Policy Research Working Paper 9399

Determinants of Property Tax Revenue

Lessons from Empirical Analysis

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WORLD BANK GROUP
Governance Global Practice
&
Macroeconomics, Trade and Investment Global Practice
September 2020

Policy Research Working Paper 9399

Abstract

Many developing countries have struggled with realizing sufficient revenues from property tax. However, as developing countries experience economic growth, they are also seeing property values rising, providing a bigger tax base from which to realize revenues. Technology has made tax administration easier and more effective and developing country governments have been improving their quality of governance and considering introducing or enhancing property tax revenue collection to diversify their tax and fiscal revenues. This paper explores the determinants of property tax revenue using data from the United States, Canada, Australia, Chile, and the Organisation for Economic Co-operation and Development for 2006 to 2016, using a fixed effects model. The results show that increases in gross domestic product and population lead to increases in property tax revenue and an increase in federal transfers decreases it. The outcomes of the empirical analysis highlight the statistically significant impacts on property tax collection of a country's state of development and its demographic, fiscal, and property tax–specific characteristics. A critical question for further research is whether and how the empirical methodologies and specifications as applied to the set of developed economies would be replicated in the context of developing countries.

This paper is a product of the Governance Global Practice and the Macroeconomics, Trade and Investment Global Practice. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at rawasthi@worldbank.org and tle@worldbank.org.

Determinants of Property Tax Revenue: Lessons from Empirical Analysis

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JEL Code: H71

Keywords: Local Government Revenue, Local Government Subsidies, Local Government Taxation, Local Tax, Property Tax, Sales Tax, State Government Subsidies, State Lottery, State Revenue, State Tax, Taxation

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I. Introduction

Property tax revenue plays an important role in tax collection in developed countries. It becomes revealing, theoretically and empirically, that property tax is the most efficient tax, encompassing a number of other virtues of a tax instrument: transparency, equity, and direct linkage to benefits.[1] The tax has become even more relevant in the evolving trends of urbanization and fiscal decentralization.[2]

In some of the high-performing countries, the immovable property tax brings in as much as 3 percent of GDP in revenues. At the same time, many developing countries have struggled with realizing sufficient revenues from property tax. However, as developing countries experience economic growth they are also seeing property values rising, providing a bigger tax base from which to realize revenues. Technology has made tax administration easier and more effective and developing country governments have been improving their quality of governance and have been considering introducing or enhancing property tax revenue collection to diversify their tax and fiscal revenues. Taxation of immovable properties not only improves the tax revenue collections but also works as an instrument for income redistribution, given that it is progressive by nature.

Exploring the determinants of property tax revenue using data from developed countries gives us important insights into understanding the extent to which these factors impact property tax collection. This research provides useful experiences for developing countries that are considering or planning to enforce the property tax collection.

In this research, we review literature that has focused on the determinants of property tax revenue throughout the world. We then collect state/provincial-level data for the United States, Canada, Australia, and Chile, as well as country-level data for all the OECD countries. Our data allow us to build up a panel data set for sophisticated econometrics regressions and estimations. We use OLS, Fixed Effects Model, and Random Effects Models to estimate the impact of various determinants on the property tax revenue. Our econometric analysis allows us to measure the impact of key economic and demographic factors that influence property tax revenue.

According to our research results (see Tables 5 and 6), we find that every 1 percent increase in GDP and population will increase the property tax revenue by around 0.13% and 0.76% on

[1] OECD (2010), for example, ranks the order of efficiency (or least economic distortion, growth-impeding) tax types: property tax, VAT, personal income tax and corporate income tax.

[2] Bahl (1999) reflects the criticality of property taxes in its direct linkage to efficiency in service delivery at the local government level.

average, respectively.[3] In the meantime, a 1 percent decrease in federal transfer and one person decrease in household size will increase tax revenue by 0.03% and 84%, respectively. Besides these determinants above, if the property tax rate increases by 1 percentage point, the tax revenue will increase by 8%. We attempted to measure the impact of governance on property tax revenue but found that the governance indicator does not have a significant impact on property tax revenue.[4]

II. Literature Review

A series of research has focused on the importance and function of property and land tax revenues. After reviewing the history of the property tax in the United States, Wallis (2000) points out that the advantage of local governments is the ability to match taxpayers and beneficiaries. Since local governments are able to utilize the benefit tax features of the property tax, the property tax has been, and will continue to be, the main source of revenue for local governments in the United States.

Bahl, FAO (2002) concludes that the demand for tax revenue will likely be growing for local governments as infrastructure needs and service demands grow. In the meantime, most major taxes – collected at the federal level in most countries -- are under pressure from international competition and the limits of public acceptance. So, there are limits to tax revenues and hence, fiscal transfers from federal to local governments. Consequently, property tax revenues become important as the potential yields can be increased in most countries.

International Handbook of Land and Property Taxation (2004) reviews the taxation of land and property in 25 countries (five in each of five regions – OECD, Central and Eastern Europe, Asia, Africa, and Latin America). The handbook concludes that taxes on land and property are at best minor revenue sources in all countries studied. But property taxes are useful sources of subnational revenue in many countries, and more so in developing than in developed or transition countries. The main functions of the property taxes include financing local governments and affecting land use.

A policy guide for land and property tax by UN-Habitat (2011) concludes that the potential of Land and Property Tax (LPTs) to contribute to the improvement of local communities is high. The realization of the potential requires policies and administrative procedures to be efficient to produce a fair and stable tax system that would yield between 1 and 2 percent of GDP on a

[3] The results are calculated from the regression results in Tables 5 and 6, Column 4. The numbers are the average of the two coefficients from the two tables for each variable.

[4] Our empirical results may underly a caveat when selecting the governance indicator for the sample of developed countries. The narrow variation in governance quality may not warrant the otherwise statistical impact on property tax collection. The selection of the sample thus indicates the trade-off between a reliable overall data set and the missing variation in some likely plausible variable.

sustainable basis. It requires that the policies and administrative procedures are adapted to the cultural views of property rights, to the ways in which property rights are acknowledged and defended in the communities, to the realities of land and property markets and the administrative capacities of the governments.

Property taxation practices and the determinants of the tax across the world have also been explored by researchers. De Cesare (1998) concludes that public investment in urban areas often results in increased land value, benefiting only a small group of private owners. However, in a pioneering initiative, the city of Porto Alegre in Brazil uses the property tax as an instrument for capturing land value increments, which deters land speculation and promotes rational urban development. Franzsen (2003) briefly overviews the property tax systems in five of the member states of the Southern African Development Community (SADC): Botswana, Lesotho, Namibia, South Africa and Eswatini. The author finds that the property tax is not utilized optimally in any of the five countries. However, it is generally recognized that property tax could and should become a more important source of revenue for all five countries. It is crucial to improve capacity in the areas of professional, technical and management skills, training, computerization, collection and enforcement procedures.

In a 2012 report, the Lincoln Institute of Land Policy proposed three categories of factors affecting revenue generation: socioeconomic (i.e. size of real estate stock, real estate prices, poverty levels, income distribution, urbanization, and land tenure), fiscal decentralization (i.e. intragovernmental transfers and subnational revenue), and institutional arrangements (e.g. sales tax). Bonet, Muñoz, and Pineda (2014) elaborate an approach to capture heterogeneity in property tax revenue across provinces within Argentina, using province GDP per capita, dependency on national transfers, export rights revenue, informality of house tenancy, property tax decentralization, and other taxes. Manaf, Hasseldine, and Hodges (2006) analyze the determinants of Malaysian land taxpayers' compliance attitudes. They test a compliance model for land tax in Malaysia with four previously untested variables (race, positive incentives, land type and location) to identify characters that are associated with landowners' compliance attitudes. The regression results show that age, race, level of education, level of income, occupation and ethics strongly impact land tax compliance attitudes.

Martinez-Vazquez and Youngman (2008) draw four main conclusions from property tax practice experiences from developing and transitional countries. First, during a transition period, second-best approaches could be the right strategy. Market-assisted information could be an acceptable substitute for actual transaction data for valuation. Second, institutions matter greatly. It is essential for developing a workable property, investing records management, identifying the right collection machinery, and finding a way to gather reliable data on sales transactions. Third, accurate valuation of the tax base is the crucial to success with the property tax. Finally, and most importantly, the property tax can be a key point to strengthening local government finance, promoting rural development, and improving the fairness of the tax burdens distribution.

Literature has also used panel data across the world to discuss sophisticated methodologies of verifying determinants of the property taxes and estimating their impacts on the property tax revenue. Davoodi and Grigorian (2007) attribute urbanization's importance to high demand for public services.

Using data from Office of Real Property Tax Service and Office of State Comptroller's Office of New York State in 1992, Tae Ho Eom (2008) examines a model for the determinants of property tax assessment quality. The author uses two stage least square (2SLS) regression to solve the endogeneity of the property tax administration variables and concludes that "the median tax share, the median property value as a share of median income, the ratio of state aid to total expenditures, and the share of adults with college or higher education have significant impacts on the quality of property tax assessment".

Sepulveda and Martinez−Vazquez (2012) estimate the determinants for property tax collection for nine Latin American countries during 1990-2007. They use fiscal decentralization, dependency of transfers, government size, income per capita, municipal cadaster, competition for public positions, and index of democracy as main independent variables. They find that fixed effect results yield statistically significant effects for fiscal decentralization, dependency on transfers, GDP per capita, competition for public positions and index of democracy. And for the random effects model, the rest of the variables are statistically significant (urbanization, municipal cadaster, government size).

Hultquist and Petras (2012) employ a panel of 635 year-location observations covering the largest city in each U.S. state from 1997-2010 to measure the impact of the various political, fiscal, administrative, demographic, and economic factors on the use of fractional assessment of local property taxation. They use panel data techniques incorporating both year and location-specific fixed effects and conclude that fractional assessment is associated with political factors, such as higher levels of Republican legislative representation and divided government, suggesting that the fractional assessment of local property taxation may be the path of least resistance for enacting effective property tax relief.

Norregaard (2013) discusses policy and administrative issues to be considered for successful reform. Based on panel data for 64 countries between 1990−2010, he uses GDP per capita, urbanization, openness of the economy, and a dummy if the country's legal heritage (is of Anglo−Saxon origin) to estimate recurrent immovable property revenue. He also estimates a Fixed Effects model to account for the influence the variations of income per capita have on property tax collection over time. He finds that a country's development over time has positive exponential effects over time.

III. Data

We use the following data from different countries for our research. To run the econometrics model with panel data, we collect data through years 2006 to 2016.

- United States: data within the United States are mainly from U.S. Census Bureau. According to the literature, the most important variables include property tax revenue, GDP, population, public finance (i.e. federal transfers[5]), property tax rate, household size, and governance quality.[6] U.S. data have the most variables and the best quality among the data we have collected.
- Canada: data are mainly collected from Statistics Canada, the statistics department of the government. Main variables include property tax revenue, GDP, population, public finance (i.e. federal transfers), and household size. Besides the United States, Canada is the only country that provides clear federal transfer data publicly online.
- Australia: Australian Bureau of Statistics has the main variables we need, including property tax revenue, GDP, population, and household size.
- Chile: variables for Chile are also property tax revenue, GDP, population, and household size, the same as Australia. And they are collected from the National Statistics Institute.
- OECD: data on OECD countries are all from the official OECD website. Variables are the same as for Australia and Chile, including property tax revenue, GDP, population, and household size.

IV. Methodology

Most of the previous research simply use pooled Ordinary Least Squares (OLS), which is very likely to cause endogeneity (e.g. omitted variable bias), due to the different environments and situations in different countries (or states/provinces within a country). Since there exist some structural differences between countries, they are not consistently comparable using pooled OLS model. Therefore, we utilize Fixed Effects model[7] to estimate the impact of the important factors on property tax revenue, using only within-country (or within states/provinces) variations. This would provide a better estimator for the key determinants of property tax revenues even allowing extrapolation for developing countries.

[5] Revenues of state and local governments that are received from federal government transfers. They are redistribution of income and wealth by means of the federal government making a payment, without goods or services being received in return.

[6] The overall scores of the economic competitiveness for each state from The Beacon Hill Institute. The scores range from 1.9 to 8.1, with higher scores indicating better governance quality.

[7] A fixed effects regression is an estimation technique employed in a panel data setting that allows researchers to control for time-invariant unobserved individual characteristics that can be correlated with the observed independent variables. It uses within-individual variations, so it is usually called "within estimator". In our model, it controls for time-invariant unobserved individual characteristics within states/provinces in United States, Australia, Canada, and Chile, as well as within OECD countries. So, the results can be recognized as within-state/province/country estimators.

Due to the specialty of the data availability, we run our regressions on two data samples. Firstly, we only work on U.S. data, with 50 states across 11 years (2006-2016). As U.S. data have the most important variables and best quality, we are able to take advantage of these estimations to better understand the determinants of property tax revenue. We use both OLS and Fixed Effects models as shown in Equation (1) - (4).[8] Secondly, to utilize all the data we have, we combine data from all the countries, including Australia, Canada, Chile, USA, and OECD. State and province level data from Australia, Canada, and the United States are also pooled together to construct our panel data set. Since our data availability is limited, we can only use a few control variables in these specifications, such as GDP, population, and household size (we use government transfer for both the United States and Canada). Details are shown in Equations (5) - (8)[9] as below.

$$\text{Property Tax Revenue} = \text{constant} + \beta_1.\text{GDP} + \beta_2.\text{Population} + \beta_3.\text{Government Transfer} + \beta_4.\text{Property Tax Rate} + \beta_5.\text{Household Size} + \epsilon \quad (1)$$

$$\text{Property Tax Revenue} = \text{constant} + \beta_1.\text{GDP} + \beta_2.\text{Population} + \beta_3.\text{Government Transfer} + \beta_4.\text{Property Tax Rate} + \beta_5.\text{Household Size} + \beta_6.\text{Governance} + \epsilon \quad (2)$$

$$\text{Property Tax Revenue} = \text{constant} + \beta_1.\text{GDP} + \beta_2.\text{Population} + \beta_3.\text{Government Transfer} + \beta_4.\text{Property Tax Rate} + \beta_5.\text{Household Size} + \text{Year Dummy} + \text{State Dummy} + \epsilon \quad (3)$$

$$\text{Property Tax Revenue} = \text{constant} + \beta_1.\text{GDP} + \beta_2.\text{Population} + \beta_3.\text{Government Transfer} + \beta_4.\text{Property Tax Rate} + \beta_5.\text{Household Size} + \beta_6.\text{Governance} + \text{Year Dummy} + \text{State Dummy} + \epsilon \quad (4)$$

$$\text{Property Tax Revenue} = \text{constant} + \beta_1.\text{GDP} + \beta_2.\text{Population} + \beta_3.\text{Household Size} + \epsilon \quad (5)$$

$$\text{Property Tax Revenue} = \text{constant} + \beta_1.\text{GDP} + \beta_2.\text{Population} + \beta_3.\text{Household Size} + \beta_4.\text{Government Transfer} + \epsilon \quad (6)$$

$$\text{Property Tax Revenue} = \text{constant} + \beta_1.\text{GDP} + \beta_2.\text{Population} + \beta_3.\text{Household Size} + \text{Year Dummy} + \text{State/Province/Country Dummy} + \epsilon \quad (7)$$

$$\text{Property Tax Revenue} = \text{constant} + \beta_1.\text{GDP} + \beta_2.\text{Population} + \beta_3.\text{Household Size} + \beta_4.\text{Government Transfer} + \text{Year Dummy} + \text{State/Province/Country Dummy} + \epsilon \quad (8)$$

Property Tax Revenue is total property tax revenues as million dollars;

GDP is GDP as million dollars;

Population stands for the population as thousands of people;

Government Transfer is the government transfer as million dollars;

[8] Equations 1 and 2 are OLS, while Equations 3 and 4 are fixed effects.

[9] Equations 5 and 6 are OLS, while Equations 7 and 8 are fixed effects.

Property Tax Rate is the tax rate as percent of the value of the property[10];

Household Size is the average number of persons living in each household;

Governance Quality is the overall quality of governance.

To better deal with the variables, we have conducted logarithm transformation on property tax, GDP, population, and government transfer. This serves three main purposes: (1) to solve the highly skewed distributions issue; (2) to directly estimate elasticities of property tax revenues by various determinants; and (3) to control for the wide variation in these variables.

We also include both regional and time dummies. The regions are countries, states, and provinces. The time dummies are annual.

According to economic intuition and literature, GDP and population are expected to have positive impacts on property tax revenue. Higher economic growth leads to an increase in demand for properties which then become more expensive and the size of the tax base becomes greater. An increase in population means an increase in demand for housing and increase in number of properties, again increasing the size of the tax base. Both factors lead to higher property tax revenue. As far as the property tax rate is concerned, clearly a higher rate is positively correlated with higher revenues. On the contrary, household size and government transfers are expected to have negative impacts on property tax revenue. As household size increases, more persons live in each property, reducing the demand for properties and consequently the tax base. Federal transfers tend to be negatively correlated with property tax revenues if they are raised by local governments; higher federal transfers reduce the importance of raising own-source revenues and are expected to have a negative impact on property tax revenues.

V. Hausman Test

There is a question whether the Random Effects model is more suitable for our research. However, under the circumstances, we think the Fixed Effects model is more appropriate for this research project. Generally, if omitted variables are uncorrelated with the explanatory variables that are in the model, then a random effects model is probably best. If there are omitted variables, and these variables are correlated with the variables in the model, then fixed effects models may provide a means for controlling for omitted variable bias. In our research we believe that some important explanatory variables (urbanization, e.g.,) might be missing and correlated with the existing variables, and thus a Fixed Effects model is found more suitable than a Random Effects model.

To test the advantage of the Fixed Effects model, we conduct Hausman Tests for Equations (3), (4), (7), and (8). Table 4 displays the results of Hausman Tests. Since results show that Chi2 are generally big enough, so that the probabilities that are bigger than Chi2 are small, we reject the

[10] In the regressions, it has been multiplied by 100 to be consistent with the logarithm transformation of the dependent variable.

null hypothesis that Random Effects models are appropriate. Therefore, this research has utilized the Fixed Effects Model.

VI. Estimation Results

Descriptive statistics for the 50 U.S. states are shown in Table 1. Among the 50 states, California has the highest property tax revenue, while New York and Texas rank second and third respectively. In terms of GDP and population, California also ranks first, while Texas takes the second place and New York takes the third.

Table 2 displays the statistics through years, to demonstrate the data characteristics from another dimension. As GDP, population, and property tax rate are all increasing over time, property tax revenue has also been increasing over the years.

Regression results of the 50 U.S. states are shown in Table 5. All the coefficients are basically in line with our predictions. Comparing between OLS and Fixed Effects Models would be helpful. In the OLS models (Columns 1 and 2), both property tax rate and governance quality have significant positive impacts on the property tax revenue. In the meantime, coefficients of federal transfer and household size are insignificant, while household size has positive impact on the dependent variable, which is a bit counter intuitive. The result might be because of running pooled OLS regressions on the sample, without dealing with differences between the states. When we run OLS regressions, we are pooling all the observations together for the estimation without controlling for time-invariant unobserved individual characteristics that can be correlated with the observed independent variables.[11] This could cause potential omitted variable bias due to unobserved heterogeneity when this heterogeneity is constant over time. Therefore, we use Fixed Effects Model to remove heterogeneity from the data through differencing (i.e. removing any time invariant components of the model).

When we move to Columns 3 and 4, regression results from the Fixed Effects Model, GDP and population are still significantly positive, while property tax rate and governance now turn to insignificant. The reason that coefficients of property tax rate and governance change to insignificant mainly comes from controlling for time-invariant unobserved state characteristics. When we run OLS regressions, property tax rate and governance have important impacts on the tax revenues because we consider the variations across states. But when we use the Fixed Effects Model, we estimate the impacts within states, so that impacts from the tax rate and governance diminish significantly, since tax rates and governance within each state maintain very similar levels across time. The most important changes are in the observed coefficients of federal transfer and household size. Now, both of them show negative impacts on property tax revenue as expected and are statistically significant. Since Fixed Effects Models are more sophisticated to deal with the

[11] Some plausible indicators can be cited—especially those related to the indexation applied in perception surveys to reveal the intrinsic pricing of local benefits provided by property taxes.

potential endogeneity issues coming from the structural differences between different countries (or provinces or states), results from Columns 3 and 4 are more reliable.

To interpret the results in terms of the determinants of the property tax revenue in the United States, we look at Column 4 of Table 5. From the coefficients in the table, we can see that every 1% increase in GDP and population will increase the property tax revenue by around 0.18% and 0.63%, respectively. In the meantime, 1% increase in federal transfer will decrease the tax revenue by about 0.04%. The next three control variables are not transformed by natural logarithm and its correlation with property tax revenues (expressed in natural log form) indicates some interesting results. If the property tax rate is increased by one percentage point, the tax revenue would be expected to respond with an increase by 8%. And as explained above, the governance index exhibits negligent variation across states and that leads to the minimal impact (though positive) of this variable on tax revenues. On the other hand, a one-unit decrease in household size tends to exert substantial impact on tax intake. The governance indicator does not have much of an impact on tax revenue.[12]

Descriptive statistics for the full sample are shown in Table 3. In this table, all the OECD countries, Australian and Canadian provinces, and U.S. states have been included. Provinces in Chile are also included in our regressions, but not in the descriptive statistics table. The reason is that data from Chile use their own currency, so that they are not comparable to other countries. But this will not cause any problem for the regressions as our primary regression models are fixed effects models that use “within variation” to obtain the “within estimator."

Regression results of the full sample are shown in Table 6. As we discussed before, all the coefficients are in line with our predictions, for both OLS and Fixed Effects Models. The only issue is that both GDP and federal transfer return insignificant coefficients in Column 4 from the Fixed Effects Model. But since this model is using less observations and within estimator, we believe it is not a big issue, as the coefficients do display the expected sign.

To interpret the results in detail for the full sample, we look at Column 4 of Table 6. From the coefficients in the table, we can see that every 1% increase in GDP and population will increase the property tax revenue by around 0.09% and 0.90%, respectively. In the meantime, 1% increase in federal transfer will decrease the tax revenue by about 0.02%, while one person decrease in the household size on average will increase the tax revenue substantially.[13]

We have also included results of Random Effects Model for Equations (3), (4), (7), and (8) in Tables 5 and 6. Columns 3 and 4 of these two tables show coefficients of Random Effects regressions. There are some differences between Fixed Effects model and Random Effects model,

[12] More specifically a decrease by one unit (one person) in household size would result in the increase in property tax revenue by almost 57 percent [or, Exp(0.449)-1].

[13] Similar to the previous footnote, a one unit decrease in household size would relate to the increase of property tax revenue by almost 111 percent [or, Exp(0.747)-1].

both in magnitude and significance, especially for "log GDP" and "property tax rate". But the signs are the same for all the coefficients of both models. As discussed above, omitted variables are likely to be correlated with existing variables and based on the results from Hausman Tests, we are confident that the results from the Fixed Effects model provide more appropriate estimates.

VII. Conclusions

To study the determinants of property tax revenue, we utilize OLS, Fixed Effects Models, and Random Effects Model to research on data from the United States, as well as Australia, Canada, Chile, and all the OECD countries. As expected, the Fixed Effects model fits the data better due to potential endogeneity issues, although they all return estimates as predicted.

The outcomes of our empirical analysis highlight the statistically significant impact on property tax collection of such determinants presenting a country's state of development and its demographic, fiscal and property tax-specific characteristics. Specifically, the income level, the population density, and property tax rate correlate significantly and positively with property tax revenue, whereas federal transfers and household size have significantly negative impact. In our study, we are able to measure the impact of each of these factors and our research provides coefficients which can be used to make estimates of potential property tax revenues. Our empirical analysis draws in some relevant 'food for thought' pertinent to property taxation. First, design of fiscal transfer matters. As noted, property tax reforms typically go in conjunction with deepening fiscal decentralization. Any 'soft budget constraints' embedded in fiscal transfer schemes (equalization transfers as a case in point) can influence the fiscal policies of recipient states. Within this frame, lax behavior by states in mobilizing own revenue, most credibly through property tax, tends to be unintendedly compensated by the increased magnitude of equalization or other types of redistributive transfers.[14] The broader policy relevancy that we would venture to highlight here is: The efficiency in property taxation is directly related to or dependent upon the structure of the fiscal decentralization.

Second, economic and population growth exerts both push and pull effects on tax policy makers. As countries climb up the development ladder, the overall restructuring and rebalancing of the tax mix would inevitably pull in the vision for better designing and administering a property tax, an efficient tax. Higher population, combined with higher state income, would extend the base for property tax on the one hand, and push for revenue-enhancing measures to finance rising demand for public services, most visibly at local levels.

A third policy issue relevant to property taxation is emerging from demographic trends observed around the world; the one most pertinent to this research is the decline in household sizes around the globe.[15] Estimated trends indicate that in most countries the average household size has

[14] See, for example, Vigneault (2007) and Smart (2007) for more discussion of the disincentives from soft budget constraints and distributive transfers.

[15] Patterns and trends in household size and composition: Evidence from a United Nations dataset, United Nations, 2019.

declined over recent decades, according to the UN report. In some developing countries – for example, Botswana, Brazil, and Peru – the decline has been sharp, reducing from over 5 per household to just above 3, but the trend appears to be universal in the developing world. This is significant from the point of view of exploiting the potential of property taxation. As our model shows, reduction in the size of households has a significant, positive impact on property tax revenues.

A critical question for further research is whether and how our empirical methodologies and specifications as applied to the set of developed economies would be replicated in the context of developing countries. The sample of the latter, undoubtedly, would pose substantial challenge in terms of data availability and quality (particularly, the issues of data consistency and measurement errors). Time-series data for a specific developing country would present a possibility to explore the extent of the country's own property tax capacity and be helpful for policy design. Further research is needed to fill the analytical gap in comparative empirical analysis for a wide set of developing countries.

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Table 1. Descriptive Statistics for the States in U.S. (Averaged by years)

States	Property Tax Revenue (Million $)	GDP (Million $)	Population (Thousands)	Federal Transfer (Million $)	Property Tax Rate	Household Size	Governance
Alabama	2,448	182,397	4,771	9,170	0.0039	2.52	3.62
Alaska	1,306	52,434	713	2,892	0.0102	2.77	4.98
Arizona	6,791	268,778	6,476	11,368	0.0065	2.70	5.01
Arkansas	1,756	106,734	2,919	6,045	0.0059	2.51	4
California	53,002	2,162,854	37,556	73,316	0.0074	2.93	4.87
Colorado	6,712	274,227	5,109	7,134	0.0060	2.53	6.42
Connecticut	9,224	243,089	3,567	3,144	0.0146	2.55	4.69
Delaware	693	61,082	905	1,599	0.0049	2.60	5.2
Florida	26,028	792,266	19,179	23,337	0.0100	2.56	5
Georgia	10,479	447,658	9,755	12,357	0.0089	2.70	4.75
Hawaii	1,331	72,254	1,371	2,059	0.0029	2.93	4.36
Idaho	1,365	58,532	1,576	2,382	0.0071	2.65	5.81
Illinois	23,990	703,272	12,805	13,200	0.0175	2.63	4.25
Indiana	6,726	293,299	6,497	9,378	0.0095	2.53	4.25
Iowa	4,285	152,068	3,059	5,527	0.0132	2.40	5.98
Kansas	3,893	135,409	2,851	3,842	0.0129	2.49	5.68
Kentucky	3,007	171,493	4,346	9,043	0.0076	2.49	4.2
Louisiana	3,430	222,905	4,529	10,288	0.0045	2.62	3.81
Maine	2,379	52,794	1,328	2,593	0.0110	2.34	4.73
Maryland	8,031	326,434	5,819	9,035	0.0090	2.64	4.88
Massachusetts	13,287	431,900	6,608	8,278	0.0104	2.52	7.43
Michigan	13,798	418,479	9,943	17,024	0.0149	2.53	4.6
Minnesota	7,449	288,727	5,339	8,165	0.0103	2.46	6.36
Mississippi	2,530	97,831	2,964	7,914	0.0060	2.63	3.19
Missouri	5,614	265,009	5,984	7,151	0.0096	2.47	4.61
Montana	1,354	40,172	996	2,014	0.0074	2.42	4.97
Nebraska	2,928	97,913	1,837	2,788	0.0170	2.46	6.01
Nevada	2,967	131,667	2,720	2,682	0.0075	2.68	4.73
New Hampshire	3,422	67,009	1,323	1,732	0.0179	2.49	6.07
New Jersey	24,947	515,628	8,788	11,759	0.0187	2.71	3.7
New Mexico	1,335	85,888	2,050	5,565	0.0060	2.64	3.96
New York	45,596	1,274,318	19,422	40,021	0.0135	2.62	4.62
North Carolina	8,635	439,453	9,583	13,595	0.0079	2.51	5.18
North Dakota	789	42,238	695	1,549	0.0129	2.28	6.93
Ohio	13,562	535,710	11,551	12,018	0.0147	2.47	4.17
Oklahoma	2,285	165,534	3,770	7,849	0.0082	2.53	4
Oregon	4,904	176,240	3,863	7,283	0.0089	2.49	5.53
Pennsylvania	16,640	626,841	12,692	23,191	0.0138	2.47	4.35
Rhode Island	2,250	51,298	1,056	2,470	0.0132	2.49	5.01
South Carolina	4,845	175,678	4,658	7,672	0.0055	2.53	4.2
South Dakota	977	40,815	822	1,410	0.0122	2.44	5.96
Tennessee	5,074	277,086	6,378	11,560	0.0074	2.51	4.24
Texas	40,071	1,349,514	25,564	33,099	0.0176	2.82	5.59
Utah	2,558	127,667	2,790	3,186	0.0061	3.11	6.36
Vermont	1,371	27,804	625	1,664	0.0157	2.36	5.56
Virginia	11,332	434,326	8,060	8,395	0.0079	2.58	5.83
Washington	8,790	394,926	6,799	8,597	0.0090	2.53	5.94
West Virginia	1,408	66,055	1,844	3,908	0.0050	2.41	3.65
Wisconsin	9,242	268,659	5,689	9,967	0.0168	2.42	5.19
Wyoming	1,287	37,703	562	1,246	0.0055	2.47	5.58

Table 2. Descriptive Statistics for the Years (Averaged by 50 states)

Year	Property Tax Revenue (Million $)	GDP (Million $)	Population (Thousands)	Federal Transfer (Million $)	Property Tax Rate	Household Size	Governance
2006	7,267	272,869	5,956	7,373	0.0095	2.56	5
2007	7,748	285,437	6,013	7,585	0.0095	2.55	5
2008	8,156	290,440	6,013	7,764	0.0095	2.56	5
2009	8,661	284,998	6,070	9,260	0.0095	2.55	5
2010	8,842	295,640	6,174	11,245	0.0095	2.54	5
2011	8,880	306,426	6,219	11,354	0.0099	2.55	5
2012	8,884	319,421	6,265	10,239	0.0103	2.56	5
2013	9,025	331,133	6,308	9,975	0.0106	2.57	5
2014	9,265	345,758	6,354	10,315	0.0108	2.58	5
2015	9,642	359,644	6,401	11,346	0.0106	2.58	5
2016	10,017	369,290	6,448	11,665	0.0106	2.58	5

Table 3. Descriptive Statistics for the Full Sample (Averaged by years)[16]

State/Country	Property Tax Revenue (Million $)	GDP (Million $)	Population (Thousands)	Federal Transfer (Million $)	Household Size
Alabama	2,448	182,397	4,771	9,170	2.52
Alaska	1,306	52,434	713	2,892	2.77
Alberta	8,181	311,243	4,006	4,593	2.60
Arizona	6,791	268,778	600	11,368	3.48
Arkansas	1,756	106,734	2,919	6,045	2.51
Australia	2,497,703	969,510	302		2.83
Australian Capital Terrotory	466	44,754	387		2.55
Austria	203,638	361,340	8,452		2.28
Belgium	1,380,628	435,520	106		2.67
British Columbia	8,385	216,345	2,079	5,867	4.05
California	53,002	2,162,854	37,556	73,316	2.93
Canada	5,213,817	1,406,995	34,222		2.54
Chile	320,555	336,077	17,471		3.45
Colorado	6,712	274,227	5,109	7,134	2.53
Connecticut	9,224	243,089	3,567	3,144	2.55
Czech Republic	125,634	288,359	741		2.77
Delaware	693	61,082	905	1,599	2.60
Denmark	453,754	245,804	5,599		2.14
Estonia	9,299	31,777	1,334		2.30
Finland	252,398	209,248	5,374		2.10
Florida	26,028	792,266	19,179	23,337	2.56
France	9,057,050	2,378,147	65,379		2.40
Georgia	10,479	447,658	9,755	12,357	2.70
Germany	2,988,512	3,303,394	80,935		2.01
Greece	631,452	298,465	10,994		2.66
Hawaii	1,331	72,254	1,371	2,059	2.93
Hungary	239,479	224,986	9,954		2.53
Iceland	30,056	13,045	315		2.57
Idaho	1,365	58,532	1,576	2,382	2.65
Illinois	23,990	703,272	12,805	13,200	2.63
Indiana	6,726	293,299	6,497	9,378	2.53
Iowa	4,285	152,068	3,059	5,527	2.40
Ireland	402,556	216,183	4,491		2.73
Israel	757,883	236,276	7,908		3.47
Italy	4,925,787	2,073,733	59,623		2.38
Japan	11,480,156	4,518,232	127,600		2.53
Kansas	3,893	135,409	2,851	3,842	2.49
Kentucky	3,007	171,493	4,346	9,043	2.49
Korea	4,552,579	1,552,496	49,888		2.88
Latvia	37,906	41,013	2,106		2.53
Lithuania	21,400	67,073	3,103		2.39
Louisiana	3,430	222,905	825	10,288	2.84
Luxembourg	130,066	43,647	510		2.54
Maine	2,379	52,794	162	2,593	2.71
Manitoba	2,060	57,389	1,274	3,428	2.50
Maryland	8,031	326,434	5,819	9,035	2.64
Massachusetts	13,287	431,900	6,608	8,278	2.52
Mexico	537,764	1,827,143	1,024		2.80
Michigan	13,798	418,479	9,943	17,024	2.53
Minnesota	7,449	288,727	5,339	8,165	2.46
Mississippi	2,530	97,831	2,964	7,914	2.63
Missouri	5,614	265,009	5,984	7,151	2.47
Montana	1,354	40,172	996	2,014	2.42
Nebraska	2,928	97,913	1,837	2,788	2.46

[16] Data for Chile are included in the regression, but not in the descriptive table, since its currency unit is different from other countries. This is not a problem in the regression, as we only use within variations in fixed effects models.

Table 3 (continued). Descriptive Statistics for the Full Sample (Averaged by years)

State/Country	Property Tax Revenue (Million $)	GDP (Million $)	Population (Thousands)	Federal Transfer (Million $)	Household Size
Netherlands	1,090,903	751,763	16,644		2.27
Nevada	2,967	131,667	2,720	2,682	2.68
New Brunswick	1,156	29,410	759	2,603	2.30
New Hampshire	3,422	67,009	1,323	1,732	2.49
New Jersey	24,947	515,628	8,788	11,759	2.71
New Mexico	1,335	85,888	2,050	5,565	2.64
New South Wales	6,461	517,175	7,484		2.60
New York	45,596	1,274,318	19,422	40,021	2.62
New Zealand	276,381	140,136	4,387		2.67
Newfoundland and Labrador	423	31,026	527	820	2.35
North Carolina	8,635	439,453	9,583	13,595	2.51
North Dakota	789	42,238	695	1,549	2.28
Northern Terrotory State	103	27,095	239		2.90
Northwest Territories	71	4,542	44	1,177	2.75
Norway	350,416	294,052	4,997		2.15
Nova Scotia	1,306	34,969	942	2,919	2.30
Nunavut	16	2,316	36	1,392	3.65
Ohio	13,562	535,710	898	12,018	2.88
Oklahoma	2,285	165,534	3,770	7,849	2.53
Ontario	28,634	657,340	13,571	19,234	2.60
Oregon	4,904	176,240	3,863	7,283	2.49
Pennsylvania	16,640	626,841	12,692	23,191	2.47
Poland	1,115,706	808,202	38,371		2.90
Portugal	326,250	280,899	10,490		2.65
Prince Edward Island	166	5,210	145	537	2.35
Quebec	13,166	335,959	8,119	19,224	2.30
Queensland	4,604	327,366	4,671		2.60
Rhode Island	2,250	51,298	1,056	2,470	2.49
Saskatchewan	1,519	76,810	7,101	1,384	3.34
Slovak Republic	57,007	132,907	5,408		2.89
Slovenia	34,009	56,344	2,038		2.70
South Australia State	2,036	105,744	1,676		2.40
South Carolina	4,845	175,678	4,658	7,672	2.53
South Dakota	977	40,815	822	1,410	2.44
Spain	3,497,143	1,476,801	46,356		2.59
Sweden	434,973	405,278	9,542		2.14
Switzerland	837,033	420,128	7,889		2.32
Tasmania	462	30,962	317		3.12
Tennessee	5,074	277,086	6,378	11,560	2.51
Texas	40,071	1,349,514	25,564	33,099	2.82
Turkey	1,452,402	1,391,945	73,519		3.67
United Kingdom	9,319,319	2,348,265	62,989		2.38
United States	48,492,621	15,714,450	313,700		2.58
Utah	2,558	127,667	2,790	3,186	3.11
Vermont	1,371	27,804	1,781	1,664	2.54
Victoria	6,337	395,677	5,867		2.60
Virginia	11,332	434,326	8,060	8,395	2.58
Washington	8,790	394,926	6,799	8,597	2.53
West Virginia	1,408	66,055	1,844	3,908	2.41
Western Australia State	2,819	210,705	2,458		2.60
Wisconsin	9,242	268,659	5,689	9,967	2.42
Wyoming	1,287	37,703	562	1,246	2.47
Yukon	36	2,430	37	856	2.35

Table 4. Hausman Test

	Chi2	Prob>Chi2
Equation 3	34.56	0.0028
Equation 4	28.37	0.0286
Equation 7	242.00	0.0000
Equation 8	22.99	0.0843

Table 5. Regression Results for the U.S. Sample

	Dependent Variable: Property Tax Revenue					
log GDP	0.836***	0.781***	0.179**	0.176**	0.291***	0.280***
	(0.076)	(0.081)	(0.060)	(0.061)	(0.058)	(0.060)
log Population	0.164*	0.204*	0.617***	0.627***	0.750***	0.762***
	(0.082)	(0.084)	(0.183)	(0.187)	(0.070)	(0.072)
log Federal Transfer	-0.044	-0.021	-0.036*	-0.036*	-0.0473**	-0.0465**
	(0.027)	(0.030)	(0.017)	(0.017)	(0.017)	(0.017)
Property Tax Rate	0.580***	0.575***	0.079	0.081	0.252***	0.253***
	(0.031)	(0.031)	(0.057)	(0.057)	(0.045)	(0.045)
Household Size	0.046	0.066	-0.447***	-0.449***	-0.331**	-0.336**
	(0.067)	(0.071)	(0.114)	(0.114)	(0.107)	(0.107)
Governance		0.030*		0.002		0.005
		(0.012)		(0.007)		(0.007)
Constant	-3.042***	-3.152***	4.075	3.984	1.344*	1.272*
	(0.301)	(0.304)	(2.761)	(2.793)	(0.606)	(0.618)
Fixed Effects	NO	NO	YES	YES	NO	NO
Random Effects	NO	NO	NO	NO	YES	YES
N. of Obs	550	550	550	550	550	550
Adjusted R2	0.946	0.946	0.742	0.742	0.916	0.917

Standard errors in parentheses

* p<0.05, ** p<0.01, *** p<0.001

Table 6. Regression Results for the Full Sample

	Dependent Variable: Property Tax Revenue					
log GDP	0.859***	1.062***	0.275***	0.091	0.812***	0.151**
	(0.006)	(0.060)	(0.038)	(0.055)	(0.013)	(0.053)
log Population	0.740***	0.068	1.074***	0.896***	0.704***	0.919***
	(0.028)	(0.056)	(0.124)	(0.147)	(0.044)	(0.060)
Household Size	-0.538***	-0.716***	-0.628***	-0.747***	-0.406***	-0.725***
	(0.148)	(0.051)	(0.045)	(0.090)	(0.052)	(0.083)
log Federal Transfer		-0.0786**		-0.024		-0.025
		(0.026)		(0.016)		(0.016)
Constant	-10.56***	-2.916***	-7.130***	-4.276*	-9.713***	-5.365***
	(0.559)	(0.278)	(1.745)	(2.070)	(0.712)	(0.511)
Fixed Effects	NO	NO	YES	YES	NO	NO
Random Effects	NO	NO	NO	NO	YES	YES
N. of Obs	1275	654	1275	654	1275	654
Adjusted R2	0.892	0.947	0.684	0.75	0.892	0.932

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001