Research article

Gender inequality and gender-based poverty in Mexico

Minerva E. Ramos [a,*], Damian-Emilio Gibaja-Romero [b], Susana A. Ochoa [c]

[a] *Universidad de Monterrey (UDEM), Business School, Department of Economics, Mexico*
[b] *UPAEP-University, Deanship of Graduate Programs in Engineering and Business, Mexico*
[c] *Universidad Panamericana, Guadalajara Campus, Panamerican Institute of Family Sciences, Mexico*

A B S T R A C T

The objective of a country's government is to increase the well-being of its population. For this reason, a precise measure of inequality and poverty contributes to better development of economic and public policies to reduce the former and latter, respectively. Therefore, in recent years, various indexes have been developed to measure and compare inequality and poverty. In the case of Mexico, the Gini and Theil indexes are used to measure both problems. However, they are criticized for the overvaluation that they generate on specific population segments. For a better measurement, this paper calculates and investigates the relationship between the Palma index (inequality) and the Foster, Greer, and Thorbecke index (poverty). In addition to reducing the overvaluation problem, the indexes mentioned allow us to perform an analysis by gender and employment type (salaried and self-employed). The main results do not diverge from those already found through traditional measures. In general, a high level of inequality exists. However, our paper contributes to the literature by identifying both problems by gender. Men present greater inequality than women, whereas women present greater poverty than men. Finally, a positive, albeit weak, correlation exists between both problems, which means that poverty can be combated by combating inequality.

1. Introduction

In its 2018 report, the Organization for Economic Cooperation and Development (OECD) states that poverty and inequality have remained at historically high levels in the last decade, showing a relationship that has negatively impacted the economic development of countries around the world (Balestra et al., 2018). Esquivel (2016) emphasized that the failure to reduce poverty and inequality affects individual well-being and exerts a negative impact on economies by, for example, weakening the domestic market, generating financial market imperfections, reducing small businesses' investment capacity, and creating disturbances in human capital accumulation decisions. Notably, the quality of life of people with low income deteriorated during such a period because of the persistence of poverty and inequality. The empirical evidence indicates that the persistence of both phenomena increases crime rates (Coccia, 2018) and generates poor health (Pickett and Wilkinson, 2015).

Economic growth is recognized as a necessary condition to reduce poverty, given its capacity to generate wealth and employment, but is not enough to distribute income in a balanced manner (Stiglitz, 2016). For instance, in the early 2000s, although Latin America registered a rate of economic growth higher than the world average that contributes to reducing poverty (Amarante et al., 2016), recent empirical evidence indicates an increasing trend on income inequality from 2010 to today (Gasparini et al., 2016; Zmerli and Castillo, 2015). In general, the region is characterized by presenting income distribution mechanisms that ignore idiosyncrasy and population features as well (Fosu, 2017; Sands, 2017), and Mexico is a relevant case given the persistence of both phenomena over the last 20 years (Amarante et al., 2016).

Given the close relationship between poverty and inequality, we discuss whether a correlation exists between such phenomena in Mexico when we analyze them by region, gender, and job category. Although the Gini index (GI) is the traditional measure of determining income inequality, it underestimates inequality on the extremes of the income distribution (Paraje, 2001). Hence, we use the Palma index (PI) to analyze income inequality in Mexico because this index reflects changes between the lowest and highest income deciles, as opposed to the GI (Martinez et al., 2016). Its results are easy to implement in the design of public policies, which is not the case of indexes based on entropy concepts, such as the Theil index (TI). Formally, the PI focuses on comparing the relationship between the percentage of income earned by the

* Corresponding author.
E-mail address: minerva.ramos@udem.edu (M.E. Ramos).

wealthiest 10% of individuals (or households) and the income earned by the poorest 40%. Therefore, we answer the following research questions: i) Does the proportion of income earned by the wealthiest 10% of individuals or households, relative to the income earned by the poorest 40% of the population, differ by gender and federal entity in Mexico? and ii) Does the poverty level differ by gender, job category, and federal entity in Mexico?

Although the PI provides a novel approach to determine income inequality in Mexico, to the best of our knowledge, no studies exist that use the PI to analyze income inequality in Mexico. Income inequality satisfies desirable properties (the principles of transfer, proportionate changes in income, proportionate addition of persons, and anonymity) that make it a reliable inequality (Sen, 1973; Schröder, 2015). Thus, the PI overcomes the underestimation problems of the GI because it does not place more weight on income variations of the population in the middle part of the distribution. For previous reasons, the United Nations (UN) uses the PI to compute the Human Development Index, and the PI plays a significant role in the analysis of the OECD's statistics (Cobham et al., 2016).

Mexico is a representative example of the persistence of income inequality during the last thirty years. Despite the macroeconomic stability of the country and the decline of inequality during the 2002–2010 period, although not drastically, the phenomenon remains at high levels (Cortés, 2013) and presents an increasing trend (Martínez and Tavera, 2018). The World Bank Group (2016) indicates that Mexico is one of the ten countries with the highest inequality index worldwide and is also the country with the highest inequality level within the OECD (Balestra and Tonkin, 2018). Both organisms report a GI equal to 0.458, whereas Bustos (2015) and Reyes et al. (2017) reported a GI greater than 0.65. Hence, the literature discusses whether and why the GI index underestimates—or not—the measurement of poverty and income inequality in Mexico because a precise measure of both phenomena, and the identification of their relationship, is necessary to improve the design of public policies that ameliorate or even eradicate them (Campos-Vazquez et al., 2018; Del Castillo Negrete Rovira, 2017). By using the PI, our results illustrate a high level of income inequality through the consumption level that the wealthiest population spends relative to the population in the lowest part of the distribution.

Concerning poverty measurement, we compute the Foster, Greer, and Thorbecke index (FGTI) that measures the intensity of poverty by considering the gap that exists between the poverty line and individuals' incomes. The FGTI is appealing for our study because it allows for a poverty analysis across different population groups, classified by gender and region (Lustig, 1994; Ravallion, 1992). Together with the PI, the FGTI provides a better foundation for designing public policy proposals oriented to reduce poverty (Villar, 2015).

The paper is structured as follows. Section 2 presents a literature review on the relationship between poverty and income inequality as well as issues related to their measurement. In Section 3, we describe the methodology of our study, from the data sources to an explanation of the index that we use. In Section 4, we present the results of levels of poverty and income inequality by gender, job category, and federal entity. Finally, Section 5 presents the conclusions.

2. Literature review

Historically, the concept of poverty has relied on the concept that a group of people faces a shortage of income (Bazán et al., 2011). However, this concept has suffered modifications over the years because poverty is not solely related to economic factors; today, poverty is studied from a more general point of view that relates it to social welfare, which provides it with a multidimensional nature (Ponce, 2013). Consequently, the measurement of poverty is not an easy task given this last feature.

In 1978, Amartya Sen indicated that poor members of society can be identified using a direct or indirect method to measure their quality of life (Nina and Aguilar, 1998). Amartya Sen's ideas indicate that "quality of life" depends on the capacity of agents to consume a basket of goods (Feres and Mancero, 2001). A direct method identifies people's quality of life to establish a relationship between their income and well-being. In contrast, the indirect method is based on global variables such as consumption, which represents an approximation of people's quality of life. Hence, to better understand poverty, it needs to be related to inequality because the last concept indicates the existence of opportunities that are not available to all people, and that can induce a better quality of life by accessing them (Ravallion, 2001).

The case of Mexico is relevant for the literature that analyzes the relationship between poverty and inequality because the implementation of public policies have not had the expected effect on reducing poverty and income inequality (García et al., 2012; Sastré and Rey, 2008; Székely et al., 2007). Recent empirical evidence points out that the majority of programs based on transfers have not been effective in fulfilling their objectives (Lambert and Park, 2019).

The paper builds on investigate the relationship between these concepts in Mexico. However, we are not the first to do so. Székely (2005) analyzes poverty and inequality using data from the 1950–2004 period. He measured inequality through the GI and measured poverty by following the Mexican government's official methodology (developed and proposed by the Technical Committee for the Measurement of Poverty in 2002). This methodology measures poverty concerning food, skills, and wealth. Székely (2005) found a strong positive correlation between poverty and economic growth, where poverty and inequality stand out. Similarly, Campos-Vázquez and Monroy-Gómez-Franco (2016) observed that economic growth reduced poverty in some federal entities; however, at a national level, the impact is almost insignificant. Subsequently, Székely et al. (2007) generalized the previous results by including local data; that is, they use data from municipalities to determine the relationship between poverty and inequality through the calculation of the TI and FGTI. From a national perspective, they conclude that a higher level of poverty and inequality is concentrated in the south of Mexico, and the level decreases as we go toward the north of the country. By using the PI instead of the TI, we find the same results as Székely (2005) and Székely et al. (2007) at national and regional levels, and using the PI allows us to generalize their results by including gender and job category. Additionally, the natural interpretation of the PI provides more specific policy proposals that those derived from the TI, which is difficult to understand in a socioeconomic context because it is an entropy measure (Sen, 1973).

Despite the existence of a large number of studies that analyzed the relationship between poverty and income inequality (for a review, see Banks et al., 2017; Karagiannaki, 2017)), little is known about the impact of gender on this phenomenon when the analysis is performed by country (Bastos et al., 2009; Kabeer, 2015). Rhodes (2016) stated that, worldwide, the probability of a man being poor is lower than that of a woman, whereas income inequality studies indicated a positive relationship between such a variable and sexualization (Blake et al., 2018), diversification (Kazandjian et al., 2019), and gender marking (Shoham and Lee, 2018). In this sense, our main contribution relies on analyzing the relationship between poverty and income inequality from a gender perspective that indicates the regions/federal entities to which government transfers the need to focus on the welfare of women.

Our main contribution unfolds in two streams. First, we apply the PI to obtain a more precise income measure that analyzes the extremes of the income distribution in Mexico by federal entity, gender, and job category. Our results point out that federal entities with higher inequality also showed higher gender-based poverty, which must be addressed when designing public policies. Second, we find a positive correlation between PI and FGTI in Mexico by gender, job category, and federal entity. Together with the PI analysis, we reveal that a reduction in poverty contributes to a reduction in inequality; however, applying specific strategies by federal entity and gender to strengthen such a tendency is necessary. Concerning the job category, our results indicate that self-employed workers present the highest correlation between

poverty and income inequality, which means that such workers have a higher probability of having a low quality of life.

3. Methodology

In this paper, we study the relationship between poverty and income inequality; thus, we first measure poverty and income inequality by using the PI and FGTI indexes, respectively, for each federal entity and by gender. Later, per Akoglu (2018) and Ly et al. (2018), we compute the Pearson correlation coefficient since it is a widely used statistical measure of the strength and direction of the relationship between the PI and FGTI values, as Székely (2005) does by considering the Gini Index and dimensional measures of poverty. Hence, we require a dataset that summarizes information on the income of individuals and households. Because such information is not publicly available in Mexico, we measure poverty and income inequality using an indirect method: we gather these data from the 2010 National survey of household income and expenditure (ENIGH, 2010) because the survey includes the variable _recurrent monetary expenditure of households_, which refers to household consumption.[1] We also use the Population and Housing Census (2010) to obtain data on individuals' job category, age, and gender. Both studies are conducted by the national institute of statistics and geography (INEGI, 2014).

Although the ENIGH is an annual survey, we use the ENIGH (2010) dataset for two reasons: it coincides with the last national census, which takes place every ten years, and it does not include the effects of the structural reforms approved between 2012 and 2018, particularly those in 2012 and 2016 related to the labor market.

3.1. Income inequality measurement

Similar to the Gini coefficient, the PI measures confinable inequality (Schröder, 2015). We determine Mexican income inequality in 2010 by computing the PI, which is the quotient of the percentage income earned by the wealthiest 10% and the poorest 40% of the population. Given that income is private information, we use consumption as a proxy for income, and the mathematical formulation is

$$P^u = \frac{\sum_{h \in \mu(P_{10})} E_h}{\sum_{h \in \mu(P_{40})} E_h} \tag{1}$$

where:

a. E_h is total consumption of household h;
b. $\mu(P_{10})$ is 10% of the population with the highest consumption;
c. $\mu(P_{40})$ is the poorest 40% of the population, that is, the population with the lowest level of consumption.

Note that the PI takes positive values, and $P^u \leq 1$ indicates a situation of low-income inequality. In other words, P^u equal to 1 indicates the existence of almost equal participation on consumption from the 10% wealthiest households and the 40% poorest households. If P^u is less than 1, the consumption of the poorest 40% of the population exceeds that of the wealthiest 10% of the population. The PI indicates a high level of inequality when it takes values greater than 1; in such a situation, the consumption of the 10% richest exceeds that of the 40% poorest (Palma, 2011; Villar, 2015).

We use the STATA statistical software package to compute the PI for the 32 federal entities by considering the monetary expenses of the nation. First, we determine the lowest 40% and highest 10% of recurring monetary expenses at a national level. Second, we repeat the previous procedure to find the income inequality of each federal entity and by

gender. Finally, we apply the PI formula to obtain the inequality index for each federal entity, and later by gender.

3.2. Poverty measurement

We measure poverty through the FGTI, whose calculation requires the poverty line as a comparison point to determine the poverty level of each federal entity (Scott and Bloom, 1997; Navarro and Chávez, 2001; Olavarria, 2005). Given the different poverty line constructions, we follow the methodology of Navarro and Chávez (2001) to compute the FGTI. The mathematical formulation of the FGT index is

$$P_\alpha(y,z) = \frac{1}{N} \sum_{i=1}^{q} \left(\frac{g_i}{z}\right)^\alpha \tag{2}$$

where:

1. α is the aversion parameter, also denoted as $FGTI(\alpha)^2$, and that can take positive values. We consider that $\alpha = 2$ because P_2 satisfies the transfer-sensitivity axiom. In other words, $FGTI(2)^2$ allows for a comparison between population groups because it increases the weight of the poor in the index (Foster et al., 1984);
2. y_i is the income of the ith individual or household;
3. z is the poverty line;
4. N is the total number of individuals or households;
5. q is the number of individuals or households that are below the poverty line; and,
6. $g_i = z - y_i$ is the income deficit of the ith household.

Before we compute the FGTI, we first obtain the poverty line of each federal entity. To this end, we use the Population and Housing Census (2010) and the National commission of minimum salaries (CONASAMI, 2010) databases. The census provides information on the population aged 12 and older (total and economically active), the total working population not receiving income by gender and by job category (salaried workers[2] and self-employed workers[3]), the total working population receiving up to one minimum salary by gender and by job category, and the total working population receiving one to two minimum salaries by gender and by job category.

We obtain from the CONASAMI database the minimum salaries by geographic area from the year 2010 for each federal entity,[4] which allows computing the FGTI by region. Consequently, we show a general application of the methodology of Navarro and Chávez (2001). Then, we compute the _dependency reason_ as the quotient between the population that is economically active and the total population; therefore, the poverty line is the result of dividing the minimum salary and the dependency reason.

Note that the number of inhabitants below the poverty line is calculated by multiplying the dependency reason and the population that receives no income, from 0 to 0.5 minimum wage and from 0.5 to 1 minimum wage. Subsequently, each income group is weighted by 0.25 and 0.75, respectively; therefore, income per capita is the result of

---

[1] The sum of regular expenses that households regularly use on goods and services for their consumption (ENIGH, 2010, p. 78).

[2] People who worked for a boss or employer in the public or private sector and who received a payment, wage, salary, or daily pay (Population and Housing Census, 2010).

[3] People who worked for their own business, company, establishment, or farm and did not hire workers in exchange for payment in the referenced week, although they may have received help from workers without pay, whether or not they were family (Population and Housing Census, 2010).

[4] Geographical area A (Baja California, Baja California Sur, Chihuahua, Federal District, Guerrero, México, Tamaulipas, and Veracruz), B (Jalisco, Nuevo León, and Sonora), and C (Aguascalientes, Campeche, Coahuila, Colima, Chiapas, Durango, Guanajuato, Hidalgo, Michoacán de Ocampo, Morelos, Nayarit, Oaxaca, Puebla, Querétaro, Quintana Roo, San Luis Potosí, Sinaloa, Tabasco, Tlaxcala, Yucatán, and Zacatecas) (CONASAMI, 2010).

multiplying the poverty line and the previous weights. Finally, we compute the square of the income gap ratio g_i/z, which we include in the final calculation of $P_\alpha(y; z)$.[5]

By extending the previous reasoning, we can obtain poverty and inequality by gender and job category. In other words, it is enough to partition Mexico's population by gender (male/female) and category job (salaried/self-employed workers), and subsequently apply this methodology to each group in the partition. We perform this analysis for each of the 32 federal entities of Mexico.

Finally, we investigate the relationship among the indexes discussed by computing the Pearson correlation coefficient. In other words, we create a new dataset that summarizes the income inequality and poverty measures by federal entity and gender. Later we use this dataset to compute the Pearson correlation coefficient by using Stata. This coefficient is determined by dividing the covariance and deviations from PI and FGTI (Stock and Watson, 2015).

4. Results

In this section, we discuss the income inequality results concerning the application of the PI. Next, an analysis of poverty is performed by explaining the FGTI. The section ends by showing the correlation between both indexes.

4.1. PI results

We use the PI to measure inequality by gender and federal entity with data from the ENIGH (2010) and the Population and Housing Census (2010). For all federal entities, we obtain a PI greater than 1 for both men and women, and a national average of 2.25 for both genders. Thus, the income concentrated in the wealthiest 10% of the population is 2.25 times higher than the income of the poorest 40% of the population, whether male or female. Given that 2.25 is larger than 1, the PI indicates a high inequality level in Mexico, as is pointed out in other empirical works (Lawson and Martin, 2017).

Relative to other studies, our results differ from studies that use the GI, such as Székely et al. (2007) and CONEVAL (2010). Székely et al. (2007) indicated that Guanajuato and Oaxaca are entities with the highest and lowest levels of inequality, respectively, whereas CONEVAL (2010) indicated that Chiapas and Baja California are entities with the highest and lowest levels of inequality, respectively. In our case, the PI allows us to perform a more detailed analysis by region and gender that overcomes the underestimation problems of the GI calculation; using data from 2010, we obtain the highest inequality for women and men from Querétaro and San Luis Potosí, respectively, whereas Colima and Tamaulipas exhibited the least income inequality for women and men, respectively.

Figure 1 highlights the federal entities in which the local PI exceeds the national average for women: Querétaro, Oaxaca, Michoacán, Nayarit, Guerrero, Yucatán, Jalisco, Chihuahua, Coahuila, Zacatecas, Puebla, Durango, Hidalgo, Tabasco, and Tamaulipas. In the previous states, the income of the wealthiest 10% of the female population exceeds the average national total income of the poorest 40% of the female population. In other words, 47% of the federal entities in the country exceed the average national inequality for the female gender. Note that our results, by gender, include Guerrero and Oaxaca, which are also pointed out as states with a high inequality level by studies that use the TI to measure inequality at the national level (Galavíz, 2016). Worth noting is the presence of Chihuahua and Querétaro as states with greater female inequality despite being considered among the states with higher average life satisfaction (INEGI, 2014).

Analogously, Figure 2 highlights the federal entities in which income inequality for males exceeds the national average: San Luis Potosí, Quintana Roo, Campeche, Veracruz, Hidalgo, Nayarit, Oaxaca, Federal District, Chihuahua, Yucatán, Guerrero, Chiapas, Aguascalientes, and Colima. First, interestingly, inequality, in both genders, is highlighted as exceeding the average in the states of Oaxaca, Nayarit, Guerrero, Hidalgo, Yucatán, and Chihuahua, and Colima and Aguascalientes are part of the group of states with higher male inequality but are not present in the case of women. As Queretaro, the presence of Colima and Aguascalientes attracts our attention because they also belong to states with higher life satisfaction (INEGI, 2014). Additionally, note that male inequality is concentrated in the southern states, except Tabasco and Puebla.

In any case, interestingly, note that all federal entities present a certain level of inequality because the lowest inequality value is 1.55 and 1.58 for men and women, respectively. In other words, 10% of the wealthiest population consumes at least 50% more than 40% of the poorest population. Additionally, the lowest inequality for women is greater than the lowest inequality for men, which supports the notion that women are the more vulnerable group concerning economic issues (Rhodes, 2016).

4.2. FGTI results

As noted in the methodology section, we first compute the poverty line of each federal entity to determine their poverty level. The poverty line represents the ratio of the economic dependency ratio (the ratio of the number of economically inactive people to the number of productive people) to the minimum wage of each federal entity.

Table 1 shows the average dependency ratios of the 32 federal entities in the year 2010, calculated by the gender of the economically active person. Each employed male worker was observed to economically sustain 1.36 individuals, whereas an employed female worker economically sustains 3.16 individuals. In other words, each woman economically sustains 1.8 more individuals than economically active men. Moreover, the data in Table 1 allow us to calculate the individual poverty line, which is 18.49 pesos [1.46 US dollars[6]] per day for women and 40.91 pesos [3.24 US dollars] per day for men, considering national averages. In other words, the value of the basic basket of goods that a man requires is more than double that of a woman, enabling us to conclude that women live in a more precarious situation than men.

Additionally, we compute the dependency ratio by each federal entity. We find that Chiapas and Oaxaca had the lowest poverty line for women and men, at 11.84 and 39.19 pesos [0.94 and 3.10 US dollars] daily, respectively. In contrast, the Federal District and Baja California Sur had the highest poverty line for women and men, at 25.14 and 49.97 pesos [1.99 and 3.96 US dollars] daily, respectively. For women, the difference between the minimum and maximum poverty lines is more than double, providing evidence of the inequality experienced by this sector of the population, whereas the difference between the maximum and minimum poverty lines for men does not exceed 15%.

Subsequently, we use Table 1 data to compute the FGTI, for which the sum of the squared income gaps was divided by the total population aged 12 or older—considered to be the economically active population. We perform the previous analysis based on job category—whether salaried or self-employed.

In the first case, FGTI, the poverty level is 55.6% greater for men than for women (0.0281 for men and 0.0184 for women). Additionally, the analysis was performed for each federal entity, and we illustrate the results in Figure 3 and Figure 4. Note that the estates with the highest poverty level—concerning salaried workers—are Yucatán for women and Hidalgo for men, with an FGTI value of 0.0345 and 0.0469,

---

[5] $\alpha = 2$ to satisfy the additive separability, subgroup monotonicity, and transfer axioms.

[6] Average exchange rate pesos per US dollar in 2010 (Banxico, 2010): 12.63 pesos per 1 US dollar.

PI WOMEN

National average 2.25

Above National	
Querétaro	3.55
Oaxaca	3.17
Michoacán	3.08
Nayarit	2.88
Guerrero	2.61
Yucatán	2.58
Jalisco	2.55
Chihuahua	2.53
Coahuila	2.47
Zacatecas	2.42
Puebla	2.41
Durango	2.38
Hidalgo	2.29
Tabasco	2.27
Tamaulipas	2.27

Below National	
Sonora	2.22
Nuevo León	2.11
Federal District	2.07
México	2.04
Chiapas	2.03
Guanajuato	2.02
Tlaxcala	2.01
Veracruz	1.99
Quintana Roo	1.93
Aguascalientes	1.87
San Luis Potosí	1.86
Campeche	1.86
Morelos	1.82
Baja California Sur	1.80
Baja California	1.77
Sinaloa	1.66
Colima	1.58

PI Women

	2.00
	2.50
	3.00
	3.50

Figure 1. PI of the female population in 2010.

PI Men

National average 2.25

Above National	
San Luis Potosí	3.33
Quintana Roo	3.17
Campeche	3.07
Veracruz	2.62
Hidalgo	2.61
Nayarit	2.57
Oaxaca	2.57
Federal District	2.52
Chihuahua	2.48
Yucatán	2.41
Guerrero	2.37
Chiapas	2.35
Aguascalientes	2.33
Colima	2.28

Below National	
Zacatecas	2.21
Coahuila	2.20
Sonora	2.17
Nuevo León	2.17
México	2.12
Baja California	2.11
Michoacán	2.08
Morelos	2.04
Querétaro	2.03
Tlaxcala	1.98
Jalisco	1.97
Guanajuato	1.93
Baja California Sur	1.87
Durango	1.84
Tabasco	1.83
Puebla	1.70
Sinaloa	1.55
Tamaulipas	1.50

PI Men

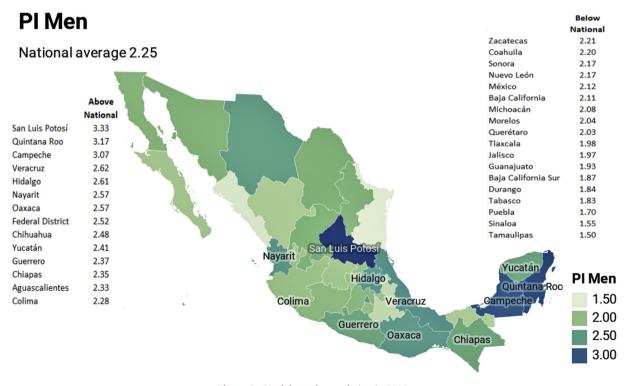|	
	1.50
	2.00
	2.50
	3.00

Figure 2. PI of the male population in 2010.

Table 1. Dependency ratio for 2010.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Workers (Male)	32	1.363651	.0294758	1.275718	1.426362
Workers (Female)	32	3.157554	.5816328	2.285369	4.600652

Source: Authors' calculation based on the Population and Housing Census (2010) database.

respectively. Thus, the percentage variation relative to the national total is 87.4% in Yucatán and 66.7% in Hidalgo.

Nuevo León presented the lowest FGTI value for salaried workers of both genders, at 0.0107 for women and 0.0142 for men, indicating a percentage variation from the national total of –41.9% for women and –49.6% for men. This finding suggests that the public policies that Nuevo León has enacted to combat poverty levels have been more effective than those implemented by other federal entities. The concentration of industrial activity and social policy planning actions stand out among these public policies (Barrón-Pérez, 2014).

Figure 5 and Figure 6 show the poverty levels of self-employed workers. The highest poverty levels are presented in Oaxaca for women and Chiapas for men, with an FGTI value of 0.037 and 0.176, respectively. The percentage variation from the national total was 93.7% in Oaxaca and 337.4% in Chiapas.

The lowest FGTI level for self-employed workers is observed in Nuevo León for women and Baja California for men, with an FGTI value of 0.0089 and 0.0052, respectively; the percentage variation from the national total was –53.8% for women and –87.0% for men. As in the inequality analysis, the statistics for the north of Mexico presented the lowest levels of poverty than those for the south, a result also presented in similar studies (Lambert and Park, 2019).

4.3. Correlation analysis

The correlation between the PI and the FGTI is weakly positive for women and men who are salaried workers, and for men who are self-employed workers, between 0.30 and 0.10, respectively. Meanwhile, for women who are self-employed workers, the correlation was moderately positive. Tables 2 and 3 provide these results.

A positive correlation indicates that poverty and income inequality levels tend to increase or decrease at the same time, even when their linear relationship is weak and moderate. Székely et al. (2007) also found a moderately positive correlation at the state level.

5. Conclusions

In this paper, we analyze the relationship between poverty and income inequality in Mexico. Given the critics around the GI, we used the PI to obtain clear insights into the income inequality in Mexico at a national level, but also by federal entity. Even more, the Palma Index allows measuring such inequality concerning gender and job category. At a national level, our results are similar to previous findings in the literature that also indicate a high inequality level in Mexico. Nonetheless, the PI ranks federal entities in a different way than other inequality indexes,

Figure 3. FGTI of male salaried workers in 2010.

FGTI Salaried Women

National average 0.0184

Above National	
Yucatán	0.0345
Tlaxcala	0.0285
Hidalgo	0.0257
Puebla	0.0245
Nayarit	0.0222
Michoacán	0.0219
Aguascalientes	0.0218
Morelos	0.0215
San Luis Potosí	0.0205
Querétaro	0.0202
Guanajuato	0.0200
Zacatecas	0.0199
Jalisco	0.0193
Baja California Sur	0.0193
México	0.0189

Below National	
Campeche	0.0182
Veracruz	0.0179
Guerrero	0.0177
Chihuahua	0.0169
Chiapas	0.0169
Federal District	0.0160
Tamaulipas	0.0159
Sonora	0.0159
Quintana Roo	0.0153
Oaxaca	0.0152
Durango	0.0150
Tabasco	0.0150
Colima	0.0149
Sinaloa	0.0141
Baja California	0.0138
Coahuila	0.0135
Nuevo León	0.0107

FGTI Women

- 0.015
- 0.020
- 0.025
- 0.030

Figure 4. FGTI of female salaried workers in 2010.

such as the GI. Our results are evidence of the underestimation that the GI performs on inequality due to the appearance of Colima and Querétaro in our ranking with a high inequality level; in opposition with other studies that point them out as federal entities with a high life satisfaction level (Barrón-Pérez, 2014; INEGI, 2014).

Due to the absence of studies that analyze poverty by gender and job features in Mexico, we compute the FGT index to obtain a general understanding of the poverty that faces each Mexican federal entity; and we also calculate the poverty level by gender and job category. Regardless gender or job's feature, we find that entities in the south of Mexico

FGTI Self-employed Men

National average 0.0402

Above National	
Chiapas	0.1760
Oaxaca	0.1242
Guerrero	0.1051
Campeche	0.0655
Yucatán	0.0633
Veracruz	0.0586
Zacatecas	0.0586
Puebla	0.0576
San Luis Potosí	0.0537
Tlaxcala	0.0505
Hidalgo	0.0501
Michoacán	0.0481
Durango	0.0424
Nayarit	0.0411

Below National	
Quintana Roo	0.0379
Tabasco	0.0363
Morelos	0.0280
Guanajuato	0.0264
Chihuahua	0.0248
Querétaro	0.0210
Sinaloa	0.0193
Jalisco	0.0188
México	0.0187
Tamaulipas	0.0164
Aguascalientes	0.0136
Colima	0.0134
Coahuila	0.0117
Federal District	0.0113
Nuevo León	0.0110
Baja California Sur	0.0105
Sonora	0.0091
Baja California	0.0052

FGTI Men

- 0.050
- 0.100
- 0.150

Figure 5. FGTI of self-employed male workers in 2010.

FGTI Self-employed Women

National average 0.0192

	Above National
Oaxaca	0.0372
Guerrero	0.0351
Chiapas	0.0339
Yucatán	0.0311
Tlaxcala	0.0289
Morelos	0.0240
Puebla	0.0240
Campeche	0.0234
Hidalgo	0.0233
Veracruz	0.0221
Michoacán	0.0203
Nayarit	0.0202
San Luis Potosí	0.0196

	Below National
Querétaro	0.0189
México	0.0184
Guanajuato	0.0182
Tabasco	0.0163
Aguascalientes	0.0157
Federal District	0.0155
Jalisco	0.0155
Zacatecas	0.0150
Baja California Sur	0.0150
Durango	0.0136
Quintana Roo	0.0132
Tamaulipas	0.0131
Chihuahua	0.0127
Sonora	0.0118
Sinaloa	0.0111
Coahuila	0.0109
Baja California	0.0107
Colima	0.0102
Nuevo León	0.0089

FGTI Women

- 0.010
- 0.015
- 0.020
- 0.025
- 0.030
- 0.035

Figure 6. FGTI of female self-employed workers in 2010.

Table 2. Correlation of the FGTI and PI indexes by job category for women.

FGTI						
PI	Salaried workers			Self-employed		
	Value	Relationship	Strength of relationship	Value	Relationship	Strength of relationship
	0.1917	Positive	Weak	0.3202	Positive	Moderate

Source: Authors' calculation based on the ENIGH (2010) and Population and Housing Census (2010) database.

present the highest level of poverty, being the opposite for the entities in the north of the country in coincidence with other empirical studies (CONEVAL, 2010). From a methodological point of view, we show that the methodology of Navarro and Chávez (2001) is flexible enough to analyze different groups of people through the calculation of the FGTI, which provide a more in-depth poverty analysis in comparison with the current methodology of CONEVAL.

Concerning the paper's main objective, we find a significant weak positive correlation between poverty and income inequality level by gender and job category in Mexico. In words, the proportion of income earned by the wealthiest 10% versus the poorest 40% of the population differs by gender and federal entity, and the poverty level differs by gender, job category, and federal entity. The intensity of the correlation

contrasts with that found in Székely (2005) but is consistent with the positive relationship that Székely finds. Therefore, the Palma and Foster, Greer, and Thorbecke indexes allow for a clear analysis of poverty and inequality by considering consumption as an indirect method to analyze income.

Our results do not only establish that income inequality may increase as poverty increases. We also provide empirical evidence that such a relationship remains when we split the analysis by federal entity, gender and job category. Our results suggest focusing public policy on salaried and self-employed workers since diminishing income inequality on such groups has a more significant impact on diminishing poverty, which can increase by targeting women in the federal entities of Querétaro, Yucatán, and Oaxaca. Similarly, we recommend designing

Table 3. Correlation of the FGTI and PI indexes by job category for men.

FGTI						
PI	Salaried workers			Self-employed		
	Value	Relationship	Strength of relationship	Value	Relationship	Strength of relationship
	0.2011	Positive	Weak	0.2929	Positive	Weak

Source: Authors' calculation based on the ENIGH (2010) and Population and Housing Census (2010) database.

policies focused on men in the federal entities of San Luis Potosí, Hidalgo, and Chiapas, where the correlation coefficient shows a higher level.

Although our paper does not analyze causality, our results bring to light the development of more precise public policies focused on a vulnerable population like self-employed women. In future work, we pretend to address the causality issue between poverty and inequality, whose answer remains as an open and interesting question in the literature (Pickett and Wilkinson, 2015; Shoham and Lee, 2018).

Declarations

Author contribution statement

Minerva E. Ramos: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Susana A. Ochoa: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Damian-Emilio Gibaja-Romero: Analyzed and interpreted the data; Wrote the paper.

Funding statement

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

References

Akoglu, H., 2018. 'User's guide to correlation coefficients'. Turkish J. Emerg. Med. 18, 91–93.

Amarante, V., Galván, M., Mancero, X., 2016. Inequality in Latin America: a global measurement global inequality. CEPAL Rev. 118, 20. Retrieved from: https://repositorio.cepal.org/bitstream/handle/11362/40423/RVI118_Amarante.pdf?sequence/1.

Balestra, C., Llena-Nozal, A., Tosetto, E., Arnaud, B., 2018. *Inequalities in Emerging Economies: Informing the Policy Dialogue on Inclusive Growth* (No. *100). Paris, France*.

Balestra, C., Tonkin, R., 2018. Inequalities in Household Wealth Across OECD Countries: Evidence from the OECD Wealth Distribution Database (OECD Statistics No. 88) (Vol. 01). Paris, France.

Banks, L.M., Kuper, H., Polack, S., 2017. Poverty and disability in low- and middle-income countries: a systematic review. PloS One 12 (12).

Banxico, 2010. Average Exchange Rate. Banco de México, México. Retrieved from: https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?accion/consultarSeries.

Barrón-Pérez, M.A., 2014. Comportamiento de la pobreza en México: una revisión de los desequilibrios. Memorias 12 (21), 7–24.

Bastos, A., Casaca, S.F., Nunes, F., Pereirinha, J., 2009. Women and poverty: a gender-sensitive approach. J. Soc. Econ. 38 (5), 764–778.

Bazán, O.A., Quintero, S.M.L., Hernández, E.A.L., 2011. Evolución del concepto de pobreza y el enfoque multidimensional para su estudio. Quivera 13 (1), 207–2019. Retrieved from: http://www.redalyc.org/pdf/401/40118420013.pdf.

Blake, K.R., Bastian, B., Denson, T.F., Grosjean, P., Brooks, R.C., 2018. Income inequality not gender inequality positively covaries with female sexualization on social media. Proc. Natl. Acad. Sci. U.S.A. 115 (35), 8722–8727.

Bustos, A., 2015. Estimation of the distribution of income from survey data, adjusting for compatibility with other sources. Stat. J. IAOS 31 (4), 565–577.

Campos-Vazquez, R.M., Chavez, E., Esquivel, G., 2018. Estimating top income shares without tax return data: Mexico since the 1990s. Latin Am. Pol. 9 (1), 139–163.

Campos-Vázquez, R.M., Monroy-Gómez-Franco, L.A., 2016. La relación entre crecimiento económico y pobreza en México. Invest. Economica 75 (298), 77–113.

Cobham, A., Schlögl, L., Sumner, A., 2016. Inequality and the tails: the Palma proposition and ratio. Global Pol. 7 (1), 25–36.

Coccia, M., 2018. Violent crime driven by income inequality between countries. Turk. Econ. Rev. 5 (1), 33–55.

CONASAMI, 2010. Salarios Mínimos. Retrieved from:http://www.conasami.gob.mx/pdf/tabla_salarios_minimos/2010/01_01_2010.pdf. .

CONEVAL, 2010. Poverty Measurement. Retrieved from: https://www.coneval.org.mx/Medicion/Paginas/Evolucion-de-las-dimensiones-de-pobreza.aspx.

Cortés, F., 2013. Medio siglo de desigualdad en el ingreso en México. Econ. UNAM 10 (29), 12–34.

Del Castillo Negrete Rovira, M., 2017. Income inequality in Mexico, 2004–2014. Latin Am. Pol. 8 (1), 93–113.

ENIGH, 2010. National Survey of Household Income and Expenditure (ENIGH). Retrieved from:http://en.www.inegi.org.mx/programas/enigh/tradicional/2010/. .

Esquivel-Hernández, G., 2015. Desigualdad extrema en México: concentración del poder económico y político. In: Reporte de Oxfam México, 23. Oxfam, pp. 1–43. Retrieved from: https://www.oxfammexico.org/sites/default/files/desigualdadextrema_informe.pdf.

Feres, J.C., Mancero, X., 2001. Enfoques para la medición de la pobreza. Breve revisión de la literatura. In: Estudios Estadísticos Y Prospectivos, 4. CEPAL, Santiago de Chile. Retrieved from: https://www.cepal.org/ilpes/noticias/paginas/2/40352/Cepal_Estudios_Est_y_Prospec_N_4_2001.pdf.

Foster, J., Greer, J., Thorbecke, E., 1984. A class of decomposable poverty measures. Econometrica 52 (3), 761–766.

Fosu, A.K., 2017. Growth, inequality, and poverty reduction in developing countries: recent global evidence. Res. Econ. 71 (2), 306–336.

Galavíz, G.R., 2016. La desigualdad y el gasto público en educación en México 1990-2010: un análisis del índice de Theil. Universidad Autónoma del Estado de México.

García, A.A., Fuentes, N.A., Montes, G.O., 2012. Desigualdad y polarización del ingreso en México: 1980-2008. Política Cult. (37), 285–310. Retrieved from: http://www.scielo.org.mx/scielo.php?script/sci_arttext&pid/S0188-77422012000100014.

Gasparini, L., Cruces, G., Tornarolli, L., 2016. Chronicle of a deceleration foretold income inequality in Latin America in the 2010s. Rev. Econ. Mund. 43, 25–46. Retrieved from: https://www.redalyc.org/pdf/866/86647324002.pdf.

INEGI, 2014. Welfare Indicators by State. Retrieved from: https://www.inegi.org.mx/app/bienestar/?ag/22#grafica.

Kabeer, N., 2015. Gender, poverty, and inequality: a brief history of feminist contributions in the field of international development. Gend. Dev. 23 (2), 189–205.

Karagiannaki, E., 2017. The Empirical Relationship between Income Poverty and Income Inequality in Rich and Middle Income Countries Middle Income Countries, 206. Centre for Analysis of Social Exclusion (CASE), London, UK. Retrieved from: http://sticerd.lse.ac.uk/dps/case/cp/casepaper206.pdf.

Kazandjian, R., Kolovich, L., Kochhar, K., Newiak, M., 2019. Gender equality and economic diversification. Soc. Sci. 8 (4), 118.

Lambert, F., Park, H., 2019. *Income inequality and Government Transfers in Mexico* (No. 19/148).

Lawson, M., Martin, M., 2017. The Commitment to Reducing Inequality index: what They Are Doing to Tackle the gap between Rich and Poor. Oxford, United Kingdom.

Lustig, N., 1994. Medición de la pobreza y de la desigualdad en la América Latina. El emperador no tiene ropa. El Trimestre Económico LXI (241), 200–2016. Retrieved from: http://aleph.academica.mx/jspui/bitstream/56789/5991/1/DOCT2065088_ARTICULO_6.PDF.

Ly, A., Marsman, M., Wagenmakers, E., 2018. 'Analytic posteriors for Pearson's correlation coefficient'. Stat. Neerl. 72 (1), 4–13.

Martínez, A.M., Tavera, C.M.-E., 2018. Distribucón del ingreso en México. In: Jiménez, G.M. (Ed.), *Problemas económicos de México* (pp. 27–40, Texcoco Estado de México, México: Asociación Mexicana de Investigación Interdisciplinaria ASMIIA, A.C.

Martinez, Z.G., Martner, G., Páez, D., Bilbao, M., 2016. Desigualdad económica y bienestar: relaciones entre los índices de Gini, Palma, los niveles del bienestar medio de las naciones y los factores explicativos de la relación entre desigualdad y felicidad, (January), 40. Retrieved from: https://www.researchgate.net/profile/Dario_Paez/publication/283509855_Desigualdad_economica_y_bienestar_relaciones_entre_los_indices_de_Gini_Palma_los_niveles_del_bienestar_medio_de_las_naciones_y_los_factores_explicativos_de_la_relacion_entre_desigualdad_y_felicidad/links/564c7ff608ae020ae9faae74/Desigualdad-economica-y-bienestar-relaciones-entre-los-indices-de-Gini-Palma-los-niveles-del-bienestar-medio-de-las-naciones-y-los-factores-explicativos-de-la-relacion-entre-desigualdad-y-felicidad.pdf.

Navarro, C.J.C.L., Chávez, C.J., 2001. El Índice de pobreza Foster Greer Thorbecke (FGT): una aplicación para Michoacán y sus municipios, 1980-2000. Econ. Soc. VI (10), 23–48. Retrieved from: https://dialnet.unirioja.es/servlet/articulo?codigo/5900498.

Nina, B.E., Aguilar, I.A., 1998. Amartya Sen y el estudio de la desigualdad económica y la pobreza monetaria. Colombia: 1978-1997. Cuad. Econ. 29, 211–233. Retrieved from: https://revistas.unal.edu.co/index.php/ceconomia/article/view/11531.

Olavarria, G.M., 2005. Pobreza, Crecimiento Económico Y Políticas Sociales, second ed. Universitaria, Chile.

Palma, J.G., 2011. Homogeneous middles vs . heterogeneous tails, and the end of the 'Inverted U": it's all about the share of the rich. Dev. Change 42 (1), 87–153.

Paraje, G., 2001. Inequality, Welfare and Polarisation in the Great Buenos Aires, 1986-1999. LACEA, Buenos Aires, Argentina. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi/10.1.1.373.771&rep/rep1&type/pdf.

Pickett, K.E., Wilkinson, R.G., 2015. Income inequality and health: a causal review. Soc. Sci. Med. (128), 316–326.

Ponce, Z.M.G., 2013. Pobreza y bienestar: una mirada desde el desarrollo. Cuad. CENDES 30 (83), 1–21. Retrieved from: http://www.scielo.org.ve/pdf/cdc/v30n83/art02.pdf.

Population and Housing Census, 2010. Population and Housing Census. Retrieved from: http://www3.inegi.org.mx/rnm/index.php/catalog/71/related_materials?idPro/.

Ravallion, M., 1992. *Poverty comparisons: a Guide to Concepts and Methods* (No. *88*). *Washington, DC*. Retrieved from: http://documents.worldbank.org/curated/en/290531468766493135/Poverty-comparisons-a-guide-to-concepts-and-methods.

Ravallion, M., 2001. Growth, inequality and poverty: looking beyond averages. World Dev. 29 (11), 1803–1815.

Reyes, M., Teruel, G., López, M., 2017. Measuring true income inequality in Mexico. Latin Am. Pol. 8 (1), 127–148.

Rhodes, F., 2016. Women and the 1%. How extreme economic inequality and gender inequality must be tackled together. Oxfam Int. (April), 1–33. Retrieved from: https://www-cdn.oxfam.org/s3fs-public/file_attachments/bp-women-and-the-one-percent-110416-en_0.pdf.

Sands, M.L., 2017. Exposure to inequality affects support for redistribution. Proc. Natl. Acad. Sci. U.S.A. 114 (4), 663–668.

Sastré, G.M.L., Rey, S.J., 2008. Polarización espacial y dinámicas de la desigualdad interregional en México. Problemas Del Desarrollo 39 (155), 181–204. Retrieved from: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0301-70362008000400009.

Schröder, M., 2015. A Tale of Two Tails – the Palma Measure of Income Inequality. LACEA, Anual Meeting.

Scott, J., Bloom, E., 1997. Criterios de asignación para la superación de la pobreza en México. Economía Mexicana-Nueva Epoca 4 (1), 83–159. Retrieved from: http://www.economiamexicana.cide.edu/num_anteriores/VI-1/03_SCOTT_(83-159).pdf.

Sen, A., 1973. On Economic Inequality. Oxford University Press, New York, United States.

Shoham, A., Lee, S.M., 2018. The causal impact of grammatical gender marking on gender wage inequality and country income inequality. Bus. Soc. 57 (6), 1216–1251.

Stiglitz, J.E., 2016. Inequality and economic growth. In: Jacobs, M., Mazzucato, M. (Eds.), Rethinking Capitalism: Economics and Policy for Sustainable and Inclusive Growth. Wiley-Blackwell, pp. 135–155.

Stock, J.H., Watson, M.W., 2015. Introduction to Econometrics, third ed. Pearson.

Székely, M., 2005. Pobreza y desigualdad en México entre 1950 y 2004. El Trimest. Econ. 472 (288), 913–931.

Székely, P.M., López, C.L.F., Meléndez, M.A., Rascón, R.E.G., Rodríguez, C.L., 2007. Poniendo a la pobreza de ingresos y a la desigualdad en el mapa de México. Economía Mexicana. Nueva Epoca XVI (2), 239–303. Retrieved from: http://ideas.repec.org/p/ega/docume/200505.html.

United Nations, 2017. Sustainable Development Goals. 17 Goals to Transform Our World. United Nations,[Online]. Available: https://www.un.org/sustainabledevelopment/energy/. (Accessed 4 June 2018).

Villar, A., 2015. Crisis, households' expenditure and family structure: the Palma ratio of the Spanish economy (2007-2014) (22 No. 15). Madrid, Spain. Retrieved from: https://www.bbva.com/wp-content/uploads/2015/08/the-palma-ratio-of-the-spanish-economy-wp.pdf.

World Bank Group, 2016. Poverty and Shared prosperity 2016: Taking on Inequality. Washington, DC.

Zmerli, S., Castillo, J.C., 2015. Income inequality, distributive fairness and political trust in Latin America. Soc. Sci. Res. 52, 179–192.