https://doi.org/10.21670/ref.2208092

Articles

North border local infrastructure financing and fiscal institutions: validating the northern border effect

Financiamiento local de infraestructura en la frontera norte e instituciones fiscales: validación del efecto frontera norte

Jorge Ibarra Salazar[a*] **https://orcid.org/0000-0002-9581-9099**
Lida Karina Sotres Cervantes[a] **https://orcid.org/0000-0003-3577-7170**

[a] Tecnológico de Monterrey, Departamento de Economía. Monterrey, Mexico, e-mail: jaibarra@tec.mx, lksotres@yahoo.com.mx

Received on October 12, 2021.
Accepted on March 10, 2022.
Published on April 29, 2022.

* Corresponding author: Jorge Ibarra Salazar. E-mail: jaibarra@tec.mx

ORIGINAL ARTICLE LANGUAGE: SPANISH.

Abstract

The objective is to acknowledge local fiscal revenue as a tool to finance infrastructure, by estimating the border effect on the collection of the property tax. A panel data set (2010-2019) of the Mexican municipalities is used to estimate different models by fixed effects. The results show that border municipalities collect $69 to $75 Mexican pesos per capita more than non-border municipalities. We argue about the use of local sources to finance infrastructure on the north border region of Mexico. In the estimation of the border effect, compared to previous studies, a broader database is used, that includes all Mexican municipalities. We conclude that institutional differences are important for explaining differences and evolution in the collection of property tax. Local sources of funding, in the face of the need for infrastructure, can be exploited if there is an adequate institutional framework.

Keywords: infrastructure financing, border effect, property tax, constitutional article 115, fiscal institutions, north border, Mexico.

Resumen

El objetivo es reconocer el ingreso fiscal local como una alternativa de financiamiento de infraestructura, estimando el efecto frontera en la recaudación del impuesto predial. Se utiliza un panel de datos anuales (2010-2019) de los municipios mexicanos para estimar distintos modelos por efectos fijos. Los resultados muestran que los municipios fronterizos recaudan de $69 a $75 pesos per cápita más que los no fronterizos. Se argumenta sobre el uso de fuentes de financiamiento local para ampliar la infraestructura en la región frontera norte de México. En la estimación del efecto frontera, en

CITATION: Ibarra Salazar, J. & Sotres Cervantes, L. K. (2022). Financiamiento local de infraestructura en la frontera norte e instituciones fiscales: validación del efecto frontera norte [North border local infrastructure financing and fiscal institutions: validating the northern border effect]. *Estudios Fronterizos*, *23*, e092. https://doi.org/10.21670/ref.2208092

comparación con estudios anteriores, se emplea una base de datos más amplia, que incluye todos los municipios mexicanos. Se concluye que las diferencias institucionales son importantes para explicar las diferencias y evolución en la recaudación del impuesto predial. Las fuentes de financiamiento locales, ante la necesidad de ampliar infraestructura, pueden explotarse si existe el marco institucional propicio.

Palabras clave: financiamiento de infraestructura, efecto frontera, impuesto predial, artículo 115 constitucional, instituciones fiscales, frontera norte, México.

Introduction

Given that assessing the sources of local revenue is essential when financing infrastructure, the objective of this article is to study what has been termed as the border effect in the collection of property taxes. Previous research has empirically shown that, after controlling for demographic, fiscal and economic differences, municipalities located in the northern border region collect more property tax per capita than non-border municipalities. These studies used data from the states of the northern border region. This article expands the literature by estimating the border effect of property tax collection in Mexico. Unlike previous studies, the estimates presented here use data from all Mexican municipalities from 2010 to 2019. With our approach, it is possible to verify whether the border effect is maintained and, if applicable, to validate previous estimates. This analysis proposes that border regions should use their own resources to finance infrastructure and discusses the fiscal institutional determinants of property tax collection.

The article is organized as follows. The next section contextualizes the border effect in terms of fiscal institutions and local financing of infrastructure. The third section discusses the relevant literature. The fourth section explains the methodology. The fifth section presents results. The final section presents the paper's conclusions.

Infrastructure, fiscal institutions and the border region

Based on an assessment of the empirical literature on the determinants of property taxes in Mexico, there are two aspects that are important to consider when analyzing the northern border effect in the collection of property taxes. The first concerns how this effect has been interpreted, whereas the second concerns local financing in the northern border region. In effect, it has been argued that the higher revenue collection of border municipalities reflects differences in fiscal institutions, as defined in Stein et al. (1999), at the subnational level. These institutions consider three categories of budgetary rules and procedures: those that set numerical references on fiscal variables, those that govern the budgeting process and those associated with the transparency of the budgetary process.

The 1983 and 1999 reforms of Article 115 of the *Constitución Política de los Estados Unidos Mexicanos* (*Political Constitution of the United Mexican States*), which made property taxes a source of revenue for municipalities and allowed defining a municipal legal and regulatory framework to collect this tax, have been key in the existence of fiscal institutional differences between Mexican states and municipalities.[1] In this regard, Cabrero Mendoza (2013) notes that

> the wave of constitutional reforms in the 1980s and 1990s granted Mexican states and municipalities unprecedented powers and responsibilities. This period marks a major transition from a *de jure* to a *de facto* more dynamic federalism, in which subnational governments have become defining actors of local and national policy as well as agents of strategic change and promoters of development and well-being. (p. 16)

The possibility of adapting the fiscal institutional framework has made it possible to respond to the demographic and economic dynamics (which translate into greater demand for goods and services provided by governments) with measures that can take advantage of the potential of the property tax. According to a recent report by Ethos (Alvarado, 2021), low property tax collection in Mexico is due to four elements: administrative factors, political factors, economic factors and taxpayer incentives. A study on Latin America by Sepúlveda and Martínez-Vázquez (2011) shows that in addition to the cadastre system the decentralization arrangements in relation to the tax are also important. As those researchers note, the latter has received less attention as a determinant of property tax collection. In effect, for the property tax to be a productive source of fiscal revenue,

> the decentralization of property tax also requires that local authorities be politically accountable to their communities, be endowed with a significant degree of fiscal autonomy, face the correct incentives within the context of central government policies, and have sufficient administrative capacity to carry out tax and expenditure policies. (pp. 2-3)

The demographic and economic dynamics observed in the northern border region of Mexico impose a need to invest in infrastructure. Wilson and Lee (2013) observe that the commercial relationship between Mexico and the United States requires infrastructure to function effectively; that one of the most obvious and frequently cited ways to reduce congestion at ports of entry is to update and expand the infrastructure of border crossings; and that for the border region to reach its potential to develop and exchange renewable energy across the border, it is necessary to construct electricity transmission infrastructure. They also recognize not only a deficient water and sewerage infrastructure along the border but also the emergence of new challenges in the environmental field: a change in the importance of issues ranging from pollution control to natural resource conservation. They estimate that coming to terms with these new challenges will involve an investment of between 12 000 000 000 USD and 20 000 000 000 USD in environmental infrastructure over the next 20 years (Wilson & Lee, 2013, p. 132).

Similarly, Erickson and Eaton (2002) consider that increasing environmental deterioration along the border has raised concerns regarding the promotion of sustainable economic development. An important element in this regard is the provision of environmental infrastructure for drinking water, wastewater treatment and solid waste management.

[1] See Santana and Sedas (1999), Santana (2000) and Cabrero Mendoza (2013) regarding the amendments to Article 115.

The need for border infrastructure was evident even before the signing of the North American Free Trade Agreement (NAFTA). Gilbreath (1992) notes that

> industrial integration between Mexico and the United States has provided the basis for a border manufacturing, retailing, and agro-industrial economy. But this growing industrial base has created infrastructure and natural resource strains that threaten the economic vitality of the region. Infrastructure and environmental concerns are closely linked, because the failure to provide sufficient public infrastructure has led to pollution of this region's dwindling resource base. Border communities and states have asked both federal governments to incorporate these concerns within negotiations for the proposed North American Free-Trade Area. Their reasoning is that if free trade will expand the economic activity of the region, it must also take into account the regional strains that such activity will generate. (p. 151)

This need for infrastructure leads precisely to the second aspect noted above: local financing in the municipalities of the northern border region of Mexico. The study by the Wilson Center on the Mexico-United States border (Wilson & Lee, 2013) provides an analysis of the main issues of the region in the binational relationship. The analysis considers quality of life, the economy, security and sustainability. Regarding all these factors, financing and investment in infrastructure are fundamental to the binational agenda. The report recognizes that both countries have

> aggressively pursued actions to reduce the lingering deficits in their respective territories and jointly address chronic development gaps affecting both sides of the border. These include the promotion of trade and regional economic growth; substantial investment in environmental infrastructure; development of local capacity for planning and governance; and the creation of a new institutional framework for cross-border cooperation. (p. 24)

Different options have been devised to address the financing of infrastructure at the border. Erickson and Eaton (2002) consider financing through taxes, general obligation bonds, revenue bonds, contracting with the private sector and philanthropy. The alternative approach of a binational bond financing mechanism for the strategic development of border infrastructure has also been studied (Espinosa, 2012; Espinosa & Moreno, 2014; Sankaran et al., 2013). Traditionally, border infrastructure projects—such as international ports of entry, border crossings, water treatment plants and water management facilities—have been financed with grants and federal transfers. Frisvold and Caswell (2002) note that the lack of local taxes and the centralized allocation of funds for infrastructure are impediments to the development of border infrastructure.

This article studies the determinants of property tax collection, the most important source of tax revenue for Mexican municipalities. We propose to analyze how the fiscal institutions of the municipalities located in the northern border region influence the collection of municipal revenue. In particular, the difference in the property tax revenue of the border municipalities from that of municipalities outside that region is calculated. If fiscal institutions prove to be important in the collection of local tax revenues, institutional change could represent a basis thorough which local municipalities could obtain own-revenue to potentially finance infrastructure development on the Mexican side of the northern border.

Because local revenues could be used to finance local infrastructure, this issue is important to the bilateral agenda.

This approach does in fact represent a real possibility for financing. The Center for Budgetary and Policy Priorities (McNichol, 2017) argues that subnational governments should address unmet infrastructure needs by taking advantage of low interest rates to finance loans or using other sources of revenue (e.g., fees, tolls, federal subsidies or new taxes) to finance schools, roads, water treatment facilities and the like. In Mexico, the idea that municipal governments can participate in social infrastructure projects is explicitly recognized in the transfer system. In particular, the Social Infrastructure Contributions Fund (FAIS in its Spanish acronym) allocates federal aid to state and municipal governments for social infrastructure with the purpose of reducing poverty. This fund distributed 85 854 000 000 MXN in 2020 (*Diario Oficial de la Federación* [*DOF*], 2020).

In support of the preceding view, Brockmeyer et al. (2021) argue that among local taxes the property tax has the greatest untapped potential in developing countries. The possibility of financing local infrastructure with revenue from property taxes is addressed in their study. They show that despite a lack of compliance in the payment of this tax, adjustments in the tax rate and the application of the associated regulations can be useful strategies for increasing tax revenue. An additional argument regarding infrastructure financing was advanced by Espinosa and Martell (2015). They find that the establishment of a property tax system increases the number of financing tools available to municipalities because the revenue from this source improves the ability to pay in bond issues in the capital market.

Regarding the financing of infrastructure on the border between the United States and Mexico, Frisvold and Caswell (2002) consider that water conservation should be implemented as part of a regional water management strategy, while Frisvold and Osgood (2011) argue that water projects should be self-financed at the local level. However, as Gurara et al. (2017) observe, one challenge to improving infrastructure is "mobilizing domestic resources for public investment by increasing tax revenue and streamlining and prioritizing expenditures" (Gurara et al., 2017, p. 9).

In different areas, the lack of financing for infrastructure on the border between the United States and Mexico is evident. Frisvold and Caswell (2002) note the following:

> Border cities, however, face a number of constraints limiting their abilities to self-finance water infrastructure. Because of political and financial risks associated with these investments, it is difficult to obtain long-term financing through international markets. Lack of capital at the local level further raises local financing costs. In addition, Mexico's legal system limits the ability of local governments to issue bonds against user fees or real estate taxes. (p. 152)

Frisvold and Osgood (2011) consider that the objective of developing locally self-financed municipal water systems on both sides of the border has remained elusive. The question of which level of government in Mexico can or will pay for future investments in water infrastructure remains uncertain.

According to Erickson and Eaton (2002), the main impediments to meeting the needs of environmental infrastructure in border communities are the lack of human capital to plan, implement and maintain environmental infrastructure and the limited capacity of communities to obtain affordable financing for the construction of the necessary projects (Erickson & Eaton, 2002, p. 204).

Although financing for the development of border infrastructure is mobilized in part through the North American Development Bank (NADB), "the magnitude of available financing is woefully inadequate when compared with the growing needs of the region and begs for alternate means of financing" (Sankaran et al., 2013, p. 71). Consequently, and as Espinosa and Moreno (2014) observe, the potential of the border region has been limited by an increasing gap between infrastructure needs and available financing.

A report by the United Nations Organization (UN-Habitat, 2015) on the disparity between the fiscal need and the fiscal capacity of local governments in developing countries applies well to border municipalities on the Mexican side:

> Local authorities in all parts of the world play an increasingly important role in the delivery of fundamental basic public services. However, authorities also confront great challenges. Most local authorities in developing countries are facing increasingly larger challenges as a result of rapid and chaotic urbanization as well as the impacts of frequent natural disasters caused by climate change. The recent global financial and economic crisis has further aggravated these challenges. The fundamental problem confronting most local authorities, especially those managing cities in developing countries, is the widening gap between the availability of financial resources and municipal spending needs. One of the main reasons for this increasing fiscal gap is the rapid growth of urban populations, which creates an ever-increasing demand for public services as well as new public infrastructure and its maintenance.
>
> Most cities in developing countries primarily depend on central government transfers, with lesser revenues derived from property taxation and service charges. The more lucrative sources of revenue potentially suitable for financing urban areas, such as income taxes, sales taxes and business taxes, continue to be controlled by central governments. Where local authorities are able to derive revenues from property taxes and service charges, meaningful tax increases are occasionally refused or delayed by central governments for fear of eroding political support from the urban population or even rejected by the local authorities themselves for fear of political backlash from local taxpayers. In most countries, there are immense vertical imbalances at the subnational level in terms of sharing responsibilities and available fiscal resources. Stated differently, many central governments refuse to pay the political and financial costs of the decentralization of roles and responsibilities. (p. 8)

Literature on property taxation in Mexico

In this section, we review the empirical literature on the determinants of property tax collection in Mexico. One issue that has been addressed by researchers is how federal transfers influence property tax collection. This relationship has been studied using a panel of aggregated state-level data (Unda Gutiérrez & Moreno Jaimes, 2015) and panel data of the municipalities (Broid Krauze, 2010; Canavire-Bacarreza & Zúñiga Espinoza, 2015; Chávez Maza & López Toache, 2019; Espinosa et al., 2018). Several of the most recent studies on the effect of transfers on property tax collection, such as that of Chávez Maza and López Toache (2019), find that the main limitation in property taxation is the policy of federal transfers. Espinosa et al. (2018) analyzed a panel of 2 267 municipalities during 2008-2013. They find that both *participaciones* and *aportaciones federales* per capita have a direct and statistically significant relationship with property tax collection.

The influence of the political environment and institutional capacities on property taxation has been analyzed by Broid Krauze (2010) and by Unda Gutiérrez (2018). The first studied the influence of the competitive political environment, while Unda Gutiérrez (2018), through semi-structured interviews performed in six municipalities, analyzes the effect of institutional capacities and the political cost of adjusting property value and taxation rates.

The most recent studies on the determinants of property tax collection in Mexico are by Ibarra Salazar and Sotres Cervantes (2021) and Unda Gutiérrez (2021). Ibarra Salazar and Sotres Cervantes (2021) study the differences in fiscal institutions of the border states and municipalities, while Unda Gutiérrez (2021) uses municipal panel data from 1990 to 2010 to analyze the determinants of property tax collection. This latter study includes economic, fiscal, political-electoral and administrative determinants. In connection with administrative determinants, the institutional capacity of the property tax is considered. To approximate institutional capacity, four variables are considered: two to reflect the structure of human resources (i.e., the proportion of base employees in the municipality and the proportion of trusted personnel) and two to indicate the effort associated with the collection of property tax (i.e., updating values and updating the cadastral register).

The origin of our study is found in a series of articles that have estimated the difference in property taxation between municipalities located in the northern border region and those that are not in border regions. In these articles, data from the municipalities of Tamaulipas (Ibarra Salazar and Sotres Cervantes, 2009), Coahuila (Ibarra Salazar & Sotres Cervantes, 2013), Chihuahua (Ibarra Salazar & Sotres Cervantes, 2014) and Sonora (Ibarra Salazar & Sotres Cervantes, 2015) were used. More recently, Ibarra Salazar and Sotres Cervantes (2021) employed data from all municipalities located in the northern border states to estimate the northern border effect. It is interesting to note that these studies focus on border states. The effects that have been estimated, although incorporating the differences between the municipalities of the border region, do not include municipalities of states outside the northern border of Mexico in the analyzed databases. This fact could bias current estimates because by limiting data regionally, a set of municipalities with important differences from those located in border states is omitted. By incorporating in the database all the municipalities of the country, a greater variety of fiscal institutional frameworks as well as economic and demographic differences among the various regions of Mexico could be considered.

Methodology

Variables

The specification of the estimated models in this article closely follows previous empirical studies on the border effect on property tax collection (Ibarra Salazar & Sotres Cervantes 2009, 2013, 2014, 2015, 2021). The control variables for studying the determinants of property tax collection include economic and demographic variables (Buchanan & Weber, 1982; Henry & Lambert, 1980; Kelsey, 1993), the transfers that municipalities receive from the federal government (Bartle, 1995, 1996; Bell & Bowman, 1987; Stine, 1994, 1985) and the political and fiscal institutional environments (Alt & Lowry, 1994; Feld & Kirchgässner, 2001; Merrifield, 2000; Shadbegian, 1999).

Among the most commonly used economic variables is per capita gross domestic product (GDP), as an approximation of revenue. While there are data on state GDP, there is no data series on GDP at the municipal level. As shown in other studies (Ibarra Salazar & Mollick, 2006; Sánchez Almanza, 2000; Unikel et al., 1976), municipal GDP can be approximated using two ways of imputing the GDP of the states to their municipalities: *a)* municipal gross production and *b)* employed municipal population.[2] In the first approach, it is assumed that the structure of GDP at the regional level is the same as that of gross municipal production, while in the second, it is assumed that partial labor productivity is constant across the municipalities of each state.

To calculate municipal GDP with the first approach, the state GDP is taken and, for each municipality, multiplied by the proportion that represents the municipal gross production in relation to the state. State GDP data are published in the Economic Information Bank (BIE in its Spanish acronym) of the Instituto Nacional de Estadística y Geografía National (Institute of Statistics and Geography) (Inegi, 2020a). The figures for municipal and state gross production were adopted from the last three economic censuses (Inegi, 2009; Inegi, 2014a; Inegi, 2019); the proportion obtained in each of these three years is repeated for the years before the next census. A problem with the municipal GDP estimated with this approach is that in certain municipalities the proportion that represents the municipal gross production in the state changes radically from one census to another, which causes an equal change in municipal GDP. For this reason, the second approach was preferred. In this case, to calculate municipal GDP, the state GDP is multiplied by the proportion of the employed municipal population in relation to the state. This information was obtained from the Censo de Población y Vivienda 2010 (2010 Population and Housing Census) (Inegi, 2010). Because the

[2] Municipal gross production refers to the monetary value of goods and services produced or marketed by economic units in a municipality, corresponding to all economic activities. It includes the value of processed products, gross marketing margin, the works executed, the revenue from the delivery of services, rental of machinery and equipment and other movable and immovable assets. Valuation is at producer prices (Inegi, 2014b). Municipal employed population is the number of individuals in the population 12 years and older that, in the week and municipality of reference, worked at least one hour, that had a job but did not work for any reason or that do not currently have jobs but will start one in four weeks or less (Inegi, 2020b).

next population census was not performed until 2020, the 2010 proportion was used as an adjustment factor for each year of the period considered in this study. The approximation to calculate the per capita income is obtained by dividing the municipal GDP by the population of the municipality.

To include the demographic characteristics of the municipalities in the estimation model, two variables are considered: population density (*D*) (number of inhabitants per km^2) and urbanization index (*URB*), defined as the percentage of the population living in localities with more than 2 500 inhabitants. For the first variable, the information on the population by municipality generated by the Censo de Población y Vivienda 2010 (2010 Population and Housing Census) (Inegi, 2010), the Encuesta Intercensal 2015 (2015 Intercensal Survey) (Inegi, 2015) and the Censo de Población y Vivienda 2020 (2020 Population and Housing Census) of the Inegi (Inegi, 2020c) are used. For the intercensal years, the population is calculated by applying the average annual growth rate. The territorial extension in square kilometers of the municipalities was obtained from the Sistema Nacional de Información Municipal National (Municipal Information System) (SNIM in its Spanish acronym), created by the Instituto Nacional para el Federalismo y el Desarrollo Municipal National (Institute for Federalism and Municipal Development) (Inafed, 2021). For its part, the urbanization index was constructed based on information from the Censo de Población y Vivienda 2010 (2010 Population and Housing Census) of Inegi (Inegi, 2010). This variable is repeated for the entire analysis period because the next population census was not performed until 2020.

Regarding the demographic variable, it was determined to include *D* and not *URB* in the models. One reason for this strategy is that this variable does not change throughout the period considered for each municipality because the urban population data at the municipal level are produced every 10 years through the Censo General de Población y Vivienda (General Population and Housing Census); thus, the same data had to be repeated every year for each municipality. Another reason why this variable was not included in the estimation is the high negative correlation with the variable *T* (transfers per capita). The *URB* - *T* correlation is -0.47 (see the correlation matrix in Table 2); if both variables are included together in the model, multicollinearity could be introduced in the estimation.

Another control variable included in this type of study is the transfers (*T*) received by local governments from the federal government. In this study, the *participaciones* and *aportaciones federales* are added and the result divided by the population of the municipality to obtain the per capita transfers. The *participaciones federales* (General Branch 28 of the Federal Expenditure Budget) adopted for the calculation are the *net participaciones federales* received by the municipality, that is, total transfers minus state transfers. The data on *aportaciones federales* considered to construct this variable refers to two of the eight funds that constitute the General Branch 33 of the Federal Expenditure Budget: the Fondo de Aportaciones para la Infraestructura Social Municipal y de las Demarcaciones Territoriales del Distrito Federal (Contribution Fund for Municipal Social Infrastructure and the Territorial Demarcations of the Federal District) (FAISM in its Spanish acronym) and the Fondo de Aportaciones para el Fortalecimiento de los Municipios y de las Demarcaciones Territoriales del Distrito Federal Contribution

(Fund for the Strengthening of Municipalities and Territorial Demarcations of the Federal District) (Fortamun in its Spanish acronym), which are intended exclusively for municipalities. Information on both federal shares and contributions was obtained from the statistics on Finanzas Públicas Municipales (Municipal Public Finance) of Inegi (Inegi, 2020d).

To control for the political environment, two variables are considered: the political affiliation of the mayor and the periods of government. In studies that incorporate the political environment, these variables have been widely used to explain the behavior of variables related to local public finances. In particular, the studies of Reed (2006), Galli and Rossi (2002), Feld and Kirchgässner (2001), Nelson (2000), Merrifield (2000), Alt and Lowry (1994) and Blais and Nadeau, (1992) include political ideology, while Galli and Rossi (2002), Nelson (2000) and Blais and Nadeau (1992) also include electoral cycles.

In this article, to capture the differences in party ideology, a dichotomous political affiliation (*DPA*) variable is included in the model, which in turn is divided into three: DPA_1 takes the value of one if the mayor is affiliated with the Institutional Revolutionary Party (PRI); DPA_2 takes the value of one if it is affiliated with the National Action Party (PAN); DPA_3 takes the value of one if it is affiliated with the Party of the Democratic Revolution (PRD) or with Morena (National Regeneration Movement). In cases in which the elected mayor was nominated by a coalition between two or more political parties, the dominant party of the coalition is used.

To capture the influence of government period, a dichotomous government period (*DGP*) variable is included. With this variable, five different government periods are identified from 2010 to 2019 (DGP_1, DGP_2, DGP_3, DGP_4 and DGP_5).[3] Given that the data used are annual, the months in which the municipal administration began and ended its functions were taken into account. If the beginning of the governmental period occurred in the first semester of the year, then that year is taken as the beginning of the governmental period. If the governmental period began in the second half of the year, the following year is considered the first year of the administration.

Information on the political environment was obtained from the SNIM (Inafed, 2021).

The institutional framework is included in the models through 31 binary variables that identify the state to which each municipality belongs (DS_k, where k is the federal entity). For example, DS_1 takes a value of one for all municipalities in the state of Aguascalientes and zero otherwise. Previous studies on municipal financial dependence (Ibarra Salazar et al., 2013; Ibarra Salazar and Mollick, 2006) and on property tax collection (Ibarra Salazar & Sotres Cervantes, 2021) have used this variable to incorporate fiscal institutional differences between municipalities of different states. According to Greene (2008) and Baltagi (2001), by including this indicator in the model, the effects of the omitted variables that are specific for the municipalities belonging to the corresponding state are captured.

[3] Most municipalities (located in 22 states) recorded four terms of municipal government; municipalities in eight states recorded five terms of government; and municipalities in one state recorded three terms of government. Generally, the duration of the municipal government period is three years. However, in certain states, the state electoral institutes modified this duration—either by reducing or extending the municipal government period—to coordinate local and federal elections.

Border municipalities are identified with dichotomous variables. In the first instance, the aim is to identify all border municipalities regardless of the federal entity to which they belong. The *DMB* variable takes a value of one if the municipality is a border municipality and zero otherwise. In addition, we sought to identify border municipalities according to the state to which they belong. In this way, five binary variables were created (DMB_K, where $k = 1, 2, \dots 5$, represent border states 1 = *BC*, 2 = *SON*, 3 = *CHIH*, 4 = *COAH* and 5 = *TAMPS*, respectively). Thus, to illustrate, the DMB_1 variable will equal one if the municipality is located in the north-border of the state of Baja California and zero otherwise. There are 37 municipalities that border the United States along the entire northern border region of Mexico: three in Baja California (Mexicali, Tecate and Tijuana), seven in Coahuila (Acuña, Guerrero, Hidalgo, Jiménez, Nava, Ocampo and Piedras Negras); seven in Chihuahua (Ascension, Guadalupe, Janos, Juárez, Manuel Benavides, Ojinaga and Praxedis G. Guerrero); one in Nuevo León (Anáhuac[4]); 10 in Sonora (Agua Prieta, Altar, Caborca, Naco, Nogales, Puerto Peñasco, San Luis Río Colorado, Santa Cruz, Sáric and General Plutarco Elías Calles); and nine municipalities in Tamaulipas (Camargo, Guerrero, Gustavo Díaz Ordaz, Matamoros, Miel, Miguel Aleman, Nuevo Laredo, Reynosa and Río Bravo).

Table 1 presents descriptions of the variables and their sources, while Table 2 provides descriptive statistics and the correlation matrix.

The dependent variable is the collection of property tax per capita (*R*). This variable is calculated by dividing the amount collected by the municipal population. Subsequently, this figure was deflated with the National Consumer Price Index (INPC base 2018 = 100) to obtain the collection amount in real terms. The same approach applies to the monetary variables included in the estimation.

Data

To estimate the different models, a panel data was used combining annual information for the period 2010-2019 for a total of 2 253 Mexican municipalities. The cutoff year for the data was determined by the availability (at the time of database construction) of the state GDP published by Inegi. Of the 2 445 municipalities in the country, 188 did not have information on property tax collection, and in four of them, it was impossible to calculate the municipal GDP because they did not have data on the employed population for 2010.[5] That is, 192 municipalities were excluded due to lack of information (for all years of the referred period) regarding two of the main variables of the model. Thus, after adjustments to obtain a balanced sample,[6] in each estimation, 16 229 observations were used.

---

[4] The municipality of Anáhuac was excluded from this group because the area bordering the United States is very small. The border population of the town of Colombia (634 inhabitants, according to data from Inegi's Censo de Población y Vivienda 2020 [2020 Population and Housing Census]) was also excluded.

[5] The following four municipalities were created after this year: Emiliano Zapata, Chiapas; Mezcalapa, Chiapas; Bacalar and Puerto Morelos, Quintana Roo.

[6] Because certain municipalities lack information for certain years, the statistical program eliminates those rows that are missing information for one of the variables; thus, the number of total observations is adjusted.

Table 1. Description of variables and information sources

Variable	Description	Source
R	Per capita property tax collection (constant 2018 pesos).	Inegi, 2020d.
PCIM	Municipal per capita income (constant 2018 pesos). Two figures were estimated: *1*) the first was obtained by multiplying the state GDP by the percentage that represents the municipal gross production with respect to the state gross production; *2*) the second was calculated by multiplying the state GDP by the percentage of the employed municipal population in relation to the state. Subsequently, this value was divided by the total municipal population.	Inegi, 2020a, 2009, 2014a, 2019, 2010.
D	Population density. Calculated by dividing the population of the municipality by its territorial extent (inhabitants per km^2). For the intermediate years, an average annual growth rate was calculated.	Inegi, 2010, 2015, 2020c; Inafed, 2021.
T	Revenue from transfers per capita (constant 2018 pesos). Includes net *participaciones federales* (excluding state *participaciones*) and *aportaciones federales* of Branch 33.	Inegi, 2020d.
DGP_m	Dichotomous variable to control for the period of municipal government in each state. Five variables were included for five periods of government: the variable takes a value of 1 in the first period of government (DGP_1), in the second (DGP_2), in the third (DGP_3), in the fourth (DGP_4) or in the fifth (DGP_5) and zero otherwise.	Inafed, 2021.
DPA_j	Dichotomous variable to control for the political affiliation of the municipal president. Three variables were included. DPA_1 takes a value of 1 if the affiliation is to the PRI; DPA_2 takes a value of 1 if the affiliation is with PAN; and DPA_3 takes a value of 1 if the affiliation is with PRD or Morena. Otherwise, the variable takes a value of zero.	Inafed, 2021.
DMB	Dichotomous variable to incorporate the difference in property tax collection in the set of border municipalities. The variable takes a value of 1 if the municipality is a border municipality (36 municipalities in total) and zero otherwise.	Own construction.
DMB_f	Dichotomous variable to incorporate the difference in property tax collection due to the institutional framework of the border municipality belonging to state *f* (1 = Baja California BC; 2 = Sonora SON; 3 = Chihuahua CHIH; 4 = Coahuila COAH; and, 5 = Tamaulipas TAMPS). The variable takes a value of 1 if the municipality belonging to state *f* is a border municipality and zero otherwise.	Own construction.
DS_k	Dichotomous variable to incorporate the difference in property tax collection due to the institutional framework of state *k*. The variable takes a value of 1 if the municipality belongs to state *k* and zero otherwise.	Own construction.

Table 2. Descriptive statistics (*N* = 16 229)

	R	PCIM	D	URB	T	DMB	DMB_{BC}	DMB_{SON}	DMB_{CHIH}	DMB_{COAH}	DMB_{TAMPS}	DMB_{RI}	DMB_{AN}	DMB_{RD}
Mean	123.60	127 200	281.40	43.74	3 937	0.02	0.00	0.01	0.00	0.00	0.00	0.42	0.21	0.12
Maximum	5 368	1 363 137	17 628	100.0	46 976	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Minimum	0.01	18 489	0.14	0.0	459	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
St. Dev.	224	79 592	1 006	36	2 493	0.13	0.04	0.08	0.06	0.06	0.06	0.49	0.41	0.32
Correlation matrix														
R	**1.000**													
PCIM	0.246	**1.000**												
D	0.183	0.010	**1.000**											
URB	0.268	0.177	0.316	**1.000**										
T	-0.008	0.172	-0.173	-0.471	**1.000**									
DMB	0.089	0.136	-0.026	0.101	0.000	**1.000**								
DMB_{BC}	0.036	0.031	0.006	0.048	-0.026	0.285	**1.000**							
DMB_{SON}	0.049	0.106	-0.020	0.061	-0.022	0.569	-0.003	**1.000**						
DMB_{CHIH}	0.049	0.032	-0.012	0.013	0.025	0.424	-0.002	-0.004	**1.000**					
DMB_{COAH}	0.052	0.078	-0.013	0.020	0.034	0.416	-0.002	-0.004	-0.003	**1.000**				
DMB_{TAMPS}	0.015	0.040	-0.012	0.078	-0.009	0.477	-0.002	-0.005	-0.004	-0.004	**1.000**			
DMB_{RI}	0.073	0.146	0.064	0.131	-0.043	0.032	0.010	-0.019	0.017	0.053	0.021	**1.000**		
DMB_{AN}	0.103	0.143	-0.025	0.087	0.003	0.056	0.023	0.067	0.012	-0.013	0.023	-0.441	**1.000**	
DMB_{RD}	-0.034	-0.066	0.011	0.029	-0.072	-0.040	-0.014	-0.020	-0.021	-0.020	-0.014	-0.309	-0.189	**1.000**

Models

Similar to previous studies, particularly Ibarra Salazar and Sotres Cervantes (2021), in the specification of the models, a strategy was followed that facilitates assessing the consistency of the results while performing statistical inference with respect to the variables that include fiscal institutions in the state and (what is most interesting in this article) determining if the border effect is important for explaining the differences in property tax collection. The strategy consists of gradually adding the variables associated with fiscal institutions and the identification of border municipalities. In Model 1, considered as a reference, only the control variables were included: municipal per capita income (PCIM), population density (*D*), the amount of per capita transfers that municipalities receive from the federal government (*T*) and the variables considered for the political environment (period of local government, *DGP*, and the affiliation of the municipal president, *DPA*):

$$R = \alpha + \theta_1\, PCIM + \theta_2\, D + \theta_3\, T + \sum\nolimits_{j=1}^{3} \gamma_j\, DPA_j + \sum\nolimits_{m=1}^{5} \delta_m\, DGP_m + \varepsilon. \qquad (1)$$

Each observation is defined for a municipality (2 253), a state (31) and a year (2010-2019). ε is the error term. According to the analytical goal of this article, this model represents the restricted approach to explaining the variation in property tax collection because it does not include the differences in fiscal institutions between states or the variables that identify the border municipalities.

In Model 2, the dichotomous variable *DMB* was included, which identifies all the municipalities of the northern border regardless which state they belong to:

$$R = \alpha + \beta\, DMB + \theta_1\, PCIM + \theta_2\, D + \theta_3\, T + \sum_{j=1}^{3} \gamma_j\, DPA_j + \sum_{m=1}^{5} \delta_m\, DGP_m + \varepsilon. \qquad (2)$$

With this model, we want to estimate what has been termed the *global border effect*, which is captured through the parameter β. Even without including fiscal institutional differences but controlling for variations and differences in municipal per capita income, transfers from the federal government, population density and variables of the political environment, Model 2 was used to calculate whether there is a difference in per capita property tax collection between border and non-border municipalities. The hypothesis is that the global border effect is statistically greater than zero ($\beta > 0$). The estimated value of this parameter will provide a numerical estimate of this effect.

Next, in Model 3, the differences in fiscal institutions at the state level are included. This is achieved through the binary variables for each federal entity (*DS*) and by estimating this specification without a constant so that a different constant is obtained for each federal entity (α_k):

$$R = \sum_{k=1}^{31} \alpha_k + \beta\, DMB + \theta_1\, PCIM + \theta_2\, D + \theta_3\, T + \sum_{j=1}^{3} \gamma_j\, DPA_j + \sum_{m=1}^{5} \delta_m\, DGP_m + \varepsilon. \qquad (3)$$

As noted by Hsiao (2003), in relation to the models with panel data, the set of constants α_k, $k=1,\ldots 31$, represents those characteristics associated with all municipalities of state k, which are omitted in the model and relatively stable over time (Hsiao, 2003, p. 30). These characteristics were associated with fiscal institutions in the state.

Model 3 is more general than Model 2 because it relaxes the assumption that the constant (α) is the same for the municipalities of all states. An additional issue, which has been of interest in studies on local public finances, is whether fiscal institutions are important for explaining the behavior of fiscal variables, such as subnational revenues. The studies by Poterba (1994), Alt and Lowry (1994), Merrifield (2000), Hagen and Vabo (2005), the review of empirical studies by Kirchgässner (2001) and the book by Poterba and Von Hagen (1999) are examples of empirical studies that relate fiscal institutions to local government performance.

As is evident, the difference between Models 2 and 3 is what was interpreted as the fiscal institutional framework at the state level. It is expected that Model 3 will better explain the variations (in time) and differences (between municipalities in the collection of property taxes) of property tax collection. That is, the fiscal institutional framework is expected to be a significant determinant of property taxation. To empirically test this expectation, it is necessary to determine if the hypothesis that the constants for Model 3 are the same for all states is rejected: $\alpha_1 = \alpha_2 = \ldots = \alpha_{31}$. This phenomenon is what Greene (2008, p. 197) terms group effects.

The parameter β of Model 3 represents the difference in property tax collection per capita between border and non-border municipalities in this more general specification. Again, the hypothesis is that this parameter is positive ($\beta > 0$).

In Models 2 and 3, the global border effect was estimated with the binary variable *DMB*, which identified the municipalities of the northern border without distinguishing the state to which they belong. Next, we propose several models in which border municipalities are identified according to the state to which they belong. Here, five binary variables are included, through which the border specific effect of the border municipalities of the different states located in that region of the country is estimated. That is, while the previous models assumed that the parameter β was the same for all border municipalities, now, that assumption is relaxed, and a parameter is estimated for the municipalities of each border state. Model 3 assumes that the state effects are equal (α) but includes the variables DMB_f, $f = 1, 2, \ldots, 5$. DMB_1 identifies the border municipalities of Baja California, DMB_2 identifies the border municipalities of Sonora, DMB_3 those of Chihuahua, DMB_4 those of Coahuila, and DMB_5 identifies the border municipalities of Tamaulipas:

$$R = \alpha + \sum_{f=1}^{5} \beta_f DMB_f + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon. \quad (4)$$

Given that a common constant (α) is assumed, the parameters β_f represent the difference in property tax collection between the border municipalities of the state $f = 1, 2, \ldots, 5$ and the other municipalities included in the study. For example, the parameter β_1 is the border effect of the municipalities of Baja California, while β_5 corresponds to the municipalities of Tamaulipas.

Although both specifications include a constant parameter (α), it is interesting to note that the difference between Models 2 and 4 is the assumption regarding the β parameters. Model 4 assumes that the border effect is dissimilar among the municipalities of different states. When using these specifications, a test statistic is calculated to determine if there is statistical evidence to support the constraint imposed on Model 2 with respect to the β parameters. The null hypothesis $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$ is tested. If rejected, it is concluded that the border effect is not uniform between the states of that region.

The most general model estimated in this article includes state effects on the constant (α_k) and the binary variables for the border municipalities in each entity of that region (β_f):

$$R = \sum_{k=1}^{31} \alpha_k + \sum_{f=1}^{5} \beta_f DMB_f + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon. \quad (5)$$

Given that this specification incorporates the differences among fiscal institutions through state effects (α_k), caution should be exercised regarding the interpretation of the parameters β_f, $f = 1, 2, \ldots, 5$. For illustration purposes only, the border state of Coahuila is considered ($f = 4$). *Ceteris paribus*, parameter β_4 represents the difference in per capita property tax collection between border and non-border municipalities of the state of Coahuila. That is, parameter β_f represents the border effect with respect to the municipalities that are not located along the border of the same bordering state f.

When considering the state differences, captured with the α_k parameters, comparisons can be made between border municipalities and non-border municipalities that are part of federal entities outside the northern border region. Adopting again as an example the state of Coahuila (k = COAH, $f = 4$) and a non-border state, such as Zacatecas (k = ZAC), given the control variables, the difference in per capita property tax collection between the municipalities of Zacatecas and the border municipalities of Coahuila is $\alpha_{ZAC} - (\alpha_{COAH} + \beta_4)$, while the difference between a municipality of Zacatecas and another non-border municipality of Coahuila is $\alpha_{ZAC} - \alpha_{COAH}$. Finally, if border municipalities of two border states are compared, for example, Coahuila ($f = 4$) and Baja California ($f = 1$), the difference in property tax collection is $(\alpha_{BC} + \beta_1) - (\alpha_{COAH} + \beta_4)$. Generally, when controlling for the evolution and differences in per capita income, population density, the amount of transfers per capita and political variables, the difference in property tax collection per capita between municipalities in a non-border state (k) and border state (f) is $\alpha_k - (\alpha_f + \beta_f)$, while the difference between two border municipalities is $(\alpha_f + \beta_f) - (\alpha_g + \beta_g)$, with $f \neq g$.

In this article, it was possible to compare the per capita property tax collection between border and non-border municipalities, explained by differences in fiscal institutions, belonging to non-border states because data for all municipalities in Mexico was used. In previous studies, it was not possible to analyze this difference because only data of border states was used.

Estimation method

In addition to estimating the models that have been proposed, the hypothesis tests require the calculation of test statistics, and impose restrictions on the constant terms and those associated with the binary variables that identify the border municipalities, to determine if there is evidence that fiscal institutions and the northern border effect help explain the variations and evolution of the property tax per capita. Therefore, specifications (1), (2) and (4) were estimated by pooled ordinary least squares (pooled regression), while to estimate Models 3 and 5, the fixed effects approach and the least squares method with dichotomous variables were applied for the different groups (least squares dummy variable model) (Greene, 2008, pp. 194-196). The groups in Model 3 are represented by the federal entities, while in Model 5, the border municipalities in each federal entity were added. All models were estimated using the Newey-West HAC Standard method to correct errors in the presence of heteroscedasticity and autocorrelation.

Test statistics

The estimated models were subject to three groups of tests. Through the first group, we sought to determine if there is evidence that fiscal institutions at the state level help to explain the behavior of property tax collection. This can be achieved through Models 3 and 5, in which 31 constants are estimated, one for each federal entity. In the context of the Chow test, these would be the unrestricted models. The constraint that must be imposed to specify the restricted models is $a_1 = a_2 = a_3 = ... = a_{31}$. It should be noted that by imposing this constraint on Model 3, Model 2 is obtained, while by imposing it on Model 5, Model 4 is obtained.

The second group of hypothesis tests is related to the border effect of the property tax. The global border effect was analyzed through the parameter β in Models 2 and 3. The null hypothesis is that $\beta = 0$. In Models 4 and 5, a different binary variable was included for the border municipalities depending on the state to which they belong. With these models, it was determined whether the border effect is significant while imposing the constraints that all β parameters are equal to zero. It should be noted that Model 1 is the restricted model in which constraints are imposed on the β parameters of Models 2 or 4.

An additional question related to the border effect is whether this effect is uniform among border municipalities regardless of the state to which they belong. From the nonrestricted Models 4 and 5, the following constraints are imposed: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$. Hereby, Model 4 becomes Model 2, while Model 5 becomes Model 3.

It can be noted that Models 3 and 5 include the differences both in fiscal institutions (different α) and in the border effect on property tax collection through the β parameters. With these models, the third group of hypotheses was tested. Unlike the previous hypotheses, here, the goal was to determine if there was a statistical justification to jointly restrict the parameters associated with state fiscal institutions and those that indicate the border effect. Thus, from Model 3, it was tested whether Model 1, which does not include differences in fiscal institutions or the border effect ($\beta = 0$ and $a_1 = a_2 = a_3 = ... = a_{31}$), is a better specification with which to explain the variations in property tax collection. The same was proven based on Model 5, which indicated that in this case the parameters that capture the state border effect must also be constrained. That is, to obtain Model 1 (restricted) from Model 5 (unrestricted), the following constraints must be imposed: $a_1 = a_2 = a_3 = ... = a_{31}$ and $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$.

We have insisted on describing the restricted and unrestricted models in each case because the Chow test is performed by calculating the test statistic:

$$F = \frac{(SSE_R - SSE_U) / J}{(SSE_U / (N-K))} \quad (6)$$

where SSE_U is the sum of the square of the errors of the unrestricted model, SSE_R is the sum of the square of the errors of the restricted model, J are the constraints, N is the number of observations and K is the number of estimated parameters in the unrestricted model. This statistic has an F distribution with (J, $N - K$) degrees of freedom.

In addition to the tests of the fiscal institutional framework and the border effect and given that the database includes the municipalities of the entire Mexican Republic, using Model 5, it is possible to determine if there is evidence of differences in per capita collection between the municipalities of border and non-border areas in different states. *Ceteris paribus*, the difference in collection of the border municipalities f with respect to that of the municipalities of state k is $\alpha_f + \beta_f - \alpha_k$. This phenomenon is what is termed the *specific border effect*. The test statistic is calculated as follows:

$$t = \frac{\alpha_f + \beta_f - \alpha_k}{\sqrt{var(\alpha_i + \beta_f - \alpha_k)}} \qquad (7)$$

where var $(\alpha_f + \beta_f - \alpha_k)$= var$(\alpha_f)$+ var$(\beta_f)$+ var$(\alpha_k)$ + 2 cov (α_f, β_f) – 2 cov (α_f, α_k) – 2 cov (β_f, α_k).

Results

The estimation results and tests of hypothesis described in the previous section are presented in Tables 3 to 5. Table 3 provides the estimates of the different models. Table 4 includes the tests on the institutional framework and border effect. Table 5 shows the test statistics for the differences in per capita property tax collection between border and non-border municipalities.

Regarding the control variables considered in the models, it is interesting to note that, as expected, the approximation to PCIM displays a direct and statistically significant relationship with per capita property tax collection in the five estimated models. According to the results in Table 3, the estimated marginal effect of a change, for example, of $1 000 pesos in PCIM, increases property tax collection from $1.13 in Model 2 to $1.40 in Model 5. Thus, if per capita income increases by $1 000 pesos, the estimates indicate that the property tax collection will increase between $1.13 and $1.40 pesos per capita. The consistency of this estimated value is notable in the models estimated with fixed effects (Models 3 and 5) and those that did not include fixed effects in their estimation (Models 1, 2 and 4).

Table 3. Estimation results

Model 1. $R = \alpha + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

Model 2. $R = \alpha + \beta DMB + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

Model 3. $R = \sum_{k=1}^{31} \alpha_k + \beta DMB + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

Model 4. $R = \alpha + \sum_{f=1}^{5} \beta_f DMB_f + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

Model 5. $R = \sum_{k=1}^{31} \alpha_k + \sum_{f=1}^{5} \beta_f DMB_f + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

	1	2	3	4	5
Constant	-35.25	-35.21		-35.33	
	(-1.32)	(-1.33)		(-1.33)	
PCIM	1.15E-03	1.13E-03	1.39E-03	1.13E-03	1.40E-03
	(5.60)*	(5.50)*	(5.10)*	(5.50)*	(5.10)*
D	3.12E-02	3.14E-02	2.91E-02	3.14E-02	2.91E-02
	(4.18)*	(4.19)*	(3.98)*	(4.19)*	(3.98)*
T	-2.23E-03	-1.92E-03	-1.53E-03	-1.95E-03	-1.53E-03
	(-1.41)	(-1.24)	(-0.97)	(-1.27)	(-0.97)
DPA_{PRI}	-6.57	-6.01	-4.24	-5.90	-4.12
	(-0.97)	(-0.88)	(-0.67)	(-0.86)	(-0.65)
DPA_{PAN}	16.44	16.44	16.34	16.69	16.50
	(1.78)**	(1.79)**	(1.65)**	(1.81)**	(1.67)**
$DPA_{PRD\text{-}Mor}$	-3.99	-3.56	-4.05	-3.45	-3.92
	(-0.57)	(-0.51)	(-0.62)	(-0.50)	(-0.60)
DGP	(significance in 71% of cases)[a]	(significance in 68% of cases)[a]	(significance in 25% of cases)[a]	(significance in 66% of cases)[a]	(significance in 25% of cases)[a]
DMB		75.22	73.94		
		(2.28)*	(2.20)*		
DMB_{BC}				27.04	-77.88
				(0.35)	(-0.61)
DMB_{SON}				70.80	75.84
				(0.88)	(0.94)
DMB_{CHIH}				119.49	116.89
				(2.52)*	(2.55)*
DMB_{COAH}				76.46	74.59
				(1.01)	(0.99)
DMB_{TAMPS}				54.98	62.89
				(3.22)*	(3.95)*
Adj R^2	0.2880	0.2896	0.3049	0.2896	0.3052
Fixed effects	NO	NO	YES	NO	YES
N	16 229	16 229	16 229	16 229	16 229

Notes: * significance with *p* - value < 0.05. ** significance with *p* - value < 0.10. *T* statistic in (). All models were estimated using *Newey–West HAC Standard* error correction. [a] The results are not presented due to space constraints.

It is expected that population density, which is the demographic variable included in the specifications, has a direct relationship with property tax collection. The results in Table 3 show that the estimated parameter in all models was positive, and the population parameter was highly significant from the statistical perspective. It can be noted that the test statistic rejects the null hypothesis that the population parameter is equal to zero with a significance level below 5%.

The effect of transfers on property tax collection has been a topic of interest in related studies (Broid Krauze, 2010; Canavire-Bacarreza & Zúñiga Espinoza, 2015; Chávez Maza & López Toache, 2019; Espinosa et al., 2018). In this case, as shown in Table 3, it was found that per capita transfers have an inverse relationship with per capita property tax collection, although this result is not statistically significant. In effect, the test statistic for this case does not allow rejecting the hypothesis that the population parameter of the variable T is different from zero. In view of the findings in previous studies and given that the variable T includes *participaciones* and *aportaciones federales*, this result should be viewed with caution.

To control for political differences between municipalities and over time, two variables were considered: the political affiliation of the municipal president and the periods of government, which are also referred to as electoral cycles in the literature on the effects on fiscal variables of the political environment (Blais &. Nadeau, 1992; Galli & Rossi, 2002; Nelson, 2000). Regarding the first variable, only the parameter of the binary variable that indicates political affiliation with PAN was positive and significantly different from zero in all models (Table 3). The consistency of the estimated value of this parameter in the five models is highlighted. This result represents statistical evidence that municipal governments led by municipal presidents affiliated with the PAN observed a higher per capita taxation—$16.4 to $16.7 is the estimated range—compared to the omitted class, which in this case are all political parties nationally registered but with a lower number of activists than the PRI, PAN, PRD or Morena,[7] political parties with state registration, independent citizens, municipal councils, and tradition and customs. The municipal governments headed by mayors politically affiliated with other political parties (PRI, PRD, Morena) do not exhibit differences in the collection of property tax per capita with respect to those municipalities headed by the classes omitted in the binary variables.

The estimated parameters of the variables associated with the electoral cycles are not included in Table 3 because of space constraints.[8] Suffice it to say that the marginal impact of the municipal government periods was positive and statistically significant in the states of Colima, Guanajuato, Jalisco, Mexico, Michoacán, Morelos, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Zacatecas.

The central interest in this research is to determine the state-level effects of the fiscal institutions of the northern border municipalities. To this end, using Models 3 and 5, which were estimated with state fixed effects, the F test statistic was calculated to determine if there is evidence that the α parameters in Model 3 are the same. If so, the correct specification would be Model 1. Similarly, starting from Model 5, it should be tested whether this model reduces to Model 2, which imposes a single constant instead of state

[7] Parties such as Convergence (*Convergencia*), Green of Mexico (*Verde de México*), New Alliance (*Nueva Alianza*), Citizen Movement (*Movimiento Ciudadano*), Labor (*del Trabajo*), Social Encounter (*Encuentro Social*) and Socialdemocrat Alternative (*Alternativa Socialdemócrata*).

[8] Information available to the interested reader on request.

fixed effects. The test statistics appears in Section I of Table 4. In both cases, the null hypothesis can be rejected. This finding indicates that, regardless on how the property tax model is specified, with the global border effect (Model 3) or with the partial border effect of the different zones (Model 5), there is clear evidence that the differences in fiscal institutions help explain the variations in per capita property tax collection over time and between municipalities.

Table 4. Test statistics for the northern border effect and state fiscal institutions

Model 1. $R = \alpha + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

Model 2. $R = \alpha + \beta DMB + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

Model 3. $R = \sum_{k=1}^{31} \alpha_k + \beta DMB + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

Model 4. $R = \alpha + \sum_{n=1}^{5} \beta_n DMB_n + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

Model 5. $R = \sum_{k=1}^{31} \alpha_k + \sum_{n=1}^{5} \beta_n DMB_n + \theta_1 PCIM + \theta_2 D + \theta_3 T + \sum_{j=1}^{3} \gamma_j DPA_j + \sum_{m=1}^{5} \delta_m DGP_m + \varepsilon$

	Test #	Constraints on the parameters (null hypothesis)	F statistic *	*P* - value
I. State fiscal institutions				
Model 3	1	$a_1 = a_2 = a_3 = \ldots = a_{31}$	12.69	0.0000
Model 5	2	$a_1 = a_2 = a_3 = \ldots = a_{31}$	12.32	0.0000
II. Northern border effect				
Model 2	3	$\beta = 0$	5.20	0.0226
Model 3	4	$\beta = 0$	4.83	0.0280
Model 4	5	$\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$	3.70	0.0024
Model 5	6	$\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$	4.87	0.0002
Model 4	7	$\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$	0.47	0.7561
Model 5	8	$\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$	0.64	0.6370
III. Northern border effect and state fiscal institutions				
Model 3	9	$\beta = 0$ & $\alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_{31}$	13.01	0.0000
Model 5	10	$\alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_{31}$ & $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$	12.25	0.0000
Model 5	11	$\alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_{31}$ & $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$	14.84	0.0000

Note: * Calculated based on (6).

The results to tests the border effect on property tax collection are presented in part II of Table 4. In the first instance, according to the calculated statistics, there is evidence that the global effect, estimated in Models 2 and 3 through the parameter β, is significant in explaining the variations in property tax collection. The test statistics $F = 5.20$ and $F = 4.83$ for Models 2 and 3, respectively, indicate that the null hypothesis can be rejected at a significance level lower than 3% in each case. Regardless of whether state fixed effects are considered or not, it can be noted that the identification of border municipalities is important in the specification to explain the per capita property tax. An approximation of this effect appears in the estimated values of the parameter β in Table 3. With Model 2, which does not include state fixed effects, the global border effect is $75.22 per capita, while with Model 3, which includes state fixed effects, this value is $73.94 per capita. These estimated values are slightly larger than the $69 pesos per capita obtained in Ibarra Salazar and Sotres Cervantes (2021) when using data from the municipalities belonging to northern border region states.

The result which incorporates the particular northern border effects, as is the case of Models 4 and 5, is consistent with the previous result. In this case, the hypothesis is that the β parameters in specifications 4 and 5 are jointly equal to zero. The test statistics ($F = 3.70$ and $F = 4.87$) indicate that the null hypothesis should be rejected in both models (Table 4). Thus, whether the property tax collection model specifies state fixed effects or does not, the border effect (whether global or specific to border states) is important for explaining the variations in property tax collection of Mexican municipalities. Again, the difference between the β parameters that are estimated in Models 4 and 5 can be noted. In the first case, because the constant term is common, the hypothesis that is being rejected is that, jointly, the particular border effect of the border municipalities of each state is not statistically significant. In this way, there is evidence that, jointly, the particular border effect is relevant in explaining the property tax collection in the Mexican municipalities. In the second case, the constraint imposed on Model 5, which includes state fixed effects, is about the difference in property tax collection of border municipalities compared to non-border municipalities located within the same federal entity. In this case, the hypothesis that the particular border effect is null is also rejected.

The β parameters, estimated from Model 4 (Table 3), present the particular border effects of the municipalities located in the different states of the border region. All the parameters are positive, and those corresponding to the municipalities of Chihuahua and Tamaulipas are statistically significant. The estimated values of these parameters provide an approximation of these effects. Given the control variables and the assumption of a common constant in Model 4, the parameter $\beta_1 = 27.04$ is an estimate of the difference in property tax collection per capita of the border municipalities of Baja California and the non-border municipalities. The parameters $\beta_2 = 70.80$ for Sonora, $\beta_3 = 119.49$ for Chihuahua, $\beta_4 = 76.46$ for Coahuila and $\beta_5 = 54.98$ for Tamaulipas should be interpreted in the same way.

An additional aspect in relation to the particular border effects is their uniformity. According to the results in Table 4, the null hypotheses that $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$, which were applied to Models 4 and 5, cannot be rejected. That is, there is no evidence that these effects are different.

Hypothesis tests were also formulated to determine joint characteristics of the effect of state fiscal institutions and the border effect. The results are shown in part III of Table 4. With Model 3 it is jointly test whether there is no difference in the effect of fiscal institutions between the states and if the border effect is null (test #9). With Model 5, two joint hypotheses are examined: whether the border effects between the states that belong to that region are equal and if the institutional effect between the states is uniform (test #10); and whether the institutional effects of the states are equal and the state border effects are jointly null (test #11). As indicated by the test statistics, there is evidence that the three hypotheses are rejected.

As indicated in the methodology section, the database used in this article enables us to make statistical inferences regarding the particular border effect and, all things being equal, to compare the per capita property tax collection for border municipalities of each border state with that of the non-border municipalities in any state of the Mexican Republic. The estimated values of these differences and the test statistics are shown in Table 5. The interpretation of the numbers presented in Table 5 is as follows: each number is an estimate of the difference in the per capita property tax collection of the municipalities of the border state indicated in the first row of the table compared to the non-border municipalities of the states in the first column of the table. To illustrate, the first value in the CHIH column indicates that, given the control variables used to estimate Model 5, the border municipalities of Chihuahua collect $280 pesos per capita more than the municipalities of Aguascalientes. The test statistic, which appears in parentheses ($t = 3.77$), also indicates that this difference is statistically significant.

The border effects on property tax collection appear to be concentrated in the states of Baja California and Chihuahua, where the average annual collection per capita is $284 and $408 (constant 2018 pesos), respectively, for the period under study. In Table 5, it can be noted that in the columns that correspond to these states, BC and CHIH, the estimated values of the differences are positive and statistically significant for a good number of cases: 15 for Baja California and 22 for Chihuahua.

It is also interesting to note that for Baja California there is no significant difference between the collection in the border and non-border municipalities of that state; that the border collection of property tax in the state of Tamaulipas is only larger than that in the municipalities of Campeche, Tabasco and the non-border municipalities of Tamaulipas; and that there is no evidence that, given the controls used to estimate Model 5, the per capita property tax collection of the non-border municipalities of Baja California, Baja California Sur, Colima, Jalisco, State of Mexico, Morelos Querétaro, Quintana Roo and Zacatecas is lower than that of the border municipalities of Mexico.

Finally, we discuss the hypothesis tests on the joint restrictions of the institutional framework and the border location of the municipalities. Using Model 3 it was jointly tested if there were no institutional differences ($a_1 = a_2 = a_3 = ... = a_{31}$) and if the border effect was null ($\beta = 0$), while with Model 5 it was jointly tested if the effect of state fiscal institutions ($a_1 = a_2 = a_3 = ... = a_{31}$) and the particular border effect were uniform ($\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$), and if the effect of fiscal institutions was uniform, while the border effect was zero ($\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$). As corroborated in section III of Table 4, the three joint hypotheses were rejected.

Table 5. Particular border effect $(\alpha_f + \beta_f) - \alpha_k$, and test statistics

		BC	SON	CHIH	COAH	TAMPS
1	AGS	166.99 (5.17)*	28.35 (0.32)	279.78 (3.77)*	95.34 (1.04)	-16.38 (-0.59)
2	BC	**-77.88** **(-0.61)**	-216.53 (-1.54)	34.90 (0.26)	-149.54 (-1.05)	-261.26 (-2.30)*
3	BCS	-420.61 (-1.09)	-559.25 (-1.43)	-307.82 (-0.79)	-492.26 (-1.25)	-603.98 (-1.57)
4	CAMP	767.53 (6.61)*	628.88 (4.90)*	880.31 (6.62)*	695.87 (5.39)*	584.15 (5.05)*
5	COAH	146.24 (2.03)*	7.60 (0.07)	259.03 (2.68)*	**74.59** **(0.99)**	-37.13 (-0.54)
6	COL	-215.45 (-1.62)	-354.10 (-2.29)*	-102.67 (-0.69)	-287.10 (-1.83)**	-398.82 (-3.04)*
7	CHIS	64.13 (1.18)	-74.52 (-0.73)	176.91 (2.08)*	-7.52 (-0.07)	-119.24 (-2.45)*
8	CHIH	4.11 (0.06)	-134.54 (-1.31)	**116.89** **(2.55)***	-67.54 (-0.64)	-179.27 (-2.81)*
9	DGO	160.98 (4.31)*	22.34 (0.25)	273.77 (3.64)*	89.33 (0.95)	-22.39 (-0.76)
10	GTO	48.58 (1.22)	-90.07 (-0.99)	161.36 (2.10)*	-23.07 (-0.24)	-134.79 (-4.10)*
11	GRO	53.77 (0.76)	-84.88 (-0.77)	166.55 (1.72)**	-17.88 (-0.16)	-129.60 (-1.93)**
12	HGO	111.75 (2.68)*	-26.89 (-0.29)	224.54 (2.90)*	40.10 (0.41)	-71.62 (-2.07)*
13	JAL	-193.24 (-0.87)	-331.88 (-1.41)	-80.45 (-0.35)	-264.89 (-1.12)	-376.61 (-1.70)**
14	MÉX	8.54 (0.18)	-130.11 (-1.35)	121.32 (1.50)	-63.11 (-0.63)	-174.84 (-4.13)*
15	MICH	72.01 (1.73)**	-66.63 (-0.71)	184.80 (2.38)*	0.36 (0.004)	-111.36 (-3.22)*
16	MOR	-45.22 (-0.55)	-183.87 (-1.58)	67.56 (0.65)	-116.87 (-0.98)	-228.60 (-2.89)*
17	NAY	73.84 (1.15)	-64.81 (-0.62)	186.62 (2.05)*	2.19 (0.02)	-109.53 (-1.85)**

18	**NL**	134.52 (1.20)	-4.12 (-0.03)	247.31 (1.90)**	62.87 (0.43)	-48.85 (-0.45)
19	**OAX**	128.03 (2.72)*	-10.62 (-0.11)	240.81 (3.00)*	56.38 (0.56)	-55.34 (-1.37)
20	**PUE**	145.66 (3.49)*	7.02 (0.08)	258.45 (3.33)*	74.01 (0.76)	-37.71 (-1.08)
21	**QRO**	15.59 (0.17)	-123.06 (-1.03)	128.37 (1.16)	-56.06 (-0.46)	-167.79 (-1.93)**
22	**QROO**	-369.93 (-1.22)	-508.58 (-1.63)	-257.15 (-0.83)	-441.58 (-1.40)	-553.31 (-1.82)**
23	**SLP**	211.79 (5.17)*	73.14 (0.81)	324.57 (4.20)*	140.14 (1.49)	28.41 (0.82)
24	**SIN**	59.98 (1.17)	-78.66 (-0.82)	172.77 (2.08)*	-11.67 (-0.12)	-123.39 (-2.67)*
25	**SON**	214.49 (5.19)*	**75.84** **(0.94)**	327.27 (4.28)*	142.84 (1.60)	31.12 (0.87)
26	**TAB**	248.42 (7.89)*	109.77 (1.29)	361.20 (5.01)*	176.77 (1.99)*	65.05 (2.87)*
27	**TAMPS**	246.26 (7.98)*	107.62 (1.27)	359.05 (4.99)*	174.61 (1.97)*	**62.89** **(3.95)***
28	**TLAX**	141.91 (3.14)*	3.27 (0.03)	254.70 (3.20)*	70.26 (0.70)	-41.46 (-1.07)
29	**VER**	146.82 (3.62)*	8.17 (0.09)	259.61 (3.37)*	75.17 (0.78)	-36.55 (-1.10)
30	**YUC**	201.92 (5.49)*	63.27 (0.71)	314.70 (4.20)*	130.27 (1.39)	18.55 (0.64)
31	**ZAC**	-16.90 (-0.37)	-155.55 (-1.65)**	95.88 (1.21)	-88.55 (-0.90)	-200.27 (-5.17)*

Notes: * significance with *p* - value < 0.05. ** significance with *p* - value < 0.10. *T*-statistic in (), calculated based on (7).

Conclusions

This article has studied the effect of fiscal institutions on the collection of property taxes. The effects at the state level and those that may occur in the municipalities located on the northern border of Mexico have been incorporated. The so-called northern border effect on property tax collection had been estimated using data from municipalities belonging to the states of the northern border region. This paper extends empirical work on the determinants of property tax by using a panel of Mexican municipalities from 2010 to 2019.

The results confirm the global border effect. It was found that the parameter of the variable that identifies the border municipalities was positive and statistically significant regardless of whether state fixed effects are considered or not. Consistent with previous studies, the estimate ranged from $74 to $75 pesos per capita. Given the nature of the database and the control variables used in the models, it was possible to analyze this effect in particular to compare the collection of property tax in the border municipalities in the different states with that of the non-border municipalities.

The results indicate that the fiscal institutional framework is an important factor in explaining the variations over time and the differences between municipalities in property tax collection. This result is of substantial importance when considering the financing of infrastructure in the northern border region. Much of this article has focused on the need for infrastructure in this region and the possibility of local financing. More specifically, the central argument in light of the results is that the reform of fiscal institutions would facilitate taking advantage of the potential of the property tax to finance infrastructure with local resources.

In support of these conclusions, Cabrero Mendoza (2013) notes that institutional and administrative capacities are important in the collection of local tax revenues. In particular, the factors that can help develop these capacities are horizontal information exchange, democratic intensity of local public action, budgetary institutions and regulatory framework, emerging organizational structures and the qualifications and professional profile of local authorities. In this article, reference has been made to fiscal institutions as a differential element for identifying the border effect in property tax collection. It would be interesting to examine the quantitative elements of the factors listed by Cabrero Mendoza (2013) to determine whether they effectively induce more property tax collection in Mexican municipalities. It is interesting to note in this regard that Von Hagen (1992) and Von Hagen and Harden (1995) present methods for calculating an index of fiscal institutions.

References

Alt, J. E. & Lowry, R. C. (1994). Divided government, fiscal institutions, and budget deficits: evidence from the states. *American Political Science Review*, *88*(4), 811-828. https://www.jstor.org/stable/i336277

Alvarado, L. (Coord.). (2021). *El impuesto predial: la oportunidad que todos dejan pasar*. Ethos. https://www.ethos.org.mx/wp-content/uploads/2021/02/Predial-2021-ISBN-comprimido.pdf

Baltagi, B. H. (2001). *Econometric analysis of panel data*. John Wiley & Sons.

Bartle, J. R. (1995). The fiscal impact of federal and state aid to large U.S. cities: an empirical analysis of budgetary response. *Public Budgeting & Finance*, *15*(4), 56-67. https://doi.org/10.1111/1540-5850.01053

Bartle, J. R. (1996). The effect of intergovernmental aid on city property taxes: new results for Minnesota. *Journal of Public Budgeting, Accounting & Financial Management*, *8*(2), 150-169. https://doi.org/10.1108/JPBAFM-08-02-1996-B001

Bell, M. E. & Bowman, J. H. (1987). The effect of various intergovernmental aid types on local own-source revenues: the case of property taxes in Minnesota cities. *Public Finance Quarterly*, *15*(3), 282-297. https://doi.org/10.1177%2F109114218701500303

Blais, A. & Nadeau, R. (1992). The electoral budget cycle. *Public Choice*, *74*(4), 389-403. https://www.researchgate.net/publication/316674211_The_Electoral_Budget_Cycle

Brockmeyer, A., Estefan, A., Ramírez Arras, K. & Suárez Serrato, J. C. (2021). *Taxing property in developing countries: theory and evidence from Mexico* (Working paper series 28627). NBER http://www.nber.org/papers/W28637

Broid Krauze, D. (2010). La evolución del predial en México: Los incentivos cruzados de la descentralización fiscal y política. *Finanzas Públicas, 2*(3-4), 69-192.

Buchanan, S. C. & Weber, B. A. (1982). Growth and residential property taxes: a model for estimating direct and indirect population impacts. *Land Economics*, *58*(3), 324-337. https://www.jstor.org/stable/3145940

Cabrero Mendoza, E. (2013). Fiscal federalism in Mexico: distortions and structural traps. *Urban Public Economics Review, 18*, 12-36. https://www.redalyc.org/articulo.oa?id=50428804001

Canavire-Bacarreza, G. & Zúñiga Espinoza, N. G. (2015). Transferencias e impuesto predial en México. *Economía UNAM*, *12*(35), 69-99. http://www.scielo.org.mx/scielo.php?pid=S1665-952X2015000200069&script=sci_abstract

Chávez Maza, L. A. & López Toache, V. (2019). Determinantes del recaudo del impuesto a la propiedad inmobiliaria: un enfoque estadístico para México. *Revista Iberoamericana de Estudios Municipales*, *10*(19), 89-119. https://dx.doi.org/10.4067/S0719-17902019000100089

Diario Oficial de la Federación (DOF). (2020, January 3). *Acuerdo por el que se da a conocer a los gobiernos de las entidades federativas la distribución y calendarización para la ministración durante el ejercicio fiscal 2020, de los recursos correspondientes a los Ramos Generales 28 Participaciones a Entidades Federativas y Municipios, y 33 Aportaciones Federales para Entidades Federativas y Municipios.* https://dof.gob.mx/nota_detalle.php?codigo=5583411&fecha=03/01/2020

Erickson, C. & Eaton, D. W. (2002). Border finances: paying for environmental infrastructure. In P. Ganster (Ed.), *The U.S.-Mexican border environment: economy and environment for a sustainable border region: now in 2020* (pp. 203-249, SCERP Monograph Series no. 3). San Diego State University Press.

Espinosa P., S. (2012). *On bond markets development and strategic cross border infrastructure: highlights of a research agenda on regulatory harmonization* (no. 269). Repositorio Digital CIDE. http://repositorio-digital.cide.edu/handle/11651/99

Espinosa, S. & Martell, C. (2015). Building bond repayment capacity in developing countries: a study on property tax collections and debt affordability in Mexico. *International Journal of Public Administration*, *38*(3), 227-236. https://doi.org/10.1080/01900692.2014.934841

Espinosa, S., Martínez, J. & Martell, C. (2018). ¿Por qué algunos municipios en México son mejores recaudadores de impuesto predial que otros? *Gestión y Política Pública*, *27*(2), 375-395. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405-10792018000200375&lng=es&tlng=es

Espinosa, S. & Moreno, J. O. (2014). Regional development and cross-border infrastructure finance: comparing the yield-spread determinants of Mexican and U.S. sub-sovereign government bonds. *The Journal of Structured Finance*, *20*(1), 64-75. https://doi.org/10.3905/jsf.2014.20.1.064

Feld, L. P. & Kirchgässner, G. (2001). The political economy of direct legislation: direct democracy and local decision-making. *Economic Policy*, *16*(33), 330-367. https://www.jstor.org/stable/1344645

Frisvold, G. & Caswell, M. (2002). Financing bilateral water projects on the U.S.-Mexico border: past, present and future. In J. J. Batema, L. Fernandez & R. T. Carson (Eds.), *Both sides of the border* (The economics of non-market goods and resources, v. 2, pp. 131-159). Kluwer Academic Publishers.

Frisvold, G. B. & Osgood, D. E. (2011). Financing wastewater collection and treatment on the US-Mexico border. *Journal of Contemporary Water Resource Education*, *121*(7), 40-50.

Galli, E. & Rossi, S. P: S. (2002). Political budget cycles: the case of the Western German Länder. *Public Choice*, *110*(3-4), 283-303. https://www.jstor.org/stable/30026415

Gilbreath, J. (1992). Financing environmental and infrastructure needs on the Texas-Mexico border: will the Mexican-U.S. Integrated Border Plan help? *The Journal of Environment & Development*, *1*(1), 151-175. https://www.jstor.org/stable/44319412

Greene, W. H. (2008). *Econometric analysis*. Pearson.

Gurara, D., Klyuev, V., Mwase, N., Presbitero, A., Xu, X. C. & Bannister, G. (2017). *Trends and challenges in infrastructure investment in low-income developing countries* (WP 17/233). International Monetary Fund. https://www.imf.org/en/Publications/WP/Issues/2017/11/07/Trends-and-Challenges-in-Infrastructure-Investment-in-Low-Income-Developing-Countries-45339

Hagen, T. P. & Vabo, S. I. (2005). Political characteristics, institutional procedures and fiscal performance: Panel data analyses of Norwegian local governments, 1991-1998. *European Journal of Political Research*, *44*(1), 43-64. https://doi.org/10.1111/j.1475-6765.2005.00218.x

Henry, M. & Lambert, K. (1980). The impact of new industry on county government property tax revenue. *Journal of Agricultural and Applied Economics*, *12*(1), 193-197. https://doi.org/10.1017/S0081305200015478

Hsiao, C. (2003). *Analysis of panel data*. Cambridge University Press.

Ibarra Salazar, J., González, H. & Sotres Cervantes, L. (2013). Aspectos políticos de la dependencia financiera en los municipios mexicanos. *Revista Mexicana de Ciencias Políticas y Sociales*, *58*(217), 139-170. http://www.revistas.unam.mx/index.php/rmcpys/article/view/42181

Ibarra Salazar, J. & Mollick, A. V. (2006). Mexican northern border municipalities, financial dependence and institutions. *The Annals of Regional Science*, *40*(4), 859-874. https://link.springer.com/article/10.1007/s00168-005-0036-4

Ibarra Salazar, J. & Sotres Cervantes, L. (2009). Determinantes de la recaudación del impuesto predial en Tamaulipas: instituciones y zona frontera norte. *Frontera Norte*, *21*(42), 165-192. https://doi.org/10.17428/rfn.v21i42.968

Ibarra Salazar, J. & Sotres Cervantes, L. (2013). Las instituciones fiscales como paliativo para enfrentar crisis financieras: el impuesto predial en el estado de Coahuila.

In J. E. Mendoza Cota (Ed.), *La crisis financiera internacional. Efectos sectoriales en México y en su frontera* (pp. 315-353). El Colegio de la Frontera Norte.

Ibarra Salazar, J. & Sotres Cervantes, L. (2014). Diferencias en la recaudación del impuesto predial en la zona fronteriza: evidencia en los municipios de Chihuahua. *Estudios Demográficos y Urbanos*, *29*(1), 53-87. https://doi.org/10.24201/edu.v29i1.1455

Ibarra Salazar, J. & Sotres Cervantes, L. (2015). Property tax collection of Sonora municipalities: does border location make any difference? *Journal of Borderlands Studies*, *30*(2), 203-225. https://doi.org/10.1080/08865655.2015.1046471

Ibarra Salazar, J. & Sotres Cervantes, L. (2021). El efecto de la frontera en la recaudación del impuesto predial. *Estudios Demográficos y Urbanos*, *36*(2), 347-401. https://doi.org/10.24201/edu.v36i2.1904

Instituto Nacional de Estadística y Geografía (Inegi). (2009). *Censos Económicos 2009*. https://www.inegi.org.mx/programas/ce/2009/

Instituto Nacional de Estadística y Geografía (Inegi). (2010). Tabulados interactivos en *Censo General de Población y Vivienda 2010*. https://www.inegi.org.mx/programas/ccpv/2010/#Tabulados

Instituto Nacional de Estadística y Geografía (Inegi). (2014a). *Censos Económicos 2014*. https://www.inegi.org.mx/programas/ce/2014/

Instituto Nacional de Estadística y Geografía (Inegi). (2014b). *Censos económicos. Sistema Automatizado de Información Censal (SAIC)*. www.inegi.org.mx/app/saic

Instituto Nacional de Estadística y Geografía (Inegi). (2015). Tabulados predefinidos en *Encuesta Intercensal 2015*. https://www.inegi.org.mx/programas/intercensal/2015/#Tabulados

Instituto Nacional de Estadística y Geografía (Inegi). (2019). *Censos Económicos 2019*. https://www.inegi.org.mx/programas/ce/2019/

Instituto Nacional de Estadística y Geografía (Inegi). (2020a). *Banco de Información Económica (BIE)*. https://www.inegi.org.mx/app/indicadores/?tm=0#bodydataExplorer

Instituto Nacional de Estadística y Geografía (Inegi). (2020b). *Glosario*. https://www.inegi.org.mx/app/glosario/default.html?p=ENEU

Instituto Nacional de Estadística y Geografía (Inegi). (2020c). *Censo de Población y Vivienda 2020*. https://www.inegi.org.mx/programas/ccpv/2020/#Tabulados

Instituto Nacional de Estadística y Geografía (Inegi). (2020d). *Estadística de finanzas públicas estatales y municipales*. https://www.inegi.org.mx/sistemas/olap/proyectos/bd/continuas/finanzaspublicas/fpmun.asp?s=est&c=11289&proy=efipem_fmun

Instituto Nacional para el Federalismo y el Desarrollo Municipal (Inafed). (2021). *Sistema Nacional de Información Municipal*. Secretaría de Gobernación. www.snim.rami.gob.mx

Kelsey, T. W. (1993). Fiscal impacts of population growth and decline in small communities. *American Journal of Agricultural Economics*, *75*(5), 1169-1172. https://www.jstor.org/stable/1243447

Kirchgässner, G. (2001). The effects of fiscal institutions on public finance: a survey of empirical evidence. In S. L. Winer & H. Shibata (Eds.), *Political economy and public finance* (pp. 145-208). International Institute of Public Finance/Edward Elgar Publishing.

Mcnichol, E. C. (2017). *It's time for states to invest in infrastructure*. Center on Budgetary and Policy Priorities. https://www.researchgate.net/publication/297197245_It's_Time_for_States_to_Invest_in_Infrastructure

Merrifield, J. (2000). State government expenditure determinants and tax revenue determinants revisited. *Public Choice*, *102*(1-2), 25-50. https://www.jstor.org/stable/30026135

Nelson, M. A. (2000). Electoral cycles and the politics of state tax policy. *Public Finance Review*, *28*(6), 540-560. https://doi.org/10.1177%2F109114210002800603

Poterba, J. M. (1994). State responses to fiscal crises: the effects of budgetary institutions and politics. *Journal of Political Economy*, *102*(4), 799-821. https://doi.org/10.1086/261955

Poterba, J. M. & Von Hagen, J. (Eds.). (1999). *Fiscal institutions and fiscal performance*. University of Chicago Press.

Reed, W. R. (2006). Democrats, republicans, and taxes: evidence that political parties matter. *Journal of Public Economics*, *90*(4-5), 725-750. https://doi.org/10.1016/j.jpubeco.2004.12.008

Sánchez Almanza, A. (2000). *Marginación e ingreso en los municipios de México, 1970-1990*. UNAM/Miguel Ángel Porrúa.

Sankaran, H., Díaz, V. & Espinosa, S. (2013). The design and estimation of a bi-national bond to finance strategic infrastructure along the U.S.-Mexico border. *The Journal of Structured Finance*, *19*(2), 71-88. https://doi.org/10.3905/jsf.2013.19.2.071

Santana, S. (2000). Acciones necesarias para la implementación de la reciente reforma al artículo 115 constitucional: aspectos hacendarios. *Hacienda Municipal*, *72*, 15-22.

Santana, S. & Sedas, C. (1999). El artículo 115 constitucional y sus reformas: comentarios a los aspectos hacendarios de la Reforma de 1999. *Hacienda Municipal*, *68*, 21-35.

Sepúlveda, C. & Martínez-Vázquez, J. (2011). *Explaining property tax collections in developing countries: the case of Latin America* (International Studies Program Working Paper 11-09). Andrew Young School of Public Studies-Georgia State University. https://www.researchgate.net/publication/254391601_Explaining_Property_Tax_Collections_in_Developing_Countries_The_Case_of_Latin_America

Shadbegian, R. J. (1999). The effect of tax and expenditure limitations on the revenue structure of local government, 1962-87. *National Tax Journal*, *52*(2), 221-237. https://doi.org/10.1086/NTJ41789391

Stein, E., Talvi, E. & Grisanti, A. (1999). Institutional arrangements and fiscal performance: the Latin American experience. In J. M. Poterba & J. Von Hagen (Eds.), *Fiscal institutions and fiscal performance* (pp. 103-133). Chicago University Press.

Stine, W. F. (1985). Estimating the responsiveness of local revenue to intergovernmental aid. *National Tax Journal*, *38*(2), 227-234. https://doi.org/10.1086/NTJ41792012

Stine, W. F. (1994). Is local government revenue response to federal aid symmetrical? Evidence from Pennsylvania County governments in an era of retrenchment. *National Tax Journal*, *47*(4), 799-816. https://doi.org/10.1086/NTJ41789109

Unda Gutiérrez, M. (2018). Los límites de la recaudación predial en los municipios urbanos de México: un estudio de casos. *Estudios Demográficos y Urbanos*, *33*(3), 601-637. https://doi.org/10.24201/edu.v33i3.1741

Unda Gutiérrez, M. (2021). Una hacienda local pobre: ¿qué explica la recaudación predial en México? *Estudios Demográficos y Urbanos*, *36*(1), 49-88. https://doi.org/10.24201/edu.v36i1.1871

Unda Gutiérrez, M. & Moreno Jaimes, C. (2015). La recaudación del impuesto predial en México: un análisis de sus determinantes económicos en el periodo 1969-2010. *Revista Mexicana de Ciencias Políticas y Sociales*, *60*(225), 45-77. http://www.revistas.unam.mx/index.php/rmcpys/article/view/51788

UN-Habitat. (2015). *The challenge of local government financing in developing countries*. United Nations Human Settlements Programme. https://unhabitat.org/the-challenge-of-local-government-financing-in-developing-countries-0

Unikel, L., Ruiz Chiapetto, C. & Garza Villarreal, G. (1976). *El desarrollo urbano de México: diagnóstico e implicaciones futuras*. El Colegio de México.

Von Hagen, J. (1992). *Budgeting procedures and fiscal performance in the European communities* (Economic Papers number 96). Commission of the European Communities. http://aei.pitt.edu/37058/1/A3038.pdf

Von Hagen, J. & Harden, I. (1995). Budget processes and commitment to fiscal discipline. *European Economic Review*, *39*(3-4), 771-779. https://doi.org/10.1016/0014-2921(94)00084-D

Wilson, C. E. & Lee, E. (Eds.). (2013). *The state of the border report: a comprehensive analysis of the U.S.-Mexico border*. Wilson Center/El Colegio de la Frontera Norte/Arizona State University.

Jorge Ibarra Salazar
Mexican. PhD in economics from Southern Methodist University. Professor-researcher at the Department of Economics of Tecnológico de Monterrey and visiting professor at Southern Methodist University. Research lines: fiscal federalism, urban economy, regulatory economy and company decisions under risk. Recent publication: Ibarra Salazar, J., Romero-Rojas, J. C. & Ayala-Gaytán, E. (2021). The duration effect of pictorial health warnings on tobacco consumption in Mexico. *Global Public Health*, *16*, 1656-1674. https://doi.org/10.1080/17441692.2020.1839928

Lida Karina Sotres Cervantes
Mexican. Master in international business for Latin America by the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM-Campus Monterrey) and Thunderbird School of International Management (Phoenix, AZ). Research lines: public finance, applied microeconomics and regional economics. Currently she is an independent researcher. Recent publication: Ibarra Salazar, J. & Sotres Cervantes, L. (2021). El efecto de la frontera en la recaudación del impuesto predial. *Estudios Demográficos y Urbanos*, *36*(2), 347-401. https://doi.org/10.24201/edu.v36i2.1904