life expectancy at birth has been on the rise, from 66.5 and 61.5 years for women and men in 1960 to 73.8 and 68.4 years in 2021. By the mid-century it will probably reach 79.8 and 77.2 years for women and men respectively. Despite the COVID-19 pandemic, there is an upward trend in the mortality rate, which contrasts with a decrease in the fertility rate, resulting in very slow population growth during the second half of this century. Finally, the migration phenomenon redistributes the population from lower to higher income per capita countries, to the extent that migratory flows already surpassed the number of births in some cases (United Nations, 2022: pp.20-23). As migrants typically belong to younger generations, migration alters the demographic pyramid in both immigration and emigration countries.

Therefore, for the rest of this century, at the global level, we expect that the participation of age group 0-24 years will decrease, with a stagnation in the group 25-64 years, accompanied by a progressive increase in the group of 65 years and older. This situation will affect the population pyramid throughout the 21st century, where there is a widening at the top due to a higher proportion of OAs, despite the uncertainty associated with the number of youth. In Figure 1 we show the current global population pyramid (2023) and simulations for years 2050 and 2100.

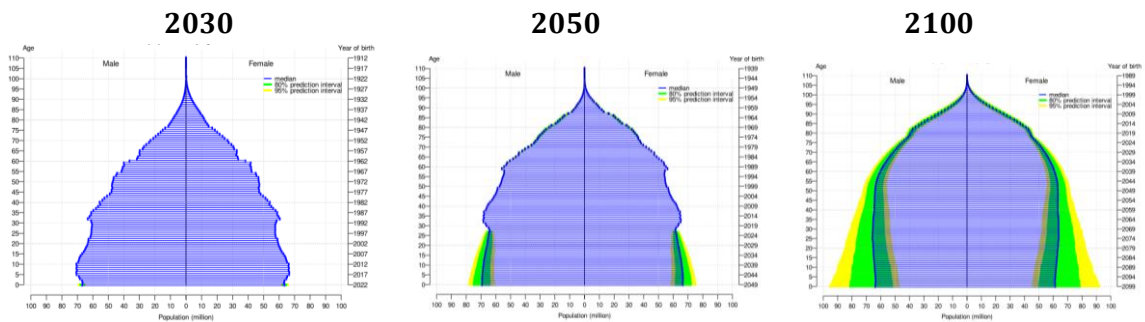
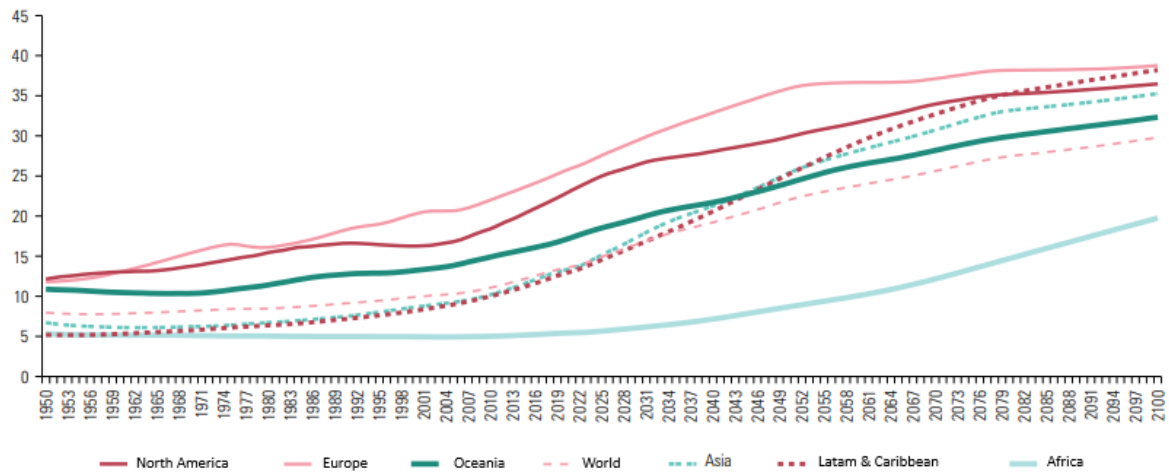


Figure 1. World: population pyramid per age and sex (2023, 2050, 2100)
 Source: United Nations (2022a).

As the proportion of OAs will continue to increase, Graph 1 represents the regions trends forecasts. Accordingly, Europe stands out for having a higher and increasing percentage of aging population, but Latin America and the Caribbean will converge to the same ratio by the end of this century. Aging will also increase significantly in Africa, despite being still a relatively "young" continent.



Graph 1. World population aged 60 and over, per region, 1950-2100
 (% of total population)
 Source: CEPAL (2023).

2.1 Mexico

In Mexico, life expectancy has doubled between 1930 and 2010, increasing from 34.7 and 33 years for women and men respectively, to 77.9 and 71.6 years. By 2022, it had further increased to 78.4 years for women and 72.6 years for men (INEGI, 2023a). However, the birth rate has sharply declined in the last 60 years, from 47 live births per 1,000 people in 1960 to only 15 in 2021. Likewise, the fertility rate has decreased 73% along the same time span, from 6.76 children per woman to 1.82 (World Bank, 2023).

Based on the above, we expect that the population pyramid, despite the uncertainty, will reverse over the course of this century. Figure 2 depicts is the current demographic pyramid (2023) and projections for years 2050 and 2100.

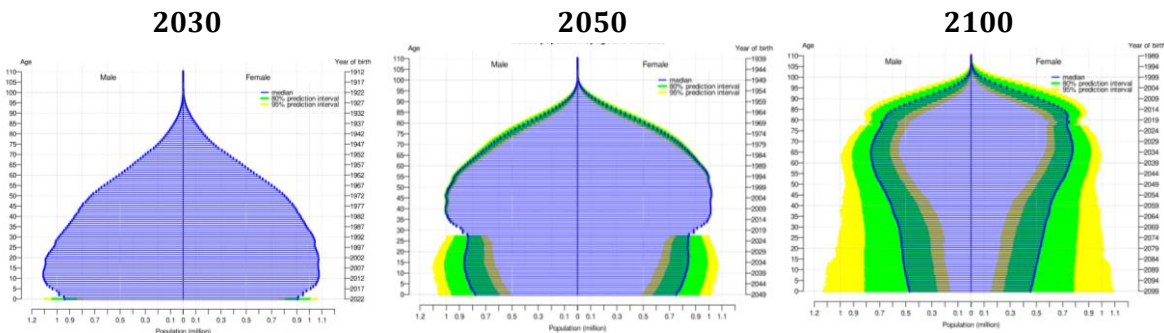
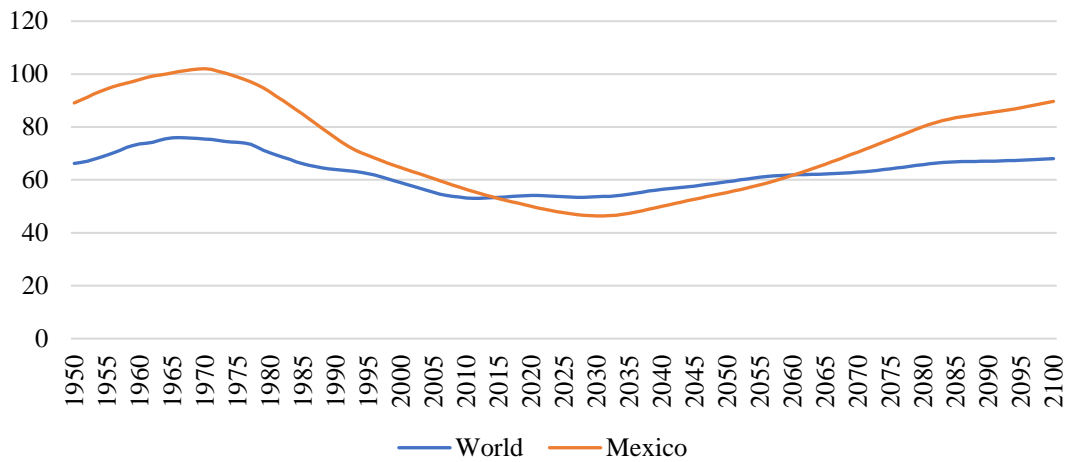


Figure 2. Mexico: population pyramid per age and sex (2023, 2050, 2100)
 Source: United Nations (2022a).

The increase in the number of OAs coupled with low population growth affects the dependency index (people 65+ years/people 15-64 years), which has been increasing globally since

the 2000-2010 decade. In Mexico, as well, estimates anticipate that the index will start increasing by 2030, and trend will persist until the end of this century (Graph 2).



Graph 2. Dependency index trend: World vs. Mexico

Note: From 2022 onwards the data are projected.

Source: Authors with United Nations (2022a) data.

The Mexican OAs have significantly increased over the past few decades, growing from 6% of the total population in 1990 to 12% in 2020. However, its distribution is not uniform across the country. The states with the highest aging index are located along the Pacific coast (from Baja California Norte to Nayarit), Atlantic coast (Tamaulipas, Veracruz, and Yucatán), north-central region (Nuevo León, San Luis Potosí), central-southern region (Hidalgo, Morelos, Mexico City, State of Mexico, and Oaxaca) (INEGI, 2021).

Due to the aging process, there is consensus in anticipating that a larger population of OAs, both in absolute and relative terms, will pose significant challenges in Mexico and other countries. As such, they must be addressed from a human rights perspective (Huenchuan, 2018) and all state governments will be called to include the aging question in their agenda.

3. Older adults in México

3.1 Sociodemographic and economic profile

According to estimates based on the Population and Housing Census 2020 (CONAPO, 2022), the population over 60 years of age in Mexico reached 12.02 million in 2020, and women represented the largest share (53.75%).

Most of the OAs are married (52.51%) or widowed (24.27%). Due to women's longer life expectancy, they lead in widowhood statistics (34.03%) compared to men (12.92%). While 84.12% of OAs have literacy, one out of five women over 60 years old is illiterate (18.48%). Additionally, 18.12% of OAs have no formal education, and basic education is common (completed primary education: 45.87%; secondary education: 13.66%).

From the health perspective, half of the OAs (52.38%) have some form of disability or limitation, but limitations are more common (60.33%). Among those with disabilities (39%), they have only one (58.39%) or two (22.26%), but 9.84% have four or more.

The great majority of OAs live with relatives (83.12%) and in 31.01% of Mexican households resides at least one elder. Living with elderly may be tough in economic terms; the statistics reveal that 43.22% of households where OAs reside is beneficiary of some government program, 34.13% receive a pension or retirement income, 8.38% receive income from other households, and 7.84% receive remittances from abroad. This is, government or relatives' financial aid is a complementary income source for households

According to the National Occupation and Employment Survey New Edition (ENOEN) for the second quarter of 2022 (INEGI, 2022a), estimates account that 17'958,707 OAs were in the country, one-third belonging to the economically active population (EAP) and the remaining being inactive. On average, men show a higher participation in the EAP (48%) compared to women (20%) but economic activity decreases for both sexes as age increases.

Even when employment rate for OAs is very high: 99%, half of women (50%) and men (48%) work as self-employed or waged-employee (38% each), but incomes are low, as 39% of men and 57% of women earn up to 1 minimum wage, as they tend to work in the informal sector (women: 75%; men: 68%). However, contrary to expectations, despite income vulnerability, OAs over 65 years were not living in a more pressing poverty situation than the rest of the Mexican population (CONEVAL, 2020).

3.2 Discrimination and abuse

As constitute an age, health, and income vulnerable group. They are also struggling to deal with various forms of violence that infringe upon their human rights, including *ageism* defined by the World Health Organization (WHO, 2021a) as: "[Ageism refers to] the stereotypes (how we think), prejudice (how we feel), and discrimination (how we act) towards others or oneself based on age.". Although negative stereotypes about aging contribute to the mistaken notion that it should be avoided, it should also recognized that aging is often the pathway to increased self-awareness, happiness, and life satisfaction, provided that OAs are healthy (Weir, 2023).

Aging consequences do not solely affect the older adult population by worsening their physical and mental health or through adopting risky behavior patterns; it also has intergenerational effects by lessening solidarity (WHO, 2021a). OAs have reported that they are seen and treated as elders due to social labels, but they also recognize that such labels often describe their own situation, an unfortunate example of self-inflicted *ageism* (Minichiello, Browne, and Kendig, 2000).

In Mexico, the Law on the Human Rights of Older Adults (*Ley de los Derechos Humanos de las Personas Adultas Mayores*) (DOF May 10, 2022, Art.3, Sec. XII) defines violence against OAs as any action or omission that causes psychological, physical, patrimonial, economic, sexual, or death, in both private and public settings. However, the Law also includes *ageism* when enouncing the broader category of "any other analogous forms that harm or are susceptible to harming the dignity, integrity, or freedom of older adults" (DOF May 20, 2021, Art. 3bis, Secc. VI). The 2022 National Survey on Discrimination (ENADIS) (INEGI, 2023) found that 17.9% of Mexican OAs experienced

discrimination in the past 12 months, primarily associated to age by women (39.4%) and men (38.9%); and 38.3% of respondents considered their rights were not respected.

When living with their families, OAs are eager to receive a mix of instrumental, financial, and emotional support, especially when they are dependent due to illness or disability (López and Aranco, 2019; Téllez, Muradás, and Aguilar, 2017). However, according to the results of the first National Survey on Discrimination in Mexico in 2005, "50.8% of older adults consider that they receive less protection in their homes compared to other family members" (Giraldo and Torres, 2010, pp.319). Recent data from the 2021 National Survey on Household Relationship Dynamics (ENDIREH) (INEGI, 2022) confirm these findings as 14.6% of women aged 60 and older reported being victims of violence, and the perpetrators are often adult sons/daughters (51.2%) or other relatives (45.6%). Elders' economic situation is also important; when older women live with financial dependents the violence intensifies, regardless of whether the older woman is financially independent (17.7%) or not (18.5%).

In Mexico, the most common types of violence detected are: psychological (13.0%), economic (4.7%), physical (1.5%), and sexual (0.5%). Underreporting is common (reaching 9 out of 10 cases of violence against women) due to the perception that it was not important enough to report (31.4%), fear of consequences/threats (22.8%), shame (14.9%), or the belief that the victim would not be believed or would be blamed (13.3%). The international literature suggests that data on episodes of violence against OAs are underestimated because victims protect the perpetrator (who, in fact, is often a kin), deny being abused, or fear, among other reasons (Storey, 2020). Beyond data, avoid reporting means that victims continue to live with or keep in touch with their abusers, which, in turn, increases the risk of continued abuse (Jackson and Hafemeister, 2012).

The violence against this age group arises when: 1) OAs are in a vulnerable situation, 2) there is a relationship of trust with the older adult (typically involving a family member) and, 3) a context that promotes violence (Han and Mosqueda, 2020). The isolation because the COVID-19 pandemic has locked OAs inside their homes, exacerbating tensions with other household members, and this situation is definitely a precursor of violence (Montiel, 2020). Chang and Levy (2021) found that COVID-19 pandemic increased the incidence of violence, particularly physical and financial, against elderly in the United States. In Mexico, according to the 2021 National Survey on Household Relationship Dynamics (ENDIREH), the perception of conflicts among women aged 15+ who have been victims of at least one case of violence increased at the national level (23.74%), but even further in the state of Tlaxcala (27.18%) (INEGI, 2022).

3.3 Financial literacy

Adults aged 65 and over have the lowest percentages of financial literacy in both developed and emerging economies (Klapper, Lusardi, & Van Oudheusden, 2015). Elders experience a deteriorating health status due to their natural biological aging process (Fulop et al., 2010), but they are also vulnerable because possessing accumulated assets over their lifetime along with a lower financial skills (Lusardi, 2012a). This has potentially severe consequences (Lusardi, Mitchell, & Curto, 2014) as it may destabilize the finances of OAs through excessive debt, low credit scores, meagre retirement planning, and unpaid medical bills (Lusardi, Mitchell, & Oggero, 2020).

The OECD defines financial education as:

“the process by which financial consumers/investors improve their understanding of financial products, concepts and risks and, through information, instruction and/or objective advice, develop the skills and confidence to become more aware of financial risks and opportunities, to make informed choices, to know where to go for help, and to take other effective actions to improve their financial well-being.” (OECD, 2005).

that needs to be paired by numeracy (Skagerlund et al., 2018), defined as:

“(…) as the ability to access, use, interpret and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life” (OECD, 2016)

These skills are positively related to financial well-being and better decision-making (Bruine de Bruin, & Slovic, 2021; Lusardi, 2012; Peters et al., 2006), but the association with education is weaker (Lipkus, Samsa, & Rimer, 2001). Higher numeracy scores are associated with less financial violence against OAs, even when controlling for physical and mental health status, dependency status, and cognition (Wood et al., 2016).

As previously mentioned, contrary to expectations based on love and support, the familial environment of OAs, where they live with younger generations, is not always a positive experience, nor is the societal one due to ageism. Ageism is the first step toward lack of respect that, through catalyzing elements, may transform into abuse. OAs may be subject to financial exploitation (FE) and financial fraud (FF). In the former case, perpetrators are generally family members or individuals with whom the victim has established a trust relationship and therefore already have access to their resources. In the latter, fraud professionals seek to "create" a relationship through experienced tactics designed for such purpose (e.g., romantic scams). DeLiema (2018), with a sample of 53 cases (28 FF and 25 FE), found that, on average, victims were individuals over 80 years, and most had some deficiencies in one or all areas of their cognitive functions. They required assistance to perform various instrumental activities of daily living (IADLs) and some activities of daily living (ADLs) with moderate to severe limitations in memory and financial capacity. Financial losses were significantly higher in FF cases (average: US\$619,000; range from US\$1,700 to US\$5 million, and 9 properties lost) compared to FE cases (average: US\$200,000; range from US\$5,000 to US\$275,000, and 8 properties lost). In either cases, monetary losses occur gradually and properties misappropriation follows. Despite financial losses, some OAs deny having been financially exploited, and some of them still hope that perpetrators will return the money, emphasizing the manipulation of trust to which OAs have been subject to.

As financial exploitation may occur with other forms of violence, Jackson and Hafemeister (2012) compared pure financial exploitation (PFE) with the co-occurrence of financial exploitation with physical abuse and neglect, coined as hybrid financial exploitation (HFE). On average, HFE victims had worse health and higher economic losses compared to PFE victims (US\$185,574 vs. US\$79,422). HFE victims often live with the perpetrator of the violence who consider as their caregiver. The caregiver is generally a family member, unemployed, and/or financially dependent on

the older adult. As both HFE and PFE victims do not recover financially (93.8% and 81%, respectively), it is evident that harsh consequences may follow. In the state of Tlaxcala, a simultaneous relationship between financial and non-financial abuse on elderly was found and a higher level of financial literacy is statistically associated with lower non-financial abuse, which, in turn, diminishes financial abuse (Raccanello, 2023). The same author reports that a financial literacy and fraud prevention program conducted over 8 weeks during 2022 has a small but positive impact on elders' financial literacy six months after the treatment (Raccanello, 2023a). However, the benefits of financial literacy are not limited to lessening abuse. Fong, Koh, Mitchell, and Rohwedder (2021), through a sample of 6,573 individuals aged 50 and over from the 2015-2017 Singapore Life Panel®, found a positive relationship between financial literacy and timely credit card payments, long-term investments, and age-adjusted investment risk. Accordingly, elders' financial literacy skills foster both household and personal financial stability.

In Mexico, the CNBV (2022) through the economic-financial competence index based on three indicators (knowledge, behaviors, and attitudes), found that people aged 60 and over had the lowest index value (52 out of 100), and individuals with primary education or less scored even lower (49 out of 100). Because Mexican OAs tend to have low levels of education, the outlook is not promising, as their characteristics align with lower scores of competence index. The described situation might last for next generations as Mexican adults (16-65 years) score very poorly in literacy, numeracy and problem solving in technology-rich environments compared to the OECD average (OECD, 2019).

4. Methodology

4.1 Sampling and questionnaire

In 2020, out of 1'342,977 people in the state of Tlaxcala, 10.86% (145,866) was aged 60 and over. In order to collect the data for the first stage of the project (diagnostic), between September and December 2020, we administered 50 questionnaires in each of 59² out of the 60 municipalities. To draw the random sample (N=2,954, 98% confidence level, error 2.1%), a team of 25 previously trained interviewers collected data a mobile application in their own smartphones. Then, on daily basis, they uploaded the collected information to the cloud.

Preferably, we surveyed elders at their doorstep or in public places, applying all health protocols and social distancing measures during the interviews to ensure the safety of both the target population and the fieldwork team because the COVID-19 pandemic. No elders with mental disability, prostrated, or under the effect of alcohol or any other substance were approached. Once we mentioned the purpose and time length (about 40-50 minutes) of the survey and elders gave their consent to participate, we ticked a requirements checklist to validate the informant. Validation required elders to: 1) identify themselves showing their voter identification card (commonly known as INE in Mexico) to verify their residency in the corresponding municipality and to be at least 60+ years old and, 2) agree to answer the survey privately with the interviewer (no other family members

² The municipality of Tenancingo has severe human trafficking problems and access was restricted.

or individuals presence was allowed). At any time during the interview elders could choose to withdraw, in which case we deleted the information in front of them.

The questionnaire inquired about:

- OAs' socioeconomic characteristics (gender, age, education, indigenous language, housing and services access, migration experience, employment, income, assets, debt, savings and financial inclusion, among others).
- OAs' health status, food insecurity, activities of daily living (ADLs – Barthel scale), and instrumental activities of daily living (IADLs – Katz & Lawton scale).
- Eight types of abuse (physical, psychological, abandonment, mistreatment, valuables' improper appropriation, properties dispossession, improper use of elderly government program money and improper use of elder's money – other than the previous), and for each one: who were the perpetrators and frequency of the abuse, abuse reports and reasons in case they did not report, and financial literacy.

To assess the level of financial literacy among OAs, the questionnaire included the five questions used in the 2014 S&P Global FinLit Survey (Klapper, Lusardi & Van Oudheusden, 2015, p.6), that cover four areas: risk diversification, inflation, numeracy – one question each –, and compound interest – two questions. Questions applied are reported next, and US dollars were replaced by Mexican pesos (MXN) [correct answers are **bolded**]:

Risk diversification (RD): Suppose you have some money. Is it safer to put your money into one business or investment, or to put your money into multiple businesses or investments? [one business or investment; **multiple businesses or investments**; don't know; refused to answer]

Inflation (INFL) Suppose over the next 10 years the prices of the things you buy double. If your income also doubles, will you be able to buy less than you can buy today, the same as you can buy today, or more than you can buy today? [less; **the same**; more; don't know; refused to answer]

Numeracy (NUM): Suppose you need to borrow 1000MXN. Which is the lower amount to pay back: 1050MXN or 1000MXN plus three percent? [1050MXN; **1000MXN plus three percent**; don't know; refused to answer]

Compound interest (CI): 1) Suppose you put money in the bank for two years and the bank agrees to add 15 percent per year to your account. Will the bank add more money to your account the second year than it did the first year, or will it add the same amount of money both years? [**more**; the same; don't know; refused to answer]

2) Suppose you had 1000 MXN in a savings account and the bank adds 10 percent per year to the account. How much money would you have in the account after five years if you did not remove any money from the account? [**more than 1500MXN**; exactly 1500MXN; less than 1500MXN; don't know; refused to answer]

According to the measurement method reported by Klapper, Lusardi, and Van Oudheusden (2015), (official classification hereafter), a person is considered financially literate when answers correctly in at least 3 out of 4 zones. Both questions about compound interest had to be answered correctly to validate this zone. Because we found that most of the OAs lacked financial literacy, we introduced an unofficial classification that identifies those individuals with fewer than 2 zones as

financially illiterate, with exactly 2 zones as being partially financially literate, and with 3 or more correct zones as financially literate. The same convention applies to municipalities and voting districts (see section 5.2 and 5.3). The rationale underlying the unofficial classification seek to display the location of those partially literate as they could be concentrated within a reasonable distance from the financially literate. In case a pattern exist, the state authorities could achieve economies of scale when training OAs in financial literacy.

Previous scholars relied on geographic analysis and mapped financial literacy. Fornero and Monticone (2011) identified that citizens in northern Italy were able to better face challenges posed by the reformed pension system than those living in the south, because of their higher financial knowledge. As well, Bumcrot, Lin and Lusardi (2011) proposed a financial literacy index (FLI) based on to the number of the correct answers on interest, inflation, bond price, mortgage and risk questions provided by US citizens. Even when only 15% of all surveyed could answer correctly all 5 questions (FLI=5) and the US FLI average was 2.99, the analysis reveals a sharp geographic variation across the US states that may be useful for policy makers and represents a good baseline to compare the effects of financial education programs at the state level (p.13).

4.2 Financial literacy spatial analysis

The state of Tlaxcala is one of the 32 federal entities in the Mexican Republic and the second smallest territory after Mexico City. It is located in the central part of the country, approximately 120 kilometers east of Mexico City. The state encompasses 60 municipalities and 1,175 localities, both urban and rural, and there are 622 voting districts along the state.

To perform the spatial analysis, we defined the scale that provided the highest precision and positional accuracy without violating the confidentiality criteria of the informants. Accordingly, we used vector cartography (in polygons) at the municipal and voting district scale. During the data collection, the key field for assigning spatial attributes and individual characterization of each record was the voting district, and the validation instrument was the voter identification card (INE), which contains both identification data (such as name, surname, address, gender, and ID number) and spatial location information (voting district).

Albeit various working scales for conducting geographical analysis are available, we relied to the voting district and the municipality only. More precise scales at the individual level or blocks would necessitate the respondents' addresses or georeferencing of their residences, which we did not employed due to confidentiality reasons and the data collection methodology.

Voting districts in vector data format allowed to link informants' data with specific geographic zones (municipality and state). We obtained georeferenced vector data for the municipal scale from the National Institute of Statistics and Geography (INEGI) through the National Geostatistical Framework 2020 (*Marco Geoestadístico Nacional, MGN 2020*), in geographic coordinates and reprojected to the Universal Transverse Mercator (UTM) Zone 14 North. To improve the working scale, vector data for voting districts were attained from the Tlaxcala Voting Institute (*Instituto Tlaxcalteca de Elecciones, ITE*), and the key field was the district code available on each voter identification card issued by the National Voting Institute (*Instituto Nacional Electoral, INE*).

We used the voting district as the primary level to group, and the municipal scale as the secondary level. This is, we calculated the financial literacy response mode for each voting district

through all informant belonging to the district first and then, the mode at municipality level was calculated by voting district data. For both scales of representation, we applied frequency ranges and mode in grouped form (by district and municipality). To obtain maps, we used the Geographic Information Systems (GIS) software, ArcGIS version 10.8.1.

The cartography we present next is at municipality and voting district scale, and for each of them, we apply the official and unofficial classification. It is important to remind that the sample at the municipal scale has a 98.33% coverage (59 out of 60 municipalities) and at the voting district has 47.11% coverage (293 out of 622 voting districts).

5. Results

5.1 Financial literacy: sample and subsamples analysis

According to financial literacy answers per zone (Table 1), on average, elders have fair numeracy skills (NUM), as 64.45% of the full sample identified the correct answer, but score poorly in all other zones. It is striking that only 1.05% of the surveyed identify the correct risk diversification (RD) strategy. It is also remarkable that as long as age increases, all financial skills weaken, although one out of four (24.21%) of those aged 90+ and over still have numeracy skills, a result previously reported by Gamble et al. (2015). Percentage drops when surpassing the 70 years old threshold, especially for inflation (INF) and compound interest (CI). Males perform slightly better than females in NUM (68.02 vs. 62.17%) but the opposite happens with CI skills (9.28 vs. 7.11%). No major differences for both sexes and age groups was found as the behavior mimics the full sample but, in general, age heavily undermines financial skills.

Table 1. Results: Financial literacy items positive answers (full, age and sex group)

Full sample										
Zone	All		60-69 years		70-79 years		80-89 years		90+ years	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
RD	31	1.05	18	1.36	8	0.74	5	1.11	0	0
INF	420	14.22	343	25.91	61	5.63	13	2.88	3	3.16
NUM	1904	64.45	1008	76.13	674	62.18	199	44.12	23	24.21
CI	249	8.43	244	18.43	3	0.28	0	0	2	2.11
Female subsample										
Zone	All		60-69 years		70-79 years		80-89 years		90+ years	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
RD	19	1.06	11	1.32	4	0.61	4	1.5	0	0
INF	256	14.22	220	26.35	26	3.99	8	3.00	2	4.35
NUM	1119	62.17	627	75.09	376	57.67	105	39.33	11	23.91
CI	167	9.28	164	19.64	2	0.31	0	0	1	2.17

Male subsample										
Zone	All		60-69 years		70-79 years		80-89 years		90+ years	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
RD	12	1.04	7	1.43	4	0.93	1	0.54	0	0
INF	164	14.21	123	25.15	35	8.1	5	2.72	1	2.04
NUM	785	68.02	381	77.91	298	68.98	94	51.09	12	24.49
CI	82	7.11	80	16.36	1	0.23	0	0	1	2.04

Source: Authors with survey data.

The financial education test yielded lower than expected results (Table 2). The majority of the elderly participants (51.86%) could answer correctly only one zone, and just one person answered all four zones. The lack of financial knowledge is patent, as over 82% of the sample answered less than two zones correctly. Additionally, as age increases, the percentages fades to such an extent that after the age of 70, over 95% of the elderly individuals cannot answer more than one zone.

Table 2. Results: Financial literacy test positive zones (full, age and gender group)

Full sample										
No. of zones	All		60-69 years		70-79 years		80-89 years		90+ years	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
0	921	31.18	220	16.62	382	35.24	247	54.77	72	75.79
1	1532	51.86	655	49.47	663	61.16	195	43.24	19	20.00
2	432	14.62	389	29.38	35	3.23	5	1.11	3	3.16
3	68	2.30	60	4.53	3	0.28	4	0.89	1	1.05
4	1	0.03	0	0	1	0.09	0	0	0	0
Total	2954	100	1324	100	1084	100	451	100	95	100
Female subsample										
No. of zones	All		60-69 years		70-79 years		80-89 years		90+ years	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
0	598	33.22	144	17.25	262	40.18	157	58.80	35	76.09
1	884	49.11	396	47.43	374	57.36	106	39.70	8	17.39
2	278	15.44	259	31.02	15	2.30	1	0.37	3	6.52
3	39	2.17	36	4.31	0	0	3	1.12	0	0
4	1	0.06	0	0	1	0.15	0	0	0	0
Total	1800	100	835	100	652	100	267	100	46	100

Male subsample										
No. of zones	All		60-69 years		70-79 years		80-89 years		90+ years	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
0	323	27.99	76	15.54	120	27.78	90	48.91	37	75.51
1	648	56.15	259	52.97	289	66.9	89	48.37	11	22.45
2	154	13.34	130	26.58	20	4.63	4	2.17	0	0
3	29	2.51	24	4.91	3	0.69	1	0.54	1	2.04
4	0	0	0	0	0	0	0	0	0	0
Total	1154	100	489	100	432	100	184	100	49	100

Source: Authors with survey data.

When analyzing statistics by sex, women show higher percentages for zero and two zones, but lower percentages corresponding to one and three zones. The only informant who answered correctly all zones was a woman. This same pattern persists among different age groups. Based on these results, despite small differences, women's test performance is similar to men's one.

Regardless basic questions to assess financial literacy, the official classification highlights that elders performs quite poorly as only 69 out of 2,954 surveyed (2.33% of the sample) are financially literate (Table 3) and no major differences among sex is detected. Even when the unofficial classification suggests that 14.62% of the sample has a partial financial literacy knowledge, the elderly financial literacy landscape is worrying, as more than 8 out of 10 elders do not manage financial basic concepts.

Table 3. Financial literacy

	Official classification						Unofficial classification					
	All		Female		Male		All		Female		Male	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
No	2885	97.66	1760	97.77	1125	97.48	2453	83.04	1482	82.33	971	84.14
Partially							432	14.62	278	15.44	154	13.34
Yes	69	2.33	40	2.23	29	2.51	69	2.33	40	2.23	29	2.51
Total	2954	100	1800	100	1154	100	2954	100	1800	100	1154	100

5.2 Financial literacy spatial analysis: Municipal level

The 60 municipalities that belong to the state of Tlaxcala spread over an area of 3,997 square kilometers (0.2% of the country land). Based on informants' performance of the financial literacy battery test, according to the methodology previously described, Figure 3 presents the mode at municipal level.

As anticipated by descriptive statistics at informants' level, 27.1% of the municipalities (16 out of 59) surveyed are financially illiterate (mode value of 0 - zero). The highest concentration has a mode of 1 and represent 67.8% of municipalities (40 out of 59). On the other hand, there are just two with a value of 2 (3.4%), and only one municipality with a value of 3 (1.7%).

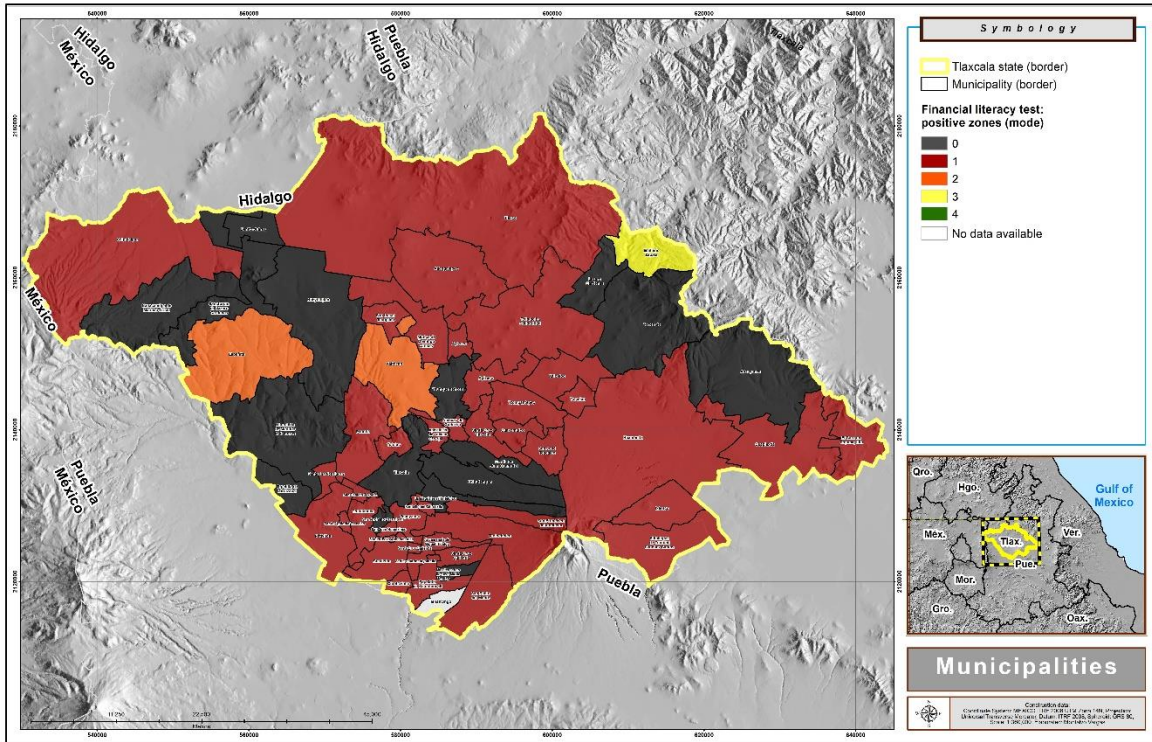


Figure 3. Financial literacy: municipal results (positive zones – mode)

Source: Authors with survey data.

The municipalities with the zero mode value have diverse characteristics. Some of them are urban, such as Tlaxcala and Santa Ana Chiautempan (two of the most populated in the state), located in the central-southern region of the state, but the majority is rural and concentrated in the northeastern region, represented by Lázaro Cárdenas, Terrenate and Altzayanca, and in the western region, where Ixtacuixtla, Hueyotlipan, Sanctorum and Nanacamilpa are found.

Municipalities with the mode value of 1 are scattered throughout the state which, except for Calpulalpan, form a homogeneous region. Surprisingly, those municipalities with mode of 2 and 3 (Xaltocan, Española, and Emiliano Zapata) are rural with a low number of inhabitants (about 10,000 for each of the former two, but less than 2,000 for the latter). No municipalities reported a mode of 4, as only one person achieved this score.

When comparing the official and unofficial financial literacy classification (see Figure 4 and 5), the focus is on three municipalities, where two of them are partially financially literate and one is financially literate.

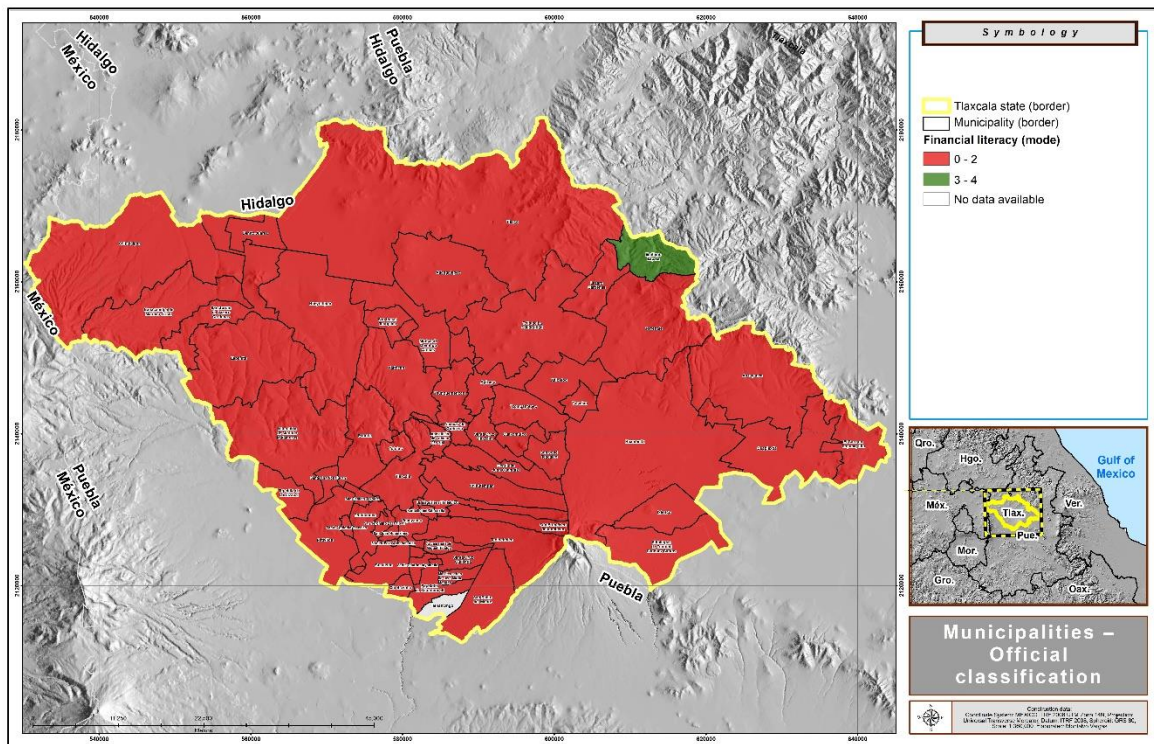


Figure 4. Financial literacy: municipalities (official classification)

Source: Authors with survey data.

Out of 59 municipalities analyzed, in 98.3% of them OAs are not financially literate (mode values: 0, 1, or 2). The only municipality where OAs are financially literate financial education is Emiliano Zapata (3), which has the highest values (see Figure 4). This municipality is located in the mountainous northeastern part of the state and most of the citizens are primarily engaged in seasonal agricultural production.

When comparing the spatial distribution based on the official and unofficial classification (see Figure 5), variations are minimal as only two municipalities with partial financial literacy (value 2) stand out, but in the remaining 94.9% (56 out of 59 municipalities) OAs are financially illiterate.

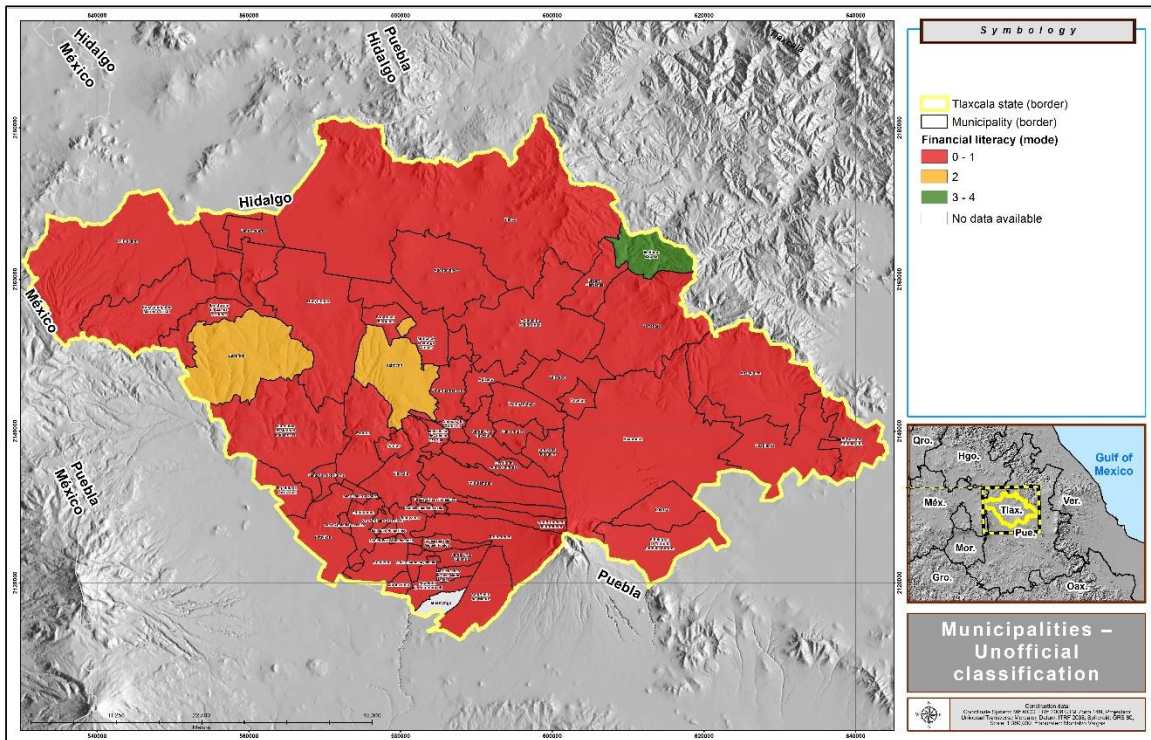


Figure 5. Financial literacy: municipalities (unofficial classification)

Source: Authors with survey data.

The two municipalities with partial financial literacy (Xaltocan and Españita) are located in the central and western part of the state. Their territorial coverage is about 6% of the Tlaxcala territory, with a population that has exceeded 60,000 inhabitants in 2023 (4.5% of the state population). Both are rural municipalities; Xaltocan has a significant accessibility and proximity to public and private services, mainly in the city of Apizaco (5 kilometers away). However, Españita is located in a rough and remote region, 20 kilometers away from the major urban areas (Calpulalpan) to the far west of the state.

Based on the municipal-scale results, it is evident that financial literacy workshops and courses for OAs should cover the majority of the state's territory, excluding Emiliano Zapata. Despite of the above, the aggregation due to the scale of analysis could disguise specific areas where elders might be, in fact, financially literate. We explore this possibility in the next section by focusing on voting districts.

5.3 Financial literacy spatial analysis: voting district level

The municipal level is the most appropriate for federal and state governments to target public policies. However, when a phenomenon is unknown by authorities, a scale with higher positional accuracy improves an exhaustive analysis of the issue in geographical areas, as well as addressing eventual remedial actions, even in the same municipality. This is the major benefit of spatial analysis at the voting district level.

The use of the district cartography offers methodological advantages for in-depth analysis, compared to the municipal cartography, which benefits from a geometric and thematic generalization resulting from the spatial attribute assignment method at its immediate lower scale, which is the district level.

In this section, the cartography encompasses 622 voting districts represented by vectors, and with different colors the status of financial literacy therein.

In Figure 6 there are 101 voting districts representing 34.5% of the 293 voting districts with no zones answered correctly (mode value of 0 – zero), and at least five regions have been identified. The highest percentage of voting districts with only one (1) zone (55.6%) concentrates in the central and southern part of the state. In just 25 districts (8.5%) the mode is 2, and only four districts (1.4%) – scattered in the northern, eastern, and southern parts of the state – have the highest value (3).

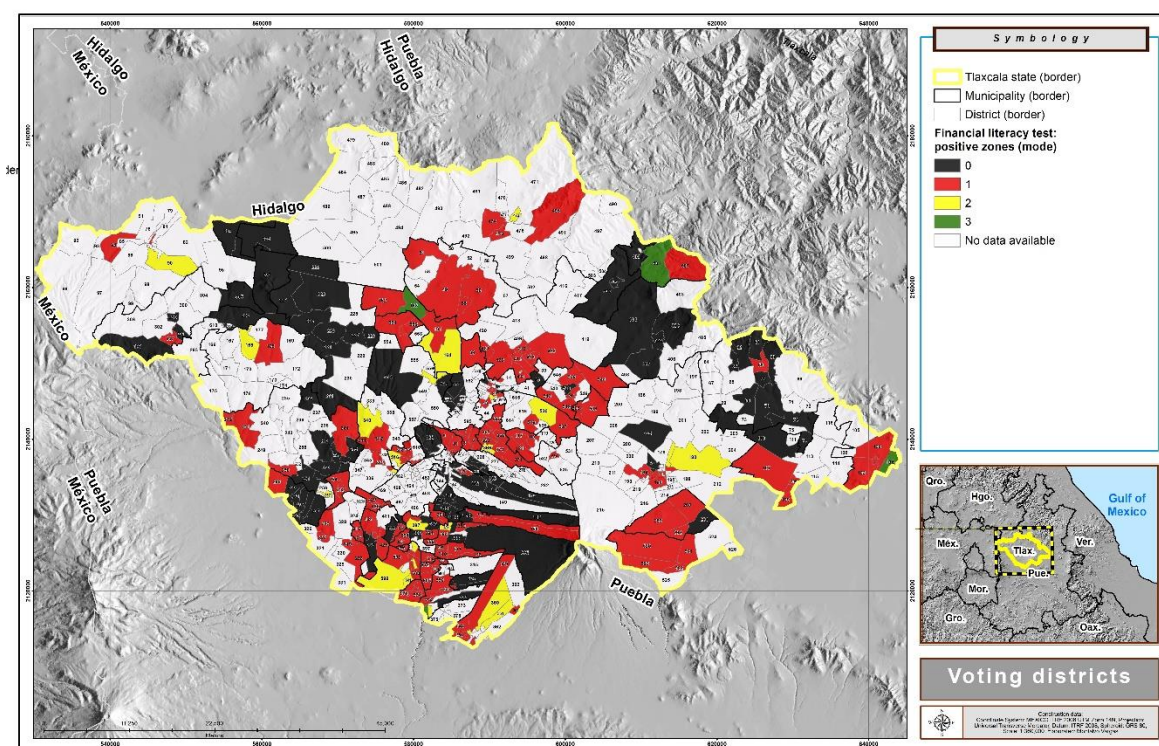


Figure 6. Financial literacy: voting district results (positive zones – mode)

Source: Authors with survey data.

There is ample heterogeneity in the spatial distribution pattern of the lowest value, and a less dense corridor is barely formed from Zitlaltépec to Tlaxco, passing through Apizaco. The dispersion of modal value 1 is more homogeneous being present in almost all the state.

Those voting district with modal value of 2 show a clear pattern in two areas. The first is an intermittent line path from the west (Calpulalpan) to the east (Huamantla). The second area has a more defined concentration that goes from the City of Tlaxcala heading south. Finally, the highest value (3) is only found in the following district numbers: 104 belonging to the municipality of El

Carmen Tequexquitla (far east), 162 in Muñoz de Domingo Arenas (north-central), 401 in Emiliano Zapata (far north), and 564 in Papalotla de Xicohtécatl (far south).

When sorting districts according to the official classification (Figure 7), there are two categories displayed: with or without financial literacy. The first category includes the four districts mentioned above, while the other embodies the remaining 98.6% (294 districts) distributed across the state.

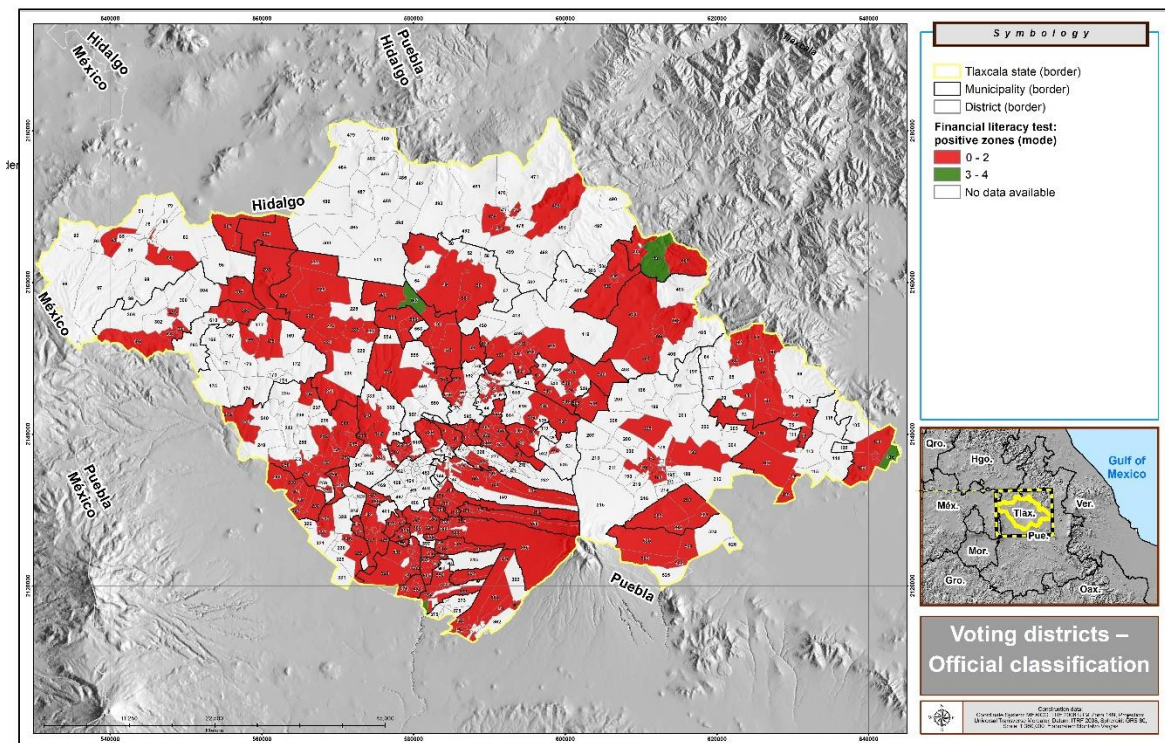


Figure 7. Financial literacy: voting districts (official classification)

Source: Authors with survey data.

Finally, Figure 8 portrays the districts representation according to the unofficial classification, which, unlike the official one, introduces a partially financially literate class using the same criteria as at the municipal level. The spatial structure of the new classification allows identifying three different kind of voting districts: those financially illiterate, partially financially literate, and financially literate.

The group of those financially illiterate (modal values 0 or 1) represents 90.1% of the surveyed districts, those partially financially literate (mode value 2) are just 8.5%, and the financially literate maintains 1.4% of the districts (modal values 3 or 4). The financial literacy landscape for both municipal and voting district level remarks the insufficient knowledge on the matter with potentially negative consequences for elderly with regard to financial decisions making, although some districts with partial financial literacy belong to municipalities that, nonetheless, classify as financially illiterate. This is because, albeit some heterogeneity exists, OAs knowledge is too low to modify the big picture. Despite many voting districts were not included in the sample, a pattern emerges, as most of the partially literate districts are located along the main roads north-south (from the municipality

of Tlaxco to San Pablo del Monte) and east-west (from the municipality of Calpulalpan to El Carmen Tequexquitla) of the state. Even though connectivity might be an avenue to develop financial skills due to trade and other business opportunities, such interpretation would need a more refined analysis by surveying those voting districts that are void.

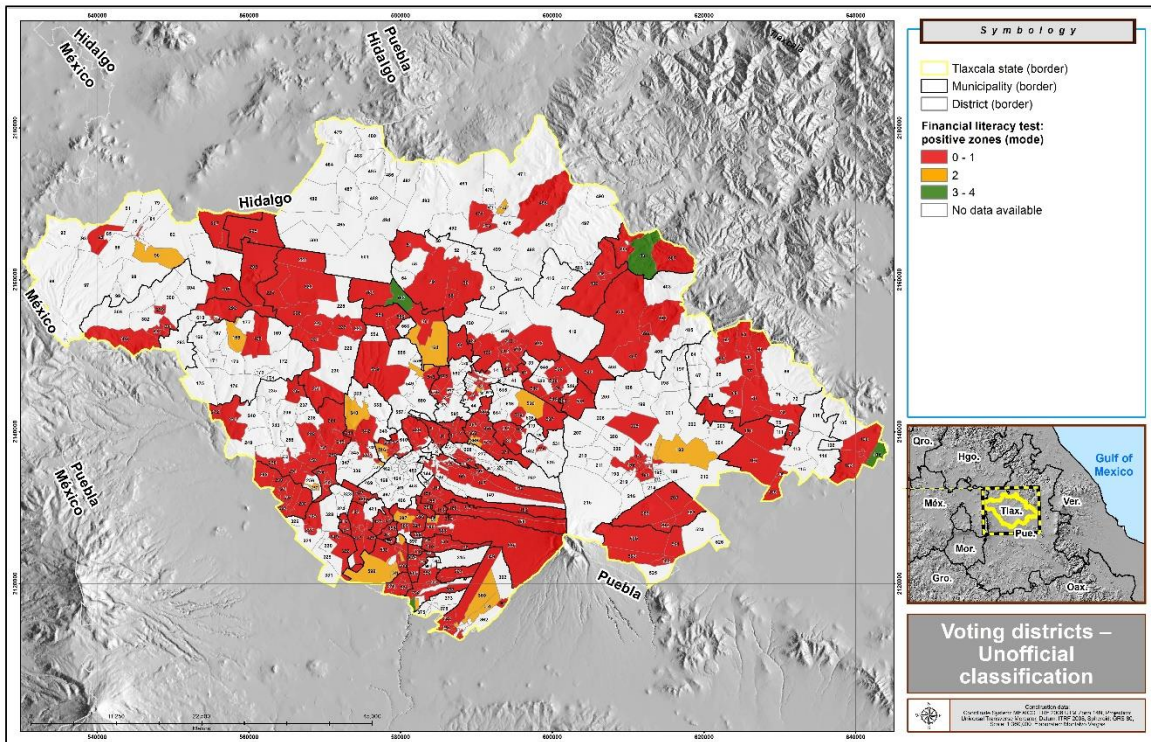


Figure 8. Financial literacy: voting districts (unofficial classification)

Source: Authors with survey data.

5.4 Financial literacy correlations

According to results, most of OAs lack a sufficient level of financial literacy that may lead to inefficient decision making, but situation can be even worse for some OAs' subgroups. As most of the sample is financially illiterate, Table 4 shows the statistics of correct zones answered by sub-groups. Following previous literature (Bumcrot, Lin and Lusardi, 2011; Fornero and Monticone, 2011), such analysis sheds light on the challenges entailed and related with specific vulnerable elders.

There is no significant difference between the sample average and sex averages, but those OAs that have a mild dependence to perform ADLs show a greater, albeit limited, knowledge than those with moderate, severe and total dependency. By considering that no autonomous OAs were detected in the sample, evidence suggests that those who might rely on familial caregivers to perform daily activities are at risk (Frazão et al., 2014; Orfila et al., 2018) and lacking basic financial skills could also impact their financial stability by promoting self-exclusion to access financial services (Thohari, & Rizky, 2021). As mentioned, in Mexico most caregivers are also OAs' relatives who, due to the bonds of trust with elders may have access to their patrimony or seek to convince them to

make financial decisions that may be not adequate (Wendt et al., 2015). The inheritance decisions by elders supports this interpretation; it is known that relatives may feel entitled to elders' properties (Bagshaw et al., 2013), but we found that elders with higher than average financial literacy did not inherited all their belongings while those who already did so (partially or totally) have a significant lower score. Although the detachment of properties and other items may be a personal decision linked to several motives, these objects may also represent a deposit value to which the OA might rely to in case of need. Thus, donating or inheriting all belongings is plausibly linked to overconfidence in the future, as well as being risk takers (i.e. not diversify risk). In either situations, such behavior is not (financially) recommended as it may jeopardize mitigating shocks.

Financial literacy is significantly lower than for specific sectors of the Tlaxcala OAs: indigenous and those with no formal education score below the sample average, and the opposite is observed for higher grades. Probably this is because higher education allows people to work in activities that makes financial matters' comprehension more likely. Finally, being financially and/or physical/psychological abused is related with lower financial literacy but only for those suffering hybrid financial exploitation is significant at 10%. It is noteworthy that, even when the difference is not significant, those OAs who have not been abused have higher financial skills, a result partially aligned with Wood et al. (2016). With this same database, a simultaneous equations model made evident the benefits of financial literacy on lessening non-financial abuse that has a reinforcing relationship with financial exploitation. This means that financial literacy has a direct effect on preventing the former abuse that, in turn, has an indirect effect on the latter. This is crucial because the lack of financial literacy is both a precursor of financial distress and abuse against this age group (Raccanello, 2023).

Table 4. Financial literacy subgroups means (correct zones)

	Fin lit average	s.e.	CI 95%		N	Avg. Δ vs. sample average	
			LB	UB			
Sample average	0.882	0.014	0.855	0.908	2954	-	
Males	0.904	0.021	0.863	0.945	1154	0.022	
Females	0.867	0.018	0.833	0.902	1800	-0.014	
Mild dependency	0.925	0.014	0.897	0.952	2733	0.043	***
Moderate dependency	0.233	0.043	0.147	0.318	129	-0.649	***
Severe dependency	0.547	0.074	0.399	0.695	75	-0.335	***
Total dependency	0.353	0.147	0.041	0.665	17	-0.529	***
Inherited all	0.785	0.032	0.722	0.849	438	-0.096	***
Inherited partially	0.729	0.025	0.679	0.779	765	-0.152	***
Inherited none	0.972	0.018	0.937	1.007	1751	0.090	***
Indigenous	0.670	0.053	0.565	0.775	194	-0.211	***
No formal education	0.720	0.023	0.675	0.764	982	-0.162	***
Primary	0.937	0.019	0.899	0.974	1452	0.055	***
Secondary	1.038	0.039	0.962	1.114	370	0.156	***
High school and above	1.020	0.057	0.907	1.133	150	0.138	**

Financial exploitation	0.769	0.078	0.615	0.923	104	-0.112	
No Financial exploitation	0.886	0.014	0.859	0.913	2850	0.004	
Other abuse	0.737	0.047	0.645	0.830	270	-0.144	
No other abuse	0.896	0.014	0.868	0.924	2684	0.015	
Hybrid exploitation	0.618	0.112	0.394	0.842	55	-0.263	*
No abuse	0.895	0.014	0.867	0.923	2635	0.014	

***, **, *: Mean difference test significant at 1, 5, and 10% respectively.

Source: Authors with survey data.

As financial illiteracy is pervasive in the Tlaxcala, state authorities should coordinate with municipalities to design public policies in order to ameliorate the OAs knowledge in this regard. Of course, a proper coordination between state and municipal authorities would be mandatory.

The Mexican government is aware of the financial literacy gap and about the importance to fill it. In fact, since more than a decade, a yearly effort to improve the financial literacy of the Mexican population has begun (Raccanello & Guzmán, 2014). The National Financial Literacy Week (*Semana Nacional de Educación Financiera*) organized by the National Commission for the Protection and Defense of Users of Financial Services (*Comisión Nacional para la Protección y Defensa de los Usuarios de Servicios Financieros – CONDUSEF*), is the most important activity that has been designed toward this aim. However, this event has a limited reach for some vulnerable groups as activities are mostly on-line and it is entirely in Spanish. Accordingly, technological and language barriers involuntary posed for OAs and indigenous people neither contribute to improve financial literacy, nor financial inclusion (CNBV, 2022). This is why specific characteristics, of the population at which both actions and the public policy are intended to reach, should be taken into account.

6. Conclusions

Financial literacy is a scant competence in most of the population, and elders – on average – score as the lowest age group; aligned with the literature (Klapper, Lusardi, & Van Oudheusden, 2015), in the state of Tlaxcala both the official and unofficial classification confirm that most of OAs are financially illiterate.

As population aging establishes new challenges to authorities that require appropriate tools to address them successfully, our results provide a baseline at the municipal level, or even at the more precise voting district level, to implement targeted actions that may benefit the older population, as well as all other residents. As such, the next step would be to commit municipal and state authorities hand-in-hand with federal government agencies, to recognize this situation and advance toward a tailored solution, instead of a one-size-fits-all remedy. As a minimum, an intensive effort to enhance elders' financial knowledge is needed in most of the municipalities surveyed. In-situ sessions and translators for those people that do not command Spanish are just a couple of few improvements to the national politics in this regard that could be considered. However, since the quasi-totality of municipalities and voting districts classify as financially illiterate, a prioritization would be also paramount.

Some OAs subgroups exhibit worrisome low levels of financial knowledge that need specific actions attached to the national level policy, and some of them may even go beyond those targeted to elders. This is the case for education for both young and old generations: as today's youth will be tomorrow's elders, numeracy and financial literacy should be taken into account in order to capitalize a positive intergenerational effect in the long run. Because education begins inside the household, the school system is not entirely responsible of people knowledge, this is why such efforts should be focused at parents, children and, of course, older generations.

From our results emerge a sort of situations already highlighted by the literature, as well as others that need further research. Even though disability tend to appear with aging, lower financial literacy make OAs who suffer from this condition, even more vulnerable of being abused. Despite international growing literature, elderly research is a topic of interest outside the Latin American region because aging is a minor priority for young countries; however, world trends anticipate that the tide is turning and governments' agenda needs to be updated to face the challenges to come. Because actions and programs are driven on field, spatial analysis is a tool that allows both researchers and decision makers to identify the issue(s) to be solved at ground level.

The major limitation of this work is that all but one municipality, nor all voting districts are represented so, to overcome this drawback the sample should be expanded to cover the entire state and analyze effects through spatial econometric techniques.

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