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Remittances and Poverty: new macroeconomic evidence at the state level in Mexico

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Abstract

The paper estimates the impact of regional remittances on poverty in Mexico, considering direct and indirect effects. We used a spatial panel Durbin specification to estimate potential spatial effects of remittances on poverty. The results showed that the coefficients of the total and direct effects were negative, implying that remittances reduce moderate and extreme poverty across Mexican states. The results indicated that spatial spillovers from economic interactions between states would only contribute to reducing extreme poverty but not moderate poverty. Per capita gross disposable income had direct and indirect effects on the reduction of moderate and extreme poverty at the state level.

Key words: spatial durbin models with time-period fixed effects and random effects, spatial panel durbin model with random time-period effects, remittances, poverty.
JEL classification: C23, C33, F23, J61.

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Resumen

Remesas y pobreza: nueva evidencia macroeconómica a nivel estatal en México

El trabajo estima el impacto de las remesas regionales sobre la pobreza en México, considerando los efectos directos e indirectos. Se utiliza un panel espacial para estimar los posibles efectos de las remesas sobre la pobreza. Los resultados mostraron que los coeficientes de los efectos totales y directos fueron negativos, lo que implica que las remesas reducen la pobreza moderada y extrema. Además, los derrames espaciales de las interacciones económicas entre estados reducen la pobreza extrema. Finalmente, la renta bruta disponible per cápita tuvo efectos directos e indirectos en la reducción de la pobreza moderada y extrema.

Palabras clave: modelos espaciales de durbin con efectos fijos de período de tiempo y efectos aleatorios, modelo de panel espacial de durbin con efectos aleatorios de período de tiempo, remesas, pobreza.
Clasificación JEL: C23, C33, F23, J61.

Introduction

One of the main objectives of economic development policy is the reduction of poverty. Generally, foreign aid or assistance directly or indirectly, through multilateral institutions or private voluntary organizations, is aimed at improving the social and economic conditions and alleviating poverty. However, foreign aid has had a limited impact on the reduction of poverty in developing countries, given the relatively limited flows of financial resources Azam, Haseeb and Samsudin (2016). In the last two decades, remittances have become an increasing source of financial resources for the households of migrants in the country of origin and have become an important source of foreign exchange. The remittances that Mexican workers send to Mexico have increased at a very rapid rate in the last 20 years. The potential effect of remittances on economic development and poverty reduction has encouraged a significant amount of research aimed at estimating the economic effect of those financial flows on receiving countries.

The potential effect of remittances on poverty is based on their impact on the households receiving them. Remittances can support consump-

tion by reducing household poverty or boost investment and modify capital constraints that impede economic development. However, there are different research results on the impact of remittances on structural poverty (Cattaneo, 2005).

Several authors have indicated that remittances have the potential effect of reducing poverty in the receiving countries, by means of increasing income, investments, and health (Gaaliche and Zayati, 2014), (Semyonov and Gorodzeisky, 2008) and (Quisumbing and McNiven, 2010). Also, remittances could provide financial resources for schooling and therefore could promote the development of human capital (Adams, 2011).

Regarding the empirical evidence between remittances and the reduction of poverty, Adams and Page (2005) wrote a seminal paper that studied the impact of remittance on poverty in developing economies, using a data set on international migration, remittances, inequality, and poverty from 71 developing countries. They estimated a cross-section econometric model with instruments for possible endogeneity. The results indicated that a 10% increase in per capita remittances will reduce the population in poverty by 3.5%.

For the Latin American economies, Acosta *et al.* (2008) used a large cross-country panel model. Their findings indicated that remittances have increased economic growth and have a small but positive effect on reducing poverty and inequality. They indicated that poverty reduction is related to higher income levels in the receiving remittances countries. Additionally, they showed that the effects of remittances are different among the Latin American countries, depending on their economic development.

Despite the overwhelming importance of migration to both Mexico and the United States, relatively little is known about the impact of remittances on poverty in Mexico. There is, however, a significant body of literature on the impact of remittances on poverty in other sending countries.

In the Mexican case, Canales (2006) proposed that remittances have a limited role in reducing poverty because they are only representing a complementary wage fund for the households receiving those resources. He mentioned that the multiplying effect of remittances is not significantly different from other components of the household income. Finally, he pointed out that remittances are not used for investment

projects, and that fact limits their importance for reducing poverty and encouraging economic development.

Esquivel and Huerta (2007) carried out an analysis of the effect of remittances on households in Mexico. They used measures of food poverty, skills poverty and patrimonial poverty and applied the propensity score matching methodology to households who receive remittances and to similar households that do not receive remittances. The results indicated that households receiving remittances have a reduced probability of experiencing food and skills poverty; however it did not show an effect on the reduction of patrimonial poverty.

Some research has shown that remittances can be a factor in countering income volatility in financially restricted households (Amuedo-Dorantes and Pozo, 2011). In particular, their quantitative results were stronger for households that consume their entire income or in female-headed households or households in rural areas which experience greater volatility. As a result, remittances are a factor that could prevent households with higher income volatility from falling into poverty levels.

Shroff (2009) investigated the effect of remittances on Mexican poverty by estimating the marginal impact of remittances using the Foster-Greer-Thorbecke measures of poverty. The author used data from transfer programs and remittances destined for the population in poverty from the National Income and Spending Survey (ENIGH).

The results revealed that internal remittances (transfers) have a greater impact on poverty than external remittances. Nevertheless, for the families receiving both internal and external remittances, the impact of external remittances is higher.

With regards to the effect of remittances on rural poverty, Adams *et al.* (2008) studied the case of Mexico using the Mexico National Rural Household Survey (ENHRUM) for the year 2003. They estimated the effect of the share of remittances in total income on income inequality. In addition, they used the Foster-Greer-Thorbecke (1984) poverty index to estimate the effect of remittances on poverty. Their findings indicate that migrants' remittances reduce inequality, although the effect differs across regions. In addition, the results showed that international remittances alleviate rural poverty.

Therefore, studies have shown that remittances can have a direct impact on poverty reduction by increasing income and consumption

in receiving countries. However, it should be noted that the regional analysis of remittances has not been widely discussed. Particularly, the possible indirect effects of remittances that may arise between contiguous regions. The objective of this paper is to estimate the regional effects of remittances on poverty, considering the direct and possible indirect effects. A spatial panel model is estimated to obtain the possible positive spillover effect of remittances at the state level in Mexico. In particular, we propose a spatial panel Durbin specification in order to estimate the potential spatial effects of remittances on poverty. We consider that regional effects could account for spatial spillover effects that could reflect how variations in neighboring states' poverty can affect the specific state's poverty. Therefore, we propose including geographical proximity as a part of the explanatory economic process of the effect of remittances on poverty.

The paper is structured as follows: the second section discusses the theoretical explanations of the impact of remittances on poverty; the third section describes the evolution of remittances, poverty, and inequality in Mexico at the state-level; in the fourth section, the methodologies used for estimating the effects of remittances on poverty are presented; section five includes the model specification and the estimations; the conclusions are discussed in the final section.

1. Theoretical Perspectives

The relationship between remittances, economic development and poverty arises from the theoretical approach that relates the migrant to his family in the country of origin. According to Johnson and Whitelaw (1974) this relationship between emigrants and their place of origin is related to the link between the migrant's utility and that of his family, who through altruism become dependent on each other, generating a transfer of income through remittances. Additionally, Lucas and Stark (1985) and Le *et al.* (2011) have pointed out that the relationship between migrants and their home of origin can be business, in which resource transfers are used for investment in the place of origin.

The new economics of labor migration developed among others by Taylor, E. J. (1999) indicates that remittances have a positive effect on the receiving households, since they help in gaining access to credit and financial resources. They also have indirect effects on the migrant-

sending country, due to market linkages that transmit the impact of remittances to other nonmigrant households in that country, therefore increasing income and reducing poverty. However, there are limits on the effects of remittances determined by the unequal regional distribution of remittances, the lack of infrastructure and the incomplete financial markets of the receiving countries.

From the Neoclassical theoretical perspective, Stark (1980) noted that remittances are used by households as a source of financial resources to improve their well-being, through productive activities and investment. He also suggested that low-income households received more remittances as they send more migrants, which seems to support the view that remittances do not significantly increase the income levels of poorer household segments.

The economics of remittances considers that the determinants of remittances depend on several factors. One perspective assumes that migrants with higher earnings will send more remittances and the lower the income of the migrant's family, the greater the number of remittances. It has also been considered that there is the possibility that migrants with the intention to return could buy assets in the country of origin, and the possibility of reducing transaction costs by spending in the country of origin. Moral Hazard and insurance related to income volatility in the agricultural activities and loans and investment objectives also encourage the flow of remittances, since the increase the income of families tend to reduce uncertainty (Rapoport and Docquier, 2005).

In another paper, Rapoport and Docquier (2006) stressed the importance of the macroeconomic effects of remittances in the receiving countries. Among the impacts (consumption, investment and employment) they identified the temporary reduction of poverty as a factor affected by remittances. The degree of the impact of remittances is related to the number of remittances, the segments of the income distribution of the receiving households, and to whether the financial resources are used for investment or consumption.

In the short term, the effect of remittances is related to consumption, investment and the size of the GDP (Glytsos, 2002a). An interesting aspect of the impact of remittances has to do with various indirect effects that contribute to the income multiplier. One indirect effect is that remittances could finance part of the trade deficit generated by

imports, although in the long run it can affect the diversification of the productive structure; in the short run, it could allow the implementation of development policies. Another impact of remittances would be the expenditure on education, which could create an "educational infrastructure" that could generate an indirect multiplier.

It has been argued that remittances are income transfers that have a moderate effect on economic growth. However, the economic and social conditions required to promote growth are influenced by the impact of remittances on poverty, income distribution and consumption. Changes in saving and consumption patterns alongside changes in social and demographic behavior, such as women's independence or the reduction of the fertility rate, could have a positive outcome for economic growth.

It must be pointed out that the magnitude of or direction of those effects cannot be stated a priori, and will depend on the size of remittances, schooling, income distribution and assets of the households for each country (Glytsos, 2002b).

Therefore, from a theoretical point of view, the literature has indicated that remittances have a positive impact on poverty reduction by increasing the income of households and, indirectly, by increasing consumption, investment, and employment. This allows the possibility of poverty alleviation. However, the alleviation of poverty might be temporary and limited since remittances are an income that depends on the conditions of the countries that receive these resources, and on the external factors related to the economies of the countries receiving migrants.

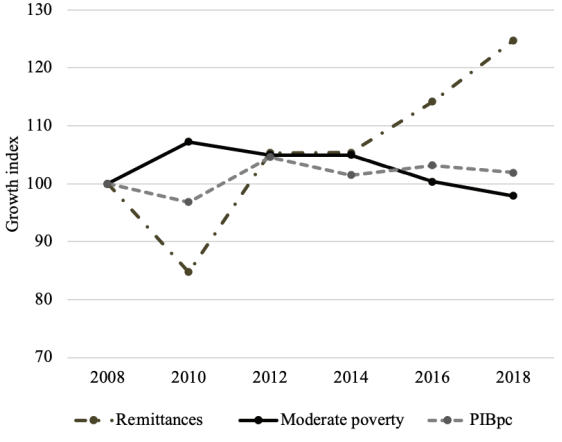
2. Poverty and remittances trends in Mexico at the regional level

At the regional level, the analysis of remittances behavior and poverty indicators in Mexico show differentiated behavior, depending on the concept of moderate or extreme poverty.[1] The remittance growth rates

[1] Extreme poverty: A person is in extreme poverty when he or she has three or more deficiencies of six possible deficiencies, within the Social Deprivation Index, and is also below the minimum welfare line. People in this situation have such a low income that, even if they were fully engaged in food procurement, they would not be able to acquire the nutrients needed to have a healthy life. Moderate poverty: It is that person who, being poor, is not extremely poor. The incidence of moderate poverty is achieved by calculating the difference between the incidence of the population in poverty minus that of the population in extreme poverty. National Council for the Evaluation of Social Development Policy. https://www.coneval.org.mx/Medicion/Paginas/Glosario.aspx.

and GDP per capita estimates were compared with the estimates of moderate and extreme poverty for the 2008-2018 period. The relationship between remittances and moderate poverty shows an inverse correlation in two periods, suggesting a direct effect of remittances in poverty alleviation. The first period from 2008 to 2010 shows a reduction in the number of remittances received by Mexico while a moderate poverty increase is experienced. In the second, between 2012 and 2014, there was a slowing down in remittances growth and moderate poverty. Finally, between 2014 and 2018, remittance growth soared, while a reduction in the population living in moderate poverty situation was observed. It should be noted that GDP per capita showed a negative relationship with the increase in a moderate poverty between 2008 and 2014. However, a stable correlation without significant effects of the GDP per capita and moderate poverty is exhibited (Figure 1).

Figure 1
Mexico: Remittances and moderate poverty trends, 2008-2018

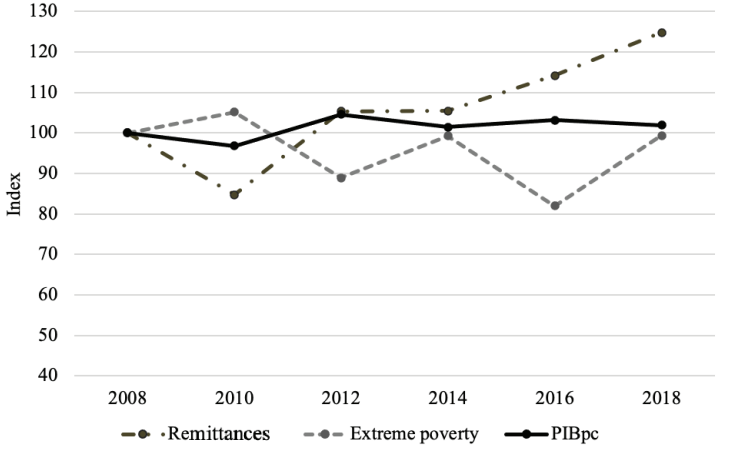


Source: own elaboration with data from Bank of Mexico (BANXICO) statistics and the National Council of the Social Development Policy Evaluation (Coneval).

The effect of remittances on extreme poverty shows a negative correlation for the period. That is, when there is a greater increase in remittances to Mexico, there is a reduction in extreme poverty. However, in the period from 2014 to 2016 remittances are observed to be rapidly growing while extreme poverty remains at the same level.

This could be related to the stagnation of the GDP per capita in that subperiod, which affected the levels of employment and labor income. Thus, statistical evidence indicates that remittances at poverty levels in Mexico have shown a negative effect at the national level for both moderate poverty and extreme poverty, contributing to poverty alleviation. However, there are subperiods where a positive correlation is not maintained because of factors related to the situation of the country's economic activity (Figure 2).

Figure 2
MEXICO: REMITTANCES AND EXTREME POVERTY, 2008-2018



Source: own elaboration with data from Bank of Mexico (BANXICO) statistics, the National Council of the Social Development Policy Evaluation (Coneval) and The National Institute of Statistics and Geography.

The analysis of the relationship of remittances to moderate and extreme poverty at the regional level in Mexico shows that, of the eleven states that received a higher percentage of remittances compared to total remittances, seven exhibited lower moderate poverty than average for those states. The only exceptions were the state of Mexico, Puebla, Mexico City and Veracruz, probably due to the comparatively higher population (Table 1). In addition, some neighboring states showed a similar relationship between remittances and moderate poverty. Such is the case of Michoacán and Jalisco and Oaxaca and Guerrero. It is therefore considered important to investigate whether there is a regional process that is impacting the relationship between remittances and poverty.

Regarding the relationship between remittances and extreme poverty, a pattern like remittances and moderate poverty is observed. However, an important feature is that the percentage of extreme poverty is relatively lower than that exhibited by the average extreme poverty except for the states of Veracruz, Guerrero and Oaxaca (Table 1). These states showed higher levels of extreme poverty than those of moderate poverty, suggesting that remittances are more important to alleviate moderate poverty than extreme poverty. For this reason, it is important to analyze whether there are indirect effects of remittances on poverty that go beyond the direct effect derived from the quantity of remittances received by households in extreme poverty conditions.

Table 1
Main states receptors of remittances and poverty in Mexico, 2018 (shares of total remittances and poverty)

States	Remittances	Moderate poverty	Extreme poverty
Mich	10.1%	4.4%	3.1%
Jal	9.8%	4.9%	2.6%
Guan	9.1%	5.4%	2.7%
Mex	5.7%	15.5%	9.3%
Oax	5.2%	4.1%	10.2%
Pue	5.1%	7.4%	5.9%
Gue	4.8%	3.3%	10.4%
CdM	4.3%	5.9%	1.6%
Ver	4.1%	8.4%	15.7%
SLP	3.7%	2.4%	2.2%
Zac	3.3%	1.6%	0.6%
Average	5.9%	5.8%	5.9%

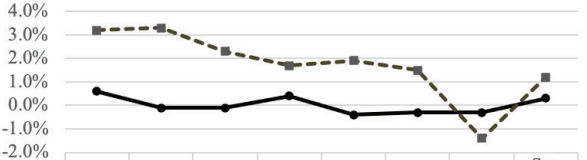
Source: own elaboration with data from Bank of Mexico (BANXICO) statistics and the National Council of the Social Development Policy Evaluation (Coneval).

Another important factor that could be affecting poverty levels in Mexico is related to levels of inequality. Several empirical studies have investigated the relationship between the degree of inequality and the levels of poverty. According to Ravallion (2001), the share of income does not necessarily increase with economic growth. Therefore, income inequality tends to increase in periods of economic growth and could negatively affect poverty, making it necessary to implement redistributive policies. Jamal, H. (2006) indicated that income inequality has an indirect effect on poverty. Fosu (2010) studied a panel of the major

regions of the world for the period 1980-2004. The findings indicate that inequality has a double impact on poverty. On the one hand, the direct effect of higher levels of unemployment is to diminish the capacity of income growth to reduce poverty. On the other hand, the increase in income inequality could create an indirect effect of raising the level of poverty.

For the case of Mexico, income inequality measured by the Gini coefficient, shows that for five of the ten Mexican states with a higher Gini coefficient, both inequality and poverty average displayed a similar trend (Figure 3). For the period 2008-2018 the average rates of growth of the Gini coefficient and moderate poverty estimates showed the same sign for Oaxaca, Guerrero, Aguascalientes, Nuevo Leon and San Luis Potosi. However, other states showed the opposite sign indicating an inverse movement of inequality and poverty. The results exhibited a heterogeneous relationship between poverty and the Gini coefficient of the Mexican states. Consequently, it is important to understand if such behavior is related to spatial effects of neighboring states that are creating indirect effects of the two variables, affecting the association between poverty and income inequality.

Figure 3
Selected Mexican states average rates of growth of the Gini coefficient and moderate poverty, 2008-2018



	Oaxaca	Chiapas	Campeche	Guerrero	Tabasco	Zacatecas	Nuevo Leon	San Luis Potosi
Gini	0.6%	-0.1%	-0.1%	0.4%	-0.4%	-0.3%	-0.3%	0.3%
Moderate poverty	3.2%	3.3%	2.3%	1.7%	1.9%	1.5%	-1.4%	1.2%

Source: CONEVAL estimates based on the ENIGH 2008-2018.

3. Remittances and poverty: methodological aspects

To estimate the effects of remittances on poverty various methodological strategies have been used. On the one hand, several papers

have focused on the macroeconomic approach to study the effect of remittances on poverty. In general, macroeconomic databases are employed to estimate the relationship between remittances and poverty. Adams and Page (2005) used ordinary least squares estimates including dummy variables to control for fixed effects, which could be related to the different geographic regions of the countries studied in their empirical model. They also applied a logarithmic transformation to all the variables to obtain the elasticities of poverty with respect to the explanatory variables.

Another approach to the study of the effect of remittances on poverty and inequality is to make use of Household Surveys in the countries that receive remittances in order to estimate applied micro-econometric models. According to Adams (2011), close to fifty papers on remittances in developing countries have used household survey data. Since throughout households in the world receive an important share of income from remittances, this methodology has been increasingly used by an important number of research papers. Some examples of the micro-econometric approach are the following papers: Gubert (2002), who indicated that 60% of households in rural Mali receive remittances from migrants; the methodology that he used was based on a Tobit censored estimator. Additionally, Adams, Cuecuecha and Page (2008) considered a household survey at the national level, to study the effect of internal and international remittances from Ghana. They applied a two-stage multinomial logit model with instrumental variables.

In addition, several papers have used longitudinal panel surveys. Wagle, U. R. and Devkota (2018) used household survey for the years 1996, 2004 and 2011 to establish a balanced panel to study the impact of remittances on poverty in Nepal. The results showed a significant effect of remittances on reducing the levels of poverty. The methodology applied to panel data has included long term panel models to estimate the effects of remittances on poverty reduction. Akobeng (2016) used data from forty-one Sub-Saharan countries to study the effectiveness of remittances in the reduction of poverty. He used a Generalized Method of Moments estimation which included a lagged dependent variable and explanatory variables. The author found that remittances reduce poverty; however, the magnitude of the effect of remittances is determined by the different measurements of poverty. Azam, Haseeb and Samsudin (2016) examined the impact of remittances, foreign aid,

debt, human capital and income on poverty for thirty-nine low, middle- and high-income countries. The authors applied a Fully Modified Least Squares (FMOLS), and their results revealed that remittances had a positive impact on poverty alleviation, but only for middle income countries. Finally, it has been indicated that the effect of remittances on poverty should include the GDP per capita and the Gini coefficient as variables in the empirical models. This is to avoid underestimating the effect of remittances when it derives from the impact of remittances on income and income inequality (Le Goff, 2010).

Most of the findings of the empirical work show a positive impact of remittances on poverty reduction. However, in our review we did not find evidence of studies on the indirect effects of remittances at the regional level. We propose to investigate whether inflows of remittances influence poverty rates across Mexican states by means of a panel model which provides us with more data variability, reduction in the risk of collinearity among the explanatory variables, and importantly, because it also augments the number of degrees of freedom, therefore favors increased efficiency in estimation (Elhorst, 2010). In particular, our model proposal follows a spatial panel Durbin specification which includes the possibility of observing significant spatial interaction both along the dependent and explanatory variables, as it is expressed in the following relationship:

$$gpov_{it}=\rho W*gpov_{it}+\theta_1\, grem_{it}+\theta_2\, gpgdp_{it}+\theta_3\, gineq_{it}+ \theta_4\, W*grem_{it}+\theta_5\, W*gpgdp_{it}+\theta_6\, W*gineq_{it}+\varepsilon \quad (1)$$

In this latter expression all the variables are expressed in growth rates, and thus proposes that the observed changes in the flow of remittances received at the state *i* (grem) may determine the observed changes in that same state's poverty rate (gpov). According to the literature, it may be the case the inflows of remittances may help alleviate poverty among those people receiving them as it turns to represent extra monetary income, and therefore a negative relationship between poverty rates and remittances' changes across time should be expected. In addition, we have also included state per capita gross disposable income (gpgdp) as a measure that helps account for differences across each state economy's capability of accessing goods and services. In this regard, it should be expected that those states displaying a higher capacity to acquire their

required goods and services would also reflect relative higher economic welfare, and therefore, it may help reduce poverty rates. Notwithstanding, because income inequality may coexist with high-income averages in a manner that only a few may sufficiently accede to their required goods and services, then, a more income-inequal situation in a state economy may also lead to higher poverty rates. This latter possibility led us to include income inequality (ineq) across states as part of the explanatory economic mechanism in our baseline empirical model.

In relation to this, the proposed spatial Durbin specification is intended to account for two aspects that emerge in presence of potential spatial effects. The first is a technical aspect which relates to the omitted variable bias that arises, in this case, when a non-spatial model is estimated instead of a spatial one disregarding the more adequate specification points to the presence of spatial interaction effects. In this respect, according to Anselin (1988), ignoring the presence of spatial interaction effects when they actually are part of the true data generating process leads to inconsistent estimated coefficients. The second aspect relates to the economic implications of spatial effects as their presence would be suggestive of geographical spillovers being part of the explanatory economic mechanism. In this respect, in our model, the presence of spatial spillovers effects would indicate that changes in neighboring states' poverty rates may endogenously explain observed changes in a specific state's poverty rate, and therefore implying geographical proximity would play a relevant role in understanding what determines poverty rates' variations across states.

Moreover, in our empirical baseline model, exogenous spatial spillovers potentially affecting poverty rates across states may also emerge as resulting from cross-border inflows of remittances between states featuring a two-way mechanism. In specific, significant spatial spillovers from inflows of remittances due to interpersonal networks, as those existing between relatives and/or informal financial networks across geographically proximate states, may prove to be helpful in reducing states' poverty rates because a part of the incoming remittances in a specific state would thereafter flow towards its neighboring states. Notwithstanding, it is because those same neighboring states benefitting from the reception of cross-border inflows of remittances may simultaneously be sending remittances out, that, potentially alleviating

effects on poverty rates might be offset, and thus making it unclear what the net spatial spillover effect should be expected.

The presence of these kind of exogenous spatial spillovers is included in our baseline model specification through the spatially lagged explanatory variable *W*grem*. Additionally, economic externalities that cross the geographical boundaries may emerge due to a strong economic interaction between states' firms and consumers. In this case, poverty rates in a specific state may be influenced by its geographically proximate states' capacity to acquire their required goods and services, which, in our empirical model, is represented by the variable *W*gpgdp*.

The variables of the empirical model were obtained from the following sources: The indicators measuring the behavior of two poverty categories, extreme poverty (extpov) and moderate poverty (modpov), were obtained from the National Council of Social Development Policy Evaluation (CONEVAL), and transformed to growth rates; the pgdp indicator was estimated with information from the National Account System published by the National Institute of Statistics and Geography (INEGI) and from The Mexican Population Projections, 2013-2050 from the National Council of Population (CONAPO). Additionally, we measured income inequality across states by means of two inequality indicators, the ratio between the 10th and 1st deciles, and the Gini coefficients, which statistical data were acquired from the Households Income and Expenditures National Survey of income (ENIGH); the Bank of Mexico provided the data for remittances.

In order to determine if the series included in the database cointegrate over time, the cointegration estimation methodology was used for a panel database. It has been shown that pooled time series data can also show a time trend and therefore may not be stationary. As a result, ordinary least squares estimates have the potential to be spurious. To avoid mis-specification errors, several authors have developed unit root tests of various series for panel data structures. The tests are divided into two types. Breitung (2001) Levin, Lin and Chia-Shang (2002) and Im, Pesaran and Shin (2003) use Augmented Dickey Fuller (ADF) tests, while Maddala and Wu (1999), Choi (2001) and Hadri (2000) use Phillip-Perron (PP) tests.

Additionally, to determine the existence of a long-term equilibrium between the variables included in the model, a panel cointegration test was estimated according to the methodology developed by Pedroni

(1999), which extended the Engle and Granger tests to include panel data. The test analyzes whether the residuals of the variables are cointegrated I (0) or not I (1). The difference is that, in the case of panel statistics, the first-order autoregressive term is assumed to be the same for all cross sections. On the other hand, each intercept is heterogeneous and the trend coefficients can vary in the cross sections.

The panel unit root tests consider the asymptotic behavior of the time series T and the cross-sectional dimension N. The Levin-Lin-Chu (LLC) test assumes the common unit root process and that the lag p varies between individuals. The null hypothesis considers that each time series contains a unit root and the alternative hypothesis is that each time series is stationary. For the LLC test, all the series were estimated, both in levels and in first differences. The null hypothesis of the existence of a unit root at a 1% confidence level was rejected for the variables: remittances, gross domestic product per capita, the proportion of the population living in moderate and extreme poverty with respect to the total population, and the Gini coefficient. To corroborate the unit root test estimates, additional tests were carried out (Table 2).

Table 2
Test panel unit root

Variable	Levin, Lin y Chu	Hadri	ADF-Fisher (ADF)	PP-Fisher
DREM	-3.48*	10.76*	81.22*	81.00*
DGINI	-9.41*	9.98*	137.97*	137.64*
DGDPpc	-12.79*	12.61*	192.06*	192.37*
DEXTPOV	-13.15*	4.20*	207.07*	213.79*
DMDPOV	-19.51*	10.06*	231.294*	227.73*

Source: own elaboration. D = first difference, Gini = Gini coefficient, GDPpc = Gross Domestic Product per capita, PobPop = proportion of the population living in poverty with respect to the total population, EDmsup = population with upper secondary education, I-IX = gap between the first and ninth income deciles, XPIB = Total exports as a proportion of GDP, IBFPIB = Gross fixed investment as a proportion of GDP.
*indicates rejection of the null hypothesis of common unit root process of Levin, Lin and Chu (LLC) and the null hypothesis of individual unit root process of Hadri, ADF and PP-Fisher, with a statistical significance of 1%. Total observations: 160.

To determine if there are cointegrating relationships in the variables included in the model, four panel statistics and three statistical tests for panel groups were estimated. The null hypothesis of the test assumes that there is no cointegration, versus the alternative of the presence of cointegration. Table 3 presents the tests divided into two sections: panel statistics and group statistics. In the first test, a first-order autoregressive term is assumed to be the same in all cross sections, whereas in

the case of group statistics, the parameter of the term varies in cross sections.

The PP estimates and the panel and group ADF statistics rejected the null hypothesis of no cointegration of the model variables. Thus, the Pedroni (1999) cointegration test rejected that the residuals of the series are integrated of order I (1), which suggests the existence of cointegration of the panel. Furthermore, the Kao test, following the basic Pedroni approach but with homogeneous coefficients, also presented evidence of the panel cointegration of the model series.

It should be noted that although the statistical tests could support the long-term analysis of the variables in levels, and suggest structural trends of the variables considered, we consider that the number of temporal data points of the time series used is not very representative of this type of study. In addition, it is considered that the analysis of spatial spillovers may be important to explain the effect of remittances on poverty at the regional level.

Table 3
COINTEGRATION TEST

Panel statistics				
			Weighted	
	Statistic	Prob.	Statistic	Prob.
rho-statistic	1.07	0.04	2.18	0.01
PP-statistic	-4.97	0	-7.65	0
ADF-statistic	-3.12	0.0009	-5.27	0
Group statistics				
rho-statistic	3.24	0.99		
PP-statistic	-10.96	0		
ADF-statistic	-6.32	0		
Kao residual cointegration test (Pedroni)				
	Statistic	Prob.		
ADF	-8.73	0		

Source: Own elaboration. Pedroni and Kao: Null: No cointegration. Alt: cointegration.

4. Model specification and estimation

Before estimation, we implement a two-step specification procedure to verify whether the empirical spatial Durbin model proposed in expression (1) accurately represents the spatial data generating process. Specifically, our model specification strategy relies on the procedure proposed by Elhorst (2014), who suggests implementing both a

specific-to-general specification test and a general-to-specific specification test. The former procedure requires, first, estimation of non-spatial versions of panel models, and then, implementation of spatial LM test is required to check for the presence of spatial interaction effects. The second procedure starts from the direct estimation of a spatial Durbin model specification, and then tests whether it collapses to some form of spatial interaction such as a spatial autoregressive process (SAR) or a spatial error model specification (SEM).

Table 4 displays the estimation results of four types of non-spatial models for our two measures of poverty across states as well as their associated spatial LM specification tests, both in their classical and robust versions, as indicated by the specific-to-general spatial specification procedure. Regarding the moderate poverty model (gmodp), it is worth noting the classical spatial LM tests strongly rejects the null of no spatial autoregressive (SAR) process in all the four types of non-spatial models, while the contrary seems to occur when observing the spatial robust LM tests results, all of which lead us to an inconclusive situation regarding the presence of SAR process. Moreover, similar tests results pointing to an inconclusive situation are obtained for the spatial error model specification tests. However, likelihood ratio tests for the joint significance of fixed effects, in the bottom of Table 2, clearly suggest the insignificance of spatial fixed effects (SFE) with probability 0.40, while it strongly rejects the null of no time-period fixed effects (TFE).

These tests results help us discard the pooled model as well as the two-way model (STFE) which considers both spatial and time-period fixed effects, as our data generating process model candidates, and let us with the time-period fixed effects models are more adequate. This specification with time-period fixed effects can also be corroborated based on the log likelihood statistic, and both the Akaike (AIC) and Bayesian (BIC) information criterion, which are among the smallest values. The R-squared statistic, of magnitude 0.28, shows the time-period fixed effects model also provides us with a better adjustment to the data relative to the other estimated models.

Moreover, the classical and robust spatial LM tests strongly suggest nonrejection of the null of no spatial autoregressive (SAR) and spatial error (SEM) process in all the four types of non-spatial extreme poverty models (gextpov). In addition, as occurred with the moderate poverty model, performed likelihood ratio tests for the joint significance of fixed

effects suggest the time-period fixed effects models are more adequate specifications than the pooled or two-way alternatives, as corroborated by the AIC, BIC, and the log likelihood statistics (Table 2).

Table 4
Estimation of poverty and remittances non spatial panel models

Dependent variable:	gmodpov				gextpov			
Explanatory variables	Pooled	SFE	TFE	STFE	Pooled	SFE	TFE	STFE
grem	-0.11	-0.21	-0.04	-0.03	-0.23	-0.27	-0.11	-0.09
t-statistic	-2.85	-4.81	-0.8	-0.48	-2.34	-2.19	-0.76	-0.59
gpgdp	-0.18	0.02	-0.51	-0.71	0.02	0.15	-0.59	-0.42
t-statistic	-2.96	0.34	-3.23	-3.59	0.10	0.52	-1.44	-0.84
gineq	-0.06	-0.02	0.09	0.02	-0.15	-0.12	0.17	0.22
t-statistic	-0.41	-0.17	0.71	0.14	-2.34	-1.73	1.82	2.43
Log L	-599.69	-583.02	-574.43	-565.7368	-738.9225	-728.5977	-727.2501	-714.5008
AIC	1.21E+03	1.24E+03	1.17E+03	1.21E+03	1.49E+03	1.53E+03	1.47E+03	1.51E+03
BIC	1.22E+03	1.35E+03	1.19E+03	1.34E+03	1.50E+03	1.64E+03	1.50E+03	1.64E+03
R2	0.02	0.20	0.28	-	0.11	0.11	0.03	0.03
Specific-to-general spatial specification tests								
LM no spatial lag	38.97	27.33	10.16	10.34	2.00	2.07	0.34	1.08
Prob.	0.00	0.00	0.00	0.00	0.16	0.15	0.56	0.3
Robust test no spatial lag	0.10	1.82	2.02	3.13	3.63	3.35	2.16	2.71
Prob.	0.75	0.18	0.16	0.08	0.06	0.07	0.14	0.10
LM no spatial error	40.84	25.53	8.70	8.42	1.20	1.31	0.64	1.66
Prob.	0.00	0.00	0.00	0.00	0.27	0.25	0.42	0.20
Robust test no spatial error	1.97	0.02	0.57	1.21	2.83	2.60	2.46	3.29
Prob.	0.16	0.89	0.45	0.27	0.09	0.11	0.12	0.07
Fixed effects specification tests								
LR-test joint significance of SFE	33.34				20.65			
Prob.	0.40				0.94			
LR-test joint significance of TFE	50.52				23.34			
Prob.	0.00				0.00			

Source: The authors' own estimations. Note: SFE, TFE, and STFE, represent the spatial fixed effects model, the time fixed effects model, and the two-way model, respectively.

Up to this point of the model specification procedure, the results of specific-to-general tests are informative regarding the presence of time-period fixed effects in both types of poverty models, although not so clear with respect to the presence and sort of spatial interaction underlaying the data generating process. This latter feature of the model specification procedure can be further addressed within the general-to-specific specification strategy.

Table 3 displays our spatial Durbin models estimates for both types of poverty, which, in concordance with the previous specification tests, also includes time-period effects. In addition, estimates for random time-period effects (RE) versions of the spatial Durbin models are also provided to determine whether both types of specifications can be considered undistinguishable between them by means of performing Hausman tests. In this regard, Wald tests results indicate, with probabilities of 0.03 and 0.02, rejection of the null of no autoregressive process (SAR) underlying the data generating process in both the time-period fixed effects (TFE) and random time-period effects (RE) models of moderate poverty (gmodpov) and extreme poverty (gextpov), respectively. Moreover, similar specification tests results are achieved when contrasting the null of no spatial error process by means of Wald tests on both the TFE and RE spatial Durbin models of moderate and extreme poverty. These results are also corroborated by means of the LR tests implemented for the presence of time-period fixed effects in both models of poverty; although, the rho parameter is statistically significant only in the moderate poverty model. The insignificance of the Rho parameter estimate in the extreme poverty model conforms with our previous results for the spatial LM tests in Table 4, which altogether with our Wald and LR tests in Table 5, strongly indicates an XLS model is more accurate than a spatial Durbin model to represent the spatial interaction process underlying the extreme poverty variation across states. In the spatial econometric literature, the XLS model is regarded as nested within a spatial Durbin model (Elhorst, 2014) because in absence of endogenous spatial interaction it advocates the presence of exogenous spatial interaction from the explanatory variables.

Regarding whether the time-period fixed effects model or the random effects model are best suited to represent the data generating process, the results from the performed Hausman test suggest non-rejection of the null of no significant differences between them in both

models of poverty, thus favoring the random effects models which renders efficient estimators. Overall, the specification tests results lead us to conclude a spatial Durbin model with random time-period effects and a XLS model with random time-period effects are best suited to accurately represent moderate and poverty growth variations across states, respectively, once spatial interaction effects are considered.

Table 5
Estimation of poverty and remittances spatial Durbin models with time-period fixed effects (TFE) and random effects (RE)

Dependent variable:	gmodpov		gextpov	
Explanatory variables	TFE	RE with time fixed effects	TFE	RE with time fixed effects
grem	-0.16	-0.15	-0.34	-0.34
t-statistic	-2.42	-2.45	-1.95	-1.99
gpgdp	-0.37	-0.37	-0.29	-0.29
t-statistic	-2.38	-2.43	-0.68	-0.69
gineq	-0.03	-0.03	0.15	0.15
t-statistic	-1.00	-1.02	1.67	1.70
Log L	-565.79	-666.98	-722.41	-785.72
R^2	0.12	0.12	0.09	0.09
W*grem	0.23	0.23	0.48	0.48
t-statistic	2.45	2.48	1.86	1.89
W*gpgdp	-0.33	-0.34	-1.59	-1.59
t-statistic	-1.36	-1.40	-2.46	-2.50
W*gineq	0.07	0.07	0.16	0.16
t-statistic	1.06	1.08	0.96	0.98
Rho	0.26	0.26	-0.08	-0.08
t-statistic	2.99	2.90	-0.78	-0.77
Theta	-	0.99	-	0.99
t-statistic	-	7.14	-	7.15
General-to-specific spatial specification tests				
Wald test spatial lag	8.42	8.69	9.41	9.72
Prob.	0.03	0.03	0.02	0.02
Wald test spatial error	8.55	8.85	9.43	9.32
Prob.	0.03	0.03	0.02	0.03
LR test spatial lag	8.48	-	9.02	-
Prob.	0.04	-	0.03	-
LR test spatial error	8.78	-	9.10	-
Prob.	0.03	-	0.03	-
Hausman test statistic	0.68		0.13	
Prob.	0.99		0.99	

Source: The authors' own estimations.

4.1. Empirical evidence

In Table 6 we show the estimated effects of changes occurred on both remittances (grem) and per capita gross disposable income (gpgdp) on moderate poverty growth across Mexican states based on estimations disentangled in direct, indirect, and total effects, which are a set of summary measures proposed by LeSage and Pace (2009), to accurately provide impact estimates in presence of significant spatial interaction. In particular, the estimated total effects of changes in remittances on poverty rates variations across states appear as statistically non-significant; although, this result can be explained by the combination of related direct and indirect effects. In light of this, the estimations show a significant direct effect of changes in remittances, yet negative, on state poverty rates. This result implies that positive variations in the number of remittances received by people located within a specific state would help diminish poverty rates within that same specific state also; specifically, according to our estimations, all other things being equal, an additional 10% increase in the remittances' rate of change would induce a 1.3% decrease in the average poverty growth across Mexican states. However, the estimated summary effects show altogether a statistically significant although positive indirect effect coming from changes in the remittances received by neighboring states. This result, which helps us elucidate spatial interaction matters in explaining states' poverty rates variations, indicate the presence of spatial spillovers across states may counteract the poverty-diminishing direct effects deployed by local or state-specific people receiving remittances. That is, all other things being equal, a 10% rise in the remittances received by neighboring states would lead to a 2.4% average increase in a state-specific poverty rate variation, therefore surpassing our direct effects estimates by 1.1% points.

In addition, our estimations in Table 6 show changes in per capita gross disposable (ggdp) income exert a statistically significant and diminishing total effect on poverty growth variation across states, which imply that improved people's economic capability to access available goods and services would help alleviate state poverty. Accordingly, all things being equal, a 10% rise in states' gross disposable income rate of change would lead to a 9.6% average reduction in states' poverty growth. Moreover, our estimations also show this total effect seems to be mutually reinforced by both the presence of significant direct and

indirect effects. In this respect, the estimated direct effect accounts for 43% of the total effect, therefore indicating that improvement gains in the internal functioning of the state economies, in terms of enhancing people's income to acquire goods and services, would reduce states' poverty growth. According to our calculations, states' poverty growth would be reduced by 4.2%, in average, in response to a 10% increase in within-state gross disposable income rate of change. While this latter result may not be unexpected, it is worth highlighting our estimations show geographic proximity is important to understand state's poverty growth variation as it seems to trigger significant spatial spillover effects due to strong economic interactions between states. In this regard, our calculations point to neighboring effects representing up to 57% of estimated total effects on poverty growth reduction which are due to pecuniary externalities arising from firms and consumers' interactions between states. Moreover, our estimations attributed income inequality, measured by the ratio of income at the 10th decile over income at the 1st decile, a positive, yet statistically non-significant effect, which means that cross-state variation in income inequality may not affect, in average, poverty growth across states. As a robustness verification test, we additionally substituted the gap between deciles by the Gini coefficient as our income inequality measure for each the 32 states and obtained similar results[2].

Table 6

Estimation of total, direct and indirect effects of remittances on moderate poverty based on a spatial panel Durbin model with random time-period effects

Dependent variable: gmodpov				
Direct effect	Coeficient	t-stat	lower 05	upper 95
grem	-0.13	-2.19	-0.26	-0.02
gpgdp	-0.42	-2.64	-0.73	-0.10
gineq	-0.03	-0.87	-0.10	0.04
Indirect effect	Coeficient	t-stat	lower 05	upper 95
grem	0.24	2.17	0.03	0.46
gpgdp	-0.54	-1.90	-1.12	0.00
gineq	0.08	0.98	-0.08	0.23
Total effect	Coeficient	t-stat	lower 05	upper 95
grem	0.10	0.97	-0.12	0.31
gpgdp	-0.96	-2.94	-1.63	-0.31
gineq	0.05	0.51	-0.13	0.22

Source: The authors' own estimations.

[2] These results are available upon request to the authors.

Table 7 below shows the calculated summary impacts for the extreme poverty model, which indicates that the direct effect of remittances on extreme poverty alleviation across states in Mexico is higher than the effect on moderate poverty by about 2.3 percentage points; that is, a 10% increase in the growth of inflows of remittances would reduce state-specific extreme poverty growth by approximately 3.6%.

Tabla 7
Estimation of total, direct and indirect effects of remittances on extreme poverty based on a XLS model with random time-period effects

Dependent variable: gextpov				
Direct effect	Coeficient	t-stat	lower 05	upper 95
grem	-0.36	-2.07	-0.68	-0.03
ggdppc	-0.22	-0.52	-1.06	0.63
gineq	0.15	1.68	-0.02	0.33
Indirect effect	Coeficient	t-stat	lower 05	upper 95
grem	0.49	1.95	-0.02	0.97
ggdppc	-1.47	-2.29	-2.75	-0.22
gineq	0.14	0.87	-0.17	0.43
Total effect	Coeficient	t-stat	lower 05	upper 95
grem	0.13	0.66	-0.27	0.53
ggdppc	-1.69	-2.68	-2.93	-0.45
gineq	0.29	1.75	-0.05	0.59

Source: The authors' own estimations.

Conversely, our estimations indicate that spatial spillovers due to cross-state inflows of remittances would not provide, on average, either supplementary support for poverty reduction or to increasing poverty. The former case could possibly be attributed to missing opportunities of interregional collaboration. This result would also explain the imperceptible average total effect of remittances on the extreme poverty rate of growth across states. Another important empirical result indicates that spatial spillovers from strong economic interactions between states would significantly contribute to reducing extreme poverty growth, even in the case of insignificant direct effects from within-state per capita disposable income growth. Therefore, these spatial spillovers would also explain most of the ameliorating total effects on extreme poverty growth. Altogether, our results show that extreme poverty alleviation across states in Mexico mostly depend on state-specific inflows of remittances and, notably, on regional economic integration of markets. This latter finding is important because it suggests regional integra-

tion of markets allowing people to find jobs or to sell their products in geographically proximate states, seems to effectively compensate for the limited capacity showed by the state economies to internally provide impoverished inhabitants with sufficient income growth and opportunities to overcome extreme poverty. Additionally, our results suggest income inequality changes may not significantly contribute to extreme poverty growth.

Concluding remarks

Most of the research indicates that remittances can have a direct impact on poverty reduction. The statistical data on remittances and moderate and extreme poverty in Mexico for the period 2008-2018 shows that there is a predominantly negative correlation between the two variables. Nevertheless, there are subperiods where a negative correlation is not observed because of factors related to changes in the country's economic activity.

At the regional level, the states receiving a larger share of remittances experienced a reduction in the level of moderate poverty, with the exception of some states such as Mexico City, the State of Mexico and Puebla, probably because of larger populations, which affect the absolute number of people living in moderate poverty. An important finding is that some neighboring states exhibited the same effect of remittances on poverty, indicating the possibility of regional indirect effects among those states. The relationship between remittances and extreme poverty follows the same pattern as that of remittances and moderate poverty. However, the indicator of extreme poverty is much higher than average in the states of Veracruz, Guerrero y Oaxaca, indicating a less significant effect of remittances on the alleviation of poverty at the regional level.

In order to contribute to the empirical evidence of the positive effect of remittances on poverty reduction from the regional perspective, we estimated a Spatial Durbin model with random time-period effects, which resulted more appropriate for the spatial estimation according to the Hausman, Wald and LR tests. This methodology allowed us to estimate poverty variation and explain the importance of spatial effects resulting from neighboring states.

The results showed the coefficients of the total, the direct and indirect effects of remittances on the reduction of poverty across Mexican states. As expected, the direct effects coefficients showed a statistically significant negative impact of remittances on poverty rates. However, the indirect effects from neighboring states receiving remittances were positive. This suggests that spatial spillovers between states receiving remittances could counteract the impact of the remittances direct effects on poverty alleviation.

With regards to the effect of the GDP, the coefficients of the direct effects showed the expected sign and were statistically significant, indicating that income has an important effect on reducing poverty. Moreover, the results showed a negative sign of the coefficient of indirect effects on poverty alleviation, showing that geographic proximity of the states has an important role in explaining the regional variation of poverty. The pecuniary interactions among states implied that the neighboring effects externalities accounted for more than half of the total effects on poverty reduction. In addition, when studying the effect of remittances son extreme poverty, the results suggested that indirect effects from spatial spillovers due to the interactions between neighboring states have contributed to reducing extreme poverty.

Overall, the findings of this paper suggest that remittances have a direct effect on reducing poverty, although the magnitude of the impact is less than that of income. In addition, although we did not find indirect effects of remittances on moderate poverty reduction, there is evidence of spatial spillovers of income behind the indirect effects on poverty reduction. Therefore, it can be concluded that this paper contributes to the empirical research of the effect of remittances on poverty by corroborating their positive effect on reducing moderate poverty, although it also suggests that these effects are limited to each state and there is not a positive interaction with other states for reducing poverty. However, the extreme poverty alleviation across states seems to depend on the inflow of remittances and the integration of the regional markets at the state level, which could help people in finding alternative sources of income and in reducing extreme poverty conditions.

Altogether, our results lead to relevant policy implications in the efforts to reduce states' poverty. First, the presence of spatial spillovers, which seem to be significant for reducing the state-specific poverty, suggests the importance of implementing regional-in-scope policies

devoted to preserving and enhancing the economic ties between states, as our results strongly indicate that interregional economic integration may help to reduce the burden of poverty. Additionally, it is worth the effort to develop regional policies which help account for the negative neighboring effects coming from remittances' rate of change, and to encourage a shift from the current rather substitutive relationship between states towards a complementary one.

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