The Effects of the Two-Rate Property Tax: What Can We Learn from the Pennsylvania Experience?

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Abstract

This paper empirically investigates the effects of the two-rate (split-rate) property taxation on the capital intensity of land development in Pennsylvania. This study makes the first attempt to overcome the major data limitations in the existing literature and further enriches the dataset by including the most recent policy changes. Using the new dataset, the study improves estimation efficiency and controls for potential biases in the estimates. Consistent with previous studies, the results indicate that taxing land at a higher rate than structures on land increases the capital/land ratio. Further, this improvement effect comes from increased density of housing units rather than bigger houses. The estimates in this paper are bigger than the ones in the literature, suggesting a stronger impact of the two-rate property tax. The findings have important policy suggestions regarding the use of tax instruments to combat urban sprawl.

Keywords: Two-Rate Property Taxation, Land Value Taxation, Urban Sprawl

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Introduction

Research on land value taxation has a long and rich history. Both scholars and practitioners have considered possible property tax reforms based on efficiency and equity concerns. As Henry George argued, the government should finance all of its projects with proceeds from only the "single tax" on land. Theoretically, a pure land value tax would not distort economic behavior if the land assessments are based on the best possible use (Oates and Schwab 1997). However, such taxes may not be politically acceptable due to the distributional implications. In reality, conventional property tax is imposed both on land and structures on land at the same rate in most states. Nevertheless, Pennsylvania's approach to property tax reform recognizes the important distinction between land and building values through the two-rate or split-rate property tax. Instead of taxing land and structures at the same rate, a two-rate tax would tax land at a higher rate than structures on land. This two-rate tax system theoretically creates incentives for property owners to build and improve their properties, and disincentives to engage in land speculation. In addition to the U.S. experience, land or two-rate taxes have also been implemented in other countries, such as Australia, Denmark, and parts of Indonesia (Youngman and Malme 1994). Interestingly, Finnish governments allowed municipalities to levy an extra property tax on undeveloped land in 2001. Finnish municipalities that implemented this tax instrument have a three-rate property tax system with varying tax rates on land before development, land after development and buildings. The rest of the municipalities utilize a two-rate system with one land tax and a tax on buildings (Lyytikäinen 2009).

As local governments strive to find a better way to generate sufficient tax revenue as well as to increase the efficiency of taxation, the two-rate property taxation has been considered as one possible way to reform current property tax system in the United States. In 2013, Connecticut governor signed a bill that allows for a pilot program for up to three municipalities to implement a two-rate property tax.[1] An important argument for the two-rate tax system relies on its potential to combat urban sprawl by alleviating conventional property tax's distortionary effect on the capital/land ratio and increasing the capital stock per unit of land (Banzhaf and Lavery 2010). The increased capital/land ratio ("improvement effect") suggests that the municipality is denser and can potentially accommodate more households. The implicit assumption for this argument is that the two-rate tax promotes the construction of more housing units per unit of land ("density effect") rather than bigger houses ("dwelling size effect").[2]

Despite the rich discussions on the two-rate property taxation, empirical evidence on its impacts is still very limited. This paper explores the effects of differential taxes on land and structures by constructing a new and richer panel dataset that covers recent rescindments and adoptions of the

[1] HB 6706, Section 329.

[2] The size of housing must remain somewhat constant. Brueckner (2001) and Brueckner and Kim (2003) offered important analyses on urban sprawl and property taxation.

two-rate tax in Pennsylvania municipalities. Moreover, this research makes the first attempt to collect the property tax rates in both single-rate and two-rate municipalities, enabling me to overcome the major data limitations in the existing literature and better specify the two-rate property tax structure in the empirical model. To best utilize the data available and explore both short-run and long-run impacts, two alternative estimation methods are employed to estimate a broad set of effects of the two-rate property taxation on the capital intensity of land development. Consistent with the findings of Banzhaf and Lavery (2010), the results using the first estimation method suggest that the two-rate tax increases the capital/land ratio and this improvement effect primarily comes from increased density of housing units per unit of land rather than bigger houses. The point estimates in this study are larger than the ones found by Banzhaf and Lavery (2010) due to different specifications of the property tax structure variable and inclusions of the most recent policy changes. Further, this paper also finds evidence that the two-rate property tax has a positive short-run effect on construction activity. The results utilizing the alternative estimation method confirm the findings of Plassmann and Tideman (2000) and further offer a picture of the dynamic responses to the two-rate property taxation.

The remainder of this paper is organized as follows. The next section provides a brief literature review highlighting the insights and limitations of previous studies, followed by the section on estimation methods and data description. The last two sections discuss the empirical results and conclude the paper with policy discussions.

Literature Review

The empirical literature on the effect of the two-rate property taxation is very limited despite the rich discussions about the two-rate tax.[3] This is largely due to few actual implementations of the tax. The existing studies generally focus on policy changes in Australia and the United States. Almost all U.S. studies concentrate on the effect of the property tax changes in Pennsylvania because it is the only state that has adopted the two-rate tax since 1913. Based on a cross-sectional analysis of 27 PA cities, Mathis and Zech (1982) investigated the effect of the two-rate tax on construction activity, but they did not find a significant impact. Bourassa (1990) examined the effects of land value taxation on housing developments in three cities of Pennsylvania: Pittsburgh, McKeesport, and New Castle. In particular, the paper investigates two ways that land value taxation can influence the development of unused parcels using residential housing data. One is the "liquidity effect": increases in the land tax rate create a cash-flow incentive for premature development of unused land parcels. The other is the "incentive effect": decreases in the tax rate on improvements encourage improvements on the land, resulting in more efficient use of land. The paper finds no evidence of a liquidity effect in any of the three cities, but finds an incentive effect in Pittsburgh.

Oates and Schwab (1997) employed a richer dataset covering both residential and nonresidential sectors and found that Pittsburgh experienced a significant increase in levels of building activity relative to other Midwestern cities during the 1980s, despite the sharp decline of the city's steel industry. They recognized that the findings were based on a single city in a special macroeco-

[3] See Anderson (2009) for a detailed review of evidence.

nomic environment at the time and they were unable to separate the effect of property tax reform from other economic events. In a more recent study, Plassmann and Tideman (2000) compared 15 Pennsylvania cities that tax land value at a higher rate than improvements with similar sized single-rate Pennsylvania cities between 1972 and 1994. The results suggest that higher tax rates on land value lead to increased construction within the jurisdiction.

The most recent paper by Banzhaf and Lavery (2010) used the decennial Census data from 1970 to 2000 to explore the effects of the two-rate tax. The paper takes a new and very interesting approach by decomposing the improvement effect of the two-rate tax into the density and dwelling size effects. The results imply that the adoption of the two-rate property tax raises the capital/land ratio. More importantly, the primary effect relies on more housing units rather than bigger houses, suggesting the two-rate tax can be used to control urban sprawl.

The papers above provide valuable insights regarding the effects of the two-rate property taxation. Nevertheless, existing papers may suffer from data and/or estimation limitations. First, previous studies do not utilize the policy changes since 2000. However, additional Pennsylvania cities have subsequently adopted the two-rate property tax since then. Moreover, eight jurisdictions have increased the land-to-structure tax ratio since 2000. On the other hand, five jurisdictions abandoned the two-rate tax and returned to the conventional property tax during recent decade. For instance, Pittsburgh reverted to the conventional property tax after 2000 due to a drastic increase in assessed land value after the property reassessment.[4] Further, seven jurisdictions have reduced the tax ratio since 2001.[5] These recent policy changes create important variation in the data, providing a good opportunity to investigate the effects of the two-rate tax.[6]

Second, recent papers include all of the Pennsylvania cities that adopted the two-rate tax over their sample periods, but only utilize the land-to-structure tax ratio or tax differential instead of the level of taxation on land and structures in the model specifications. As recognized in these papers, this is mainly due to the significant challenges of collecting tax data for all single-rate jurisdictions. However, the tax rate ratio (or tax differential) measure potentially loses the variation in the level of taxation on land and structures across two-rate jurisdictions and time. One can easily think of two jurisdictions with quite different tax rates on land and structures ending up with the same land-to-structure tax ratio. For example, the land-to-structure tax ratio was 2.06 in both Allentown and Coatesville in 1998; however, the land and structure tax rates in Coatesville were at least twice of those in Allentown. Similarly, a two-rate city that has changed both land tax and structure tax over time could have a small or no change in the tax ratio. More importantly, omitting the level of taxation could result in biased estimates in certain cases.

This paper recognizes the data limitations of previous research and makes the first attempt to collect the property tax rates for both single-rate and two-rate municipalities in Pennsylvania from 1970 to 2010, covering the recent property tax changes over the recent decade. In addition, it also utilizes alternative estimation methods based on data availability to offer a better picture

[4] Notwithstanding this change in 2001, the Pittsburgh Business Improvement District still employs a pure land value tax as a surcharge on the regular property tax.

[5] See Bourassa (2009) for an overview of the U.S. experience.

[6] See Table 1 for a list of the two-rate places in Pennsylvania.

of the effects of the two-rate property taxation on capital intensity of land development in Pennsylvania.

Estimation Methods and Data

This study employs two estimation methods to analyze the influence of the two-rate property taxation. The first method follows the empirical strategy proposed by Banzhaf and Lavery (2010) but modifies the model specification by adding the level of property taxation in the set of tax structure variables. This method uses the Census decennial data to measure the evolution of the housing stock in Pennsylvania county subdivisions over time. It provides enough time for tax policy changes to have an impact on land development. The second method recognizes the importance of annual variation in the tax structure variables and utilizes the combination of matching methods and regressions to explore any possible short-run impacts and the dynamics of responses to policy changes.

Estimation Method

Banzhaf and Lavery (2010) estimated a model using three outcome measures to separately identify the improvement, density, and dwelling size effects. The idea came from the following relationship: $\frac{\text{Capital}}{\text{Land}} = \frac{\text{Capital}}{\text{Housing Units}} \cdot \frac{\text{Housing Units}}{\text{Land}}$, where $\frac{\text{Capital}}{\text{Land}}$ measures the overall improvement effect; $\frac{\text{Capital}}{\text{Housing Units}}$ measures the dwelling size effect; and $\frac{\text{Housing Units}}{\text{Land}}$ measures the density effect. I follow this strategy and estimate the following model:

$$\text{PCT}\Delta\text{Outcome}_{\text{it}} = \propto_{\text{i}} + \beta_{\text{t}} + \gamma' \text{X}_{\text{it}-1} + \delta' \text{TR}_{\text{it}} + \varepsilon_{\text{it}}, \quad (1)$$

where $\text{PCT}\Delta\text{Outcome}_{it}$ denotes the percentage change in the outcome variable over decade t in county subdivision i; $\propto_i$, county subdivision fixed effects; β_t, decade fixed effects; $\text{X}_{\text{it}-1}$, a vector of lagged county subdivision demographic and land use variables; TR_{it}, a vector of property tax structure variables, and ε_{it}, a normally distributed error. Specific definitions of all variables are discussed below.

The dependent variable measures the percentage change in the outcome of land development. Following Banzhaf and Lavery (2010), I consider three outcome measures: the total number of rooms per unit land area (a proxy for the capital/land ratio, improvement effect), the average number of rooms per housing unit (a proxy for the capital/housing units ratio, dwelling size effect), and the number of housing units per unit land area (a proxy for the housing units/land ratio, density effect).

Tax structure variables include the level of tax rate on land and a variable capturing the two-rate property taxation.[7] In the baseline model, I use a dummy variable indicating whether the county subdivision adopted a two-rate tax over the relevant decade.[8] To account for differences in the

[7] Tax rates are adjusted by the assessment ratio to obtain the effective tax rates.

[8] Alternative definitions of the two-rate dummy variable are considered as robustness checks and discussed later.

tax differential, two alternative specifications are employed: replacing the dummy variable with the log of the land-to-structure tax ratio; replacing the dummy variable with the log of the difference between effective land tax rate and structure tax rate.[9] In addition, a dummy variable is employed to control for the impact of changes in the assessment base.

Similar to the previous study (Banzhaf and Lavery 2010), lagged demographic and land use variables are employed in the set of control variables. Table 2 presents the list of the variables. The model is estimated using the Census decennial data over the period 1970–2010.[10] In addition, the standard errors are clustered at the county level to allow for possible spatial correlations in the error term.

As noted by Banzhaf and Lavery (2010), this empirical specification implies that the effect of the two-rate tax is identified from changes in pre-existing trends in each area. For the model with the two-rate dummy, the effect is identified from county subdivisions that adopt the two-rate tax between 1980 and 2010. For the model with the land-to-structure tax rate ratio (or tax rate difference), the effect is identified from county subdivisions that change the tax ratio (or tax rate difference) during the period. It is worth noticing that the fixed effects help reduce concerns about the endogeneity of the two-rate tax variable. County subdivision might adopt the tax in response to changes in the tax base, but any endogeneity in the model would have to be conditional on pre-existing trends. Further, I test for potential endogeneity problem. The lagged two-rate tax variables are used as IVs to perform the Hausman-Wu endogeneity test. It is reasonable to believe that the higher-order lags of the two-rate tax variable are highly correlated with the contemporaneous tax variable, but they have no direct influence on the current growth rate of the outcome variable. In other words, the property tax structure several years ago directly affected the setup of current tax structure, but it would have little direct impacts on the current growth rate of land development. The test cannot reject the null hypothesis that the two-rate tax variable is exogenous.

Alternative Estimation Method

The above empirical model uses decennial data since the dependent and control variables are only decennially available. However, tax policy varies by year; especially a number of municipalities adopted the two-rate tax but abandoned or reduced the land-to-structure tax ratio within a decade. In order to fully utilize the variation in the property tax structure data, I consider an alternative data source for the dependent variable, the annual building permits data. As mentioned earlier, Oates and Schwab (1997) and Plassmann and Tideman (2000) utilized the annual building permits data to investigate the effect of the two-rate tax on construction activity. It is important to note that the building permits data include not only housing units completed, but also those under construction and those authorized to be built (but not yet started); therefore, if there is any short-run effect on land development associated with changes in the property tax policy, this dataset should provide a better chance to explore the impact.

[9] The land-to-structure tax ratio and the tax rate difference are averaged over the decade similar to previous studies using decennial data.

[10] The data on total number of rooms at county subdivision level in 2010 is not available from 2010 Census; instead, the estimate from American Community Survey is used. The measurement error in the dependent variable due to data inconsistency would not bias coefficient estimates, but it would lead to larger standard errors.

One problem still remains, that is, control variables are still decennially observable at county subdivision level, even though I can obtain annual data for my dependent and tax structure variables. To best utilize the variation in the data but still control for other factors influencing construction activity, the following two-stage method is employed: first, I use matching methods to identify the single-rate county subdivisions that are most similar to the two-rate county subdivisions based on covariates using decennial data[11]; second, I estimate a model using the matched sample with annually available county-level economic and demographic controls and year and county subdivision fixed effects.

The rationale behind the two-stage estimation method is similar to the one that Plassmann and Tideman (2000) discussed. The reduction of the sample size by selecting single-rate county subdivisions that are similar to the two-rate cities can control for potential effects of omitted variables at county subdivision level that vary over time. As Plassmann and Tideman argued, only municipalities that are in a situation somewhat similar to the two-rate cities are included in addition to the two-rate cities; hence, one would expect that omitted county subdivision variables show a similar variation over time in the reduced sample, and that the effects can be captured by the year dummies. Note that the selection of single-rate municipalities would not introduce a sample selection bias in the analysis, because the two-rate tax variable (tax rate difference or dummy) is zero for all single-rate municipalities over the sample period, and its impact is thus estimated through intra-municipality variation across time rather than inter-municipality variation. Moreover, this study also includes county-level economic and demographic variables to additionally control for changes in economic conditions at the county level. Finally, this paper further modifies the selection of single-rate municipalities in the previous study by utilizing matching methods to identify county subdivisions that are most similar to the two-rate cities based on a more comprehensive set of covariates.[12] The following first-differenced model is then estimated using the constructed sample:

$$\Delta \mathrm{Outcome}_{\mathrm{ijt}} = \rho \Delta \mathrm{Outcome}_{\mathrm{ijt-1}} + \theta' \Delta \mathrm{C}_{\mathrm{jt}} + \delta' \Delta \mathrm{TR}_{\mathrm{ijt}} + \Delta Y_t + \Delta \varepsilon_{\mathrm{ijt}}, \quad (2)$$

where $\Delta \mathrm{Outcome}_{\mathrm{ijt}}$ measures the change in construction activity in county j subdivision i from year $t-1$ to t. C_{jt} is a vector of annually available economic and demographic controls (a subset of control variables defined in the first method) for county j.[13] The tax structure variables are defined in the same way as in the previous model specification.[14] Year fixed effects are included (county subdivision fixed effects drop out of the difference specification).

[11] Following Rosenbaum and Rubin (1983), I match the two-rate ("treatment") and single-rate county subdivision ("control") observations in the same year based on the predicted probability that the county subdivision has the two-rate tax. Each two-rate city is matched with 5 single-rate county subdivisions.

[12] Plassmann and Tideman (2000) selected their single-rate municipalities based on population size, population density and population growth.

[13] Specifically, the following county-level controls are included: percentage of black population, percentage of white population, percentage of population aged 65 and above, percentage of population below 15 years old, percentage of males, total population, unemployment rate and income per capita.

[14] For the differenced model specification, two alternative measures are considered for the two-rate tax variable: the two-rate dummy and the rate difference between the land tax and the tax on structures. In addition, the tax rate difference variable enters the equation in its linear form rather than the log form.

As proxies for the improvement, density and dwelling size effects, the following three outcome measures are employed: the total construction value of building permits per unit of land (a proxy for the capital/land ratio, improvement effect), the average construction value per permit (a proxy for the capital/building permits ratio, dwelling size effect), and the number of building permits per unit of land (a proxy for the building permits/land ratio, density effect). Arellano-Bond dynamic panel estimator is used for the above equation. In addition, as alternative specifications, the lags of the two-rate tax variable are also included to explore the dynamic effects.

Data

Collecting tax data at the local level is very challenging and time consuming. The study makes the first attempt to construct the property tax dataset for all county subdivisions in Pennsylvania over the period 1970–2010. With substantial data collection efforts, I obtained the property tax data for all county subdivisions, although the number of observations for each county subdivision varies. The property tax data are mostly obtained from tax assessment offices and/or city treasurer's offices in Pennsylvania.

Table 1 reports the list of two-rate cities in Pennsylvania as well as first and last adoption years. As shown in the table, cities switched from the conventional property tax to the two-rate tax in different years. In addition, three cities switched from the conventional property tax to the two-rate tax over the recent decade whereas five cities reverted to the conventional property tax after 2000. The land-to-structure tax ratio varies across the two-rate cities as well as across time. Further, it is worth mentioning that deviations in the land tax rate and the tax rate on structures are greater than the deviation in the land-to-structure tax ratio, which suggests that using only the tax rate ratio significantly reduces the amount of the variation in the data. Moreover, a number of cities have increased their tax rates on land and lowered the tax rates on structures over time. The average land-to-structure tax ratio in the two-rate cities trends upward over the sample period.

The demographic and land use data at the county subdivision level are collected from the Census Bureau and National Historical Geographic Information System database. The building permits data are obtained from the Census Bureau as well.[15] Annual county-level economic and demographic data are obtained from the Bureau of Economic Analysis and the Census Bureau. As discussed earlier, these county-level variables help control for other factors influencing the construction decision when the data at the county subdivision level are not available.

Results

Regression results using the first estimation method are summarized in Table 3. Three outcome measures are employed as well as three model specifications for different measures of the two-rate property tax variable. Each outcome and model combination represents a separate regression. All models include the level of taxation on land in addition to the two-rate tax variable. Estimates of the coefficient on the two-rate tax variable using different outcome measures and

[15] The building permits data are collected for the period 1980-2010.

models are reported in the table. Model 1 employs the two-rate dummy indicator as the measure for the two-rate property tax variable. Models 2 and 3 exploit the tax rate differential (land tax rate minus the tax rate on structures) and land-to-structure tax rate ratio respectively.[16]

The set of results for the improvement effect (the first outcome block in Table 4) suggest that implementing the two-rate property tax increases the capital/land ratio. The coefficients are significantly positive in all three model specifications. The results from Model 1 (dummy specification) imply that the adoption of the two-rate tax increases the total number of rooms by about 8.3% points. The effect is smaller using Model 2 (tax-difference specification) or Model 3 (tax-ratio specification); however, the coefficients are not directly comparable. To make the coefficient on the tax rate difference variable comparable to the one on the two-rate dummy, one can multiply the coefficient in Model 2 by the log of average effective tax differential in the two-rate cities.[17] The comparable estimate implies that the total number of rooms would rise by 6.8% points if a single-rate county subdivision increases the tax rate difference from zero to the average effective tax rate difference in the two-rate cities. Similarly, one can also transform the coefficient on the tax ratio variable and make it comparable to the coefficient on the two-rate dummy variable.

The results for the improvement effect from all three model specifications are consistent with the economic theory and previous studies, but my estimates are bigger than the ones found by Banzhaf and Lavery (2010).[18] This is partially because my sample covers tax policy changes after 2000 and I also control for the level of property taxation. As a robustness check, I drop the level of taxation on land and just include the dummy variable as in previous studies. I find that the magnitude of the coefficient decreases when doing so. This exercise indicates that it is important to account for the level of taxation when estimating the effects of the two-rate property taxation.

The results for the dwelling size effect are mostly insignificant across models except in Model 3. According to Models 1 and 2, two-rate cities and single-rate municipalities experience a similar growth in the average dwelling size. The coefficient estimate in Model 3 suggests there is a significantly positive effect on the average number of rooms per housing unit even though it is relatively small.

Finally, the results also show evidence of the density effect. As reported in Table 3, switching from the conventional property tax to the two-rate tax would lead to an increase in the total number of housing units by about 8.4% points based on the results in Model 1. Model 2 estimates an effect of about 2% points, which translates into about 6.4 more percentage points in the growth of the total number of housing units for a single-rate county subdivision that reduces the tax rate on structures below the tax rate on land by the amount of average effective tax differential. Combing the three sets of results suggest that switching from the conventional property tax to the two-rate property tax or further raising the tax differential would increase the capital/land

[16] Tax rate difference and land-to-structure tax ratio variables are in log form.

[17] The log of the average effective tax rate difference in the two-rate cities is about 3.2; therefore, the comparable estimate is about 6.8% (3.2*2.14%).

[18] Banzhaf and Lavery (2010) reported an estimated effect of 5-6% points for the improvement effect using the model with the two-rate dummy variable.

ratio. Moreover, this improvement effect primarily comes from the increased density of housing units instead of larger housing units.[19] The results suggest that the two-rate property taxation can be used as a way to mitigate urban sprawl and encourage improvements on land.

Additional robustness checks are also performed. I first replace the total level of taxation on land with separate tax rates on land at county, school district and county subdivision levels to allow for any differential effects of taxation by various levels of governments.[20] The results are similar to the ones reported in Table 3, but the magnitude of the coefficient on the two-rate tax variable increases a little bit. Second, I redefine the two-rate dummy variable to account for the adoption by the midpoint of each decade or alternatively the adoption by the beginning of each decade. The results remain qualitatively unchanged.

The second empirical method estimates a first-differenced model using the matched sample and annual building permits data. The results are summarized in Table 4. The estimated coefficients on the tax rate difference variable and its lags are reported in the first row for each outcome panel.[21] The coefficient on the contemporaneous tax rate difference (Column 3 of Table 4) is positively significant in the regressions for improvement and density effects, suggesting that the two-rate property taxation has a positive short-run impact on construction activity. Both the total value of building permits and the number of building permits rise when a given county subdivision increases the tax rate difference between the land tax and the tax on structures. An increase in the effective tax differential of 1 mill will yield an increase of $4,637 in the total value of construction per square mile in the short run. Interestingly, the effect on the value per building permit is mixed. Increases in the current tax differential reduce the value per permit whereas rises in the tax differential last year raise the value per permit. This may reflect the dynamics of the responses to changes in the two-rate property taxation. The overall results for the three outcome measures seem to suggest that the two-rate property tax has a positive influence on construction activity in the short run. The findings from the second estimation method are generally consistent with previous research that explores the effects of the two-rate property taxation using building permits data. In addition, it provides some evidence of the dynamics of the impacts.

Conclusion

The two-rate property taxation has been advocated as a good tax instrument to encourage improvements on land and increase taxation efficiency when a pure land value tax is not politically feasible. Consistent with previous studies, this paper provides additional evidence supporting this argument. This paper makes the first attempt to collect data on the level of property taxation for both single-rate and two-rate county subdivisions in Pennsylvania to overcome the major data limitations in the existing literature. The constructed tax dataset allows me to better specify the two-rate property tax structure in the empirical model as well as to utilize important policy

[19] The interpretation of the results is subject to housing structures (vertical or horizontal) and room size.

[20] The three levels of property tax rates enter the model separately instead of the combined effective tax rates on land.

[21] The level of taxation on land is controlled as in the previous model. Tax rate difference enters the model in linear form.

changes over the recent decade. Two alternative estimation methods are employed to estimate a broad set of effects of the two-rate property taxation on the capital intensity of land development.

The results demonstrate that capital/land ratio increases in those municipalities that switch from the conventional property tax to the two-rate tax and those that have a higher tax differential between the land tax and the tax rate on structures. Confirming the findings of Banzhaf and Lavery (2010), the paper finds significant improvement and density effects but little or small dwelling size effect, suggesting that the increased capital intensity of land development resulting from the two-rate property taxation primarily comes from greater density of housing units in a given jurisdiction rather than larger houses. The estimates in this paper are bigger than those in the existing literature, indicating a stronger impact of the two-rate property taxation on capital intensity of land development. In addition, the results also imply that the two-rate property tax has a positive influence on construction activity in the short run. In general, the findings suggest that the two-rate property tax can be used an instrument to combat urban sprawl if appropriately designed.

These findings have important policy implications for those populous cities that are looking for a better way to reform the property tax system as well as to control urban sprawl. Further research on the spatial effects of the two-rate property taxation is needed to investigate the full set of impacts of the two-rate property tax.

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Tables

Table 1. Two-Rate Cities in Pennsylvania

Area Name	Starting Year	Last Year	Land-to-Structure Tax Ratio	
			Mean	SD
Aliquippa	1988	–	10.77	3.79
Allentown	1997	–	4.07	1.13
Altoona	2003	–	16.73	19.33
Clairton	1989	–	11.61	8.36
Coatesville	1991	2005	2.13	0.27
Connellsville	1992	2003	6.68	0.46
DuBois	1991	–	18.85	15.98
Duquesne	1985	–	2.03	0.36
Ebensburg	2000		3.30	0.68
Harrisburg	1975	–	3.74	1.54
Hazleton	1991	1992	3.30	0.20
Lock Haven	1991	–	4.17	1.07
McKeesport	1980	–	4.33	0.54
New Castle	1982	–	3.43	0.62
Oil City	1989	2002	2.83	0.71
Pittsburgh	1913	2000	4.48	1.67
Scranton	1913	–	4.27	1.13
Steelton	2000	2007	1.58	0.57
Titusville	1990	–	3.44	0.35
Washington	1985	–	13.09	7.60

Notes: Statistics for the cities that have already rescinded the two-rate tax are based on the data from the initial adoption to the latest effective year, except for Pittsburgh. Uniontown is excluded because it abolished the two-rate tax after only a year.

Table 2. County Subdivision Demographic Characteristics

Variable	Two-Rate County Subdivisions (Mean)	Single-Rate County Subdivisions (Mean)
Pct age < 15	25.55%	27.78%
Pct age > 65	16.80%	13.54%
Pct Black	14.13%	1.30%
Pct White	83.06%	95.87%
Pct Hispanic	1.80%	0.67%
Pct male	46.39%	49.06%
Pct in poverty	15.76%	9.32%
Pct unemployed	7.97%	5.96%
Pct age ≥ 25 with no high school diploma	10.34%	10.58%
Pct age ≥ 25 with bachelor's degree and above	6.66%	7.28%
Pct housing units >30 years old	73.24%	51.71%
Pct housing units <10 years old	4.90%	14.77%
Pct people in urban areas	61.82%	21.63%
Pct housing units vacant	15.30%	23.10%
Pct owning home	57.38%	78.30%
Average family income	26285.53	30848.51
Population per square mile	4546.83	1248.61
Rooms per square mile	10074.23	2846.12
Average # rooms per unit	5.43	5.74
Households per square mile	1731.56	471.23
Average monthly rent	255.82	173.84
Degrees Latitude	40.63	40.73
Degrees Longitude	-78.60	-77.72
N	76	10230

Notes: The statistics for the two-rate county subdivisions are based on all county subdivisions that had ever implemented the two-rate property tax over the sample period excluding Uniontown and Hazleton city. The demographic and land use controls are lagged one decade in the model; therefore, the statistics are calculated using 1970, 1980, 1990 and 2000 Census data.

Table 3. Effects of the Two-Rate Tax on Outcomes (Method 1)

	Policy Variable	**Model 1** Two-Rate Dummy	**Model 2** Tax Difference (Land-Structure)	**Model 3** Tax Rate Ratio (Land/Structure)
Outcome	**Proxy**			
Improvement Effect	Pct Change in Total # Rooms	0.083**	0.021**	0.032**
		(0.046)	(0.012)	(0.020)
		[0.762]	[0.770]	[0.772]
Size Effect	Pct Change in Avg # Rooms per Unit	-0.004	0.005	0.011**
		(0.015)	(0.004)	(0.007)
		[0.481]	[0.481]	[0.481]
Density Effect	Pct Change in # Housing Units	0.084**	0.016*	0.019
		(0.042)	(0.012)	(0.019)
		[0.730]	[0.734]	[0.736]

Notes: All models include the level of taxation on land. Each outcome and model combination represents a separate regression. Estimates are shown in the first row for each outcome and model cell. Robust standard errors are shown in parentheses with adjusted R^2 in square brackets. The control variables are listed in Table 2 plus squares of those terms (excluding latitude and longitude), and decade interactions with latitude, longitude and latitude*longitude. ***, ** and * denote one-tail test significant at 1%, 5% and 10% respectively.

Table 4. Effects of the Two-Rate Tax on Construction Activities (Method 2)

	Policy Variable	Tax Difference (Land-Structure)			
Outcome	**Proxy**	Current Period	One-year Lag	Two-year Lag	Three-year Lag
Improvement Effect	Change in Construction Value per Land Area	4636.797*	-689.104	-175.256	-806.977
		(3464.260)	(3729.517)	(3764.618)	(3237.854)
Size Effect	Change in Avg. Value per Permit	-2847.052***	2710.257**	-719.411	708.849
		(968.925)	(1423.609)	(1307.728)	(1026.284)
Density Effect	Change in # Building Permits per Land Area	0.056**	-0.001	-0.006	-0.009
		(0.033)	(0.034)	(0.035)	(0.030)

Notes: The results are based on the second method that employs a first-differenced model with county-level controls and year fixed effects on the matched sample. Estimates from the regression including tax rate differential and its lags are reported in the first row for each outcome measure. Standard errors are shown in parentheses. ***, ** and * denote one-tail test significant at 1%, 5% and 10% respectively.