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Revisiting the Excise Tax Effects of the Property Tax

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Abstract

The authors analyze the excise tax effects of a general property tax from the perspective of a small open economy facing a perfectly elastic supply of capital. The model differs from most that have appeared in the literature in the following ways: (1) the property tax is applied in a four-sector model with three taxed sectors—manufacturing, housing, and services, and a tax-exempt agricultural sector. Only manufacturing and agriculture produce tradable goods; (2) the analysis considers an "intermediate run" time frame in which labor is perfectly mobile across production sectors but fixed within the jurisdiction, while land is fixed in each sector; and (3) all production sectors use capital, labor, and land. The authors find that the excise tax effects are borne primarily by labor and land. The results also indicate that the degree of backward tax-shifting declines markedly in a longer run time frame in which labor is perfectly mobile across jurisdictions.

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Introduction and Overview

The public finance literature has examined the incidence of the property tax at length, but the issue is still far from resolved. Indeed, in a recent review, Fischel, Oates, and Youngman (2011, 1) conclude that "Our understanding of the incidence of local property taxes is in a sad state. Despite a series of books and papers stretching over a period of nearly 50 years, there is nothing approaching a consensus on this issue."[1]

This study investigates the incidence of the property tax under the assumption that it is a distortionary tax on the use of capital in the production of housing and other goods. It focuses on the "excise tax effects" of the imposition of a property tax by a single small jurisdiction. Those effects, which arise from variation in tax rates among jurisdictions and are distributed among factor owners and consumers, have received less attention in the literature; for example, in a recent review of the effects of the property tax, Fisher (2009a) discusses at some length the various excise tax effects of the property tax in general terms, but does not cite any evidence regarding their relative magnitudes. This does not, however, imply that such effects are quantitatively unimportant; for example, Gravelle (2007) estimates that excise tax effects amount to between 30 percent and 40 percent of the total burden of the property tax in the United States.

Specifically, we analyze the excise tax effects of the property tax in the context of a small open economy model with four production sectors and three factors of production (capital, labor, and land) in each sector. The property tax is assumed to apply to both capital and land used in the production of housing and two of the nonhousing goods, broadly defined as manufacturing and services, while the fourth production sector, agriculture, is assumed to be exempt from property taxation.[2] In the housing and services production sectors, goods are assumed to be nontradable with prices that are determined locally. In the other two sectors, manufacturing and agriculture, the goods are assumed to be tradable, with prices that are determined in national or international markets and are thus fixed from the perspective of the taxing jurisdiction. This allows us to examine the effects of the imposition of a property tax in three of the four sectors, which results in a

relatively realistic, although still highly stylized, representation of property taxation in the United States.[3]

Another important factor in the incidence analysis is the time frame, which is reflected in the degree of mobility of the various factors of production. We adopt the relatively standard "small open economy" assumption that the supply of capital to the taxing jurisdiction is perfectly elastic, effectively assuming that changes in new and replacement investment occur rapidly enough to reach the desired capital stocks in each sector quickly.[4] However, rather than assuming a full long-run equilibrium with perfectly mobile households and free reallocation of land across production sectors, we focus on an "intermediate run" case characterized by fixed supplies of land in each sector and partial mobility of labor. We assume that labor does not change its jurisdiction of residence (so the total supply of labor within the taxing jurisdiction is fixed), but can move freely among the four sectors within the taxing jurisdiction. (In the sensitivity results, we also consider a case in which labor is free to seek employment in other neighboring jurisdictions while continuing to reside in the taxing jurisdiction.) Thus, we effectively assume that over the relevant time period, the benefits of the additional public services received by living within the taxing jurisdiction (which are assumed to be separable in the individual utility function) as well as any attachment to community and other transactions costs associated with moving are sufficiently large to preclude a change of residence by households. Indeed, although we characterize our results as reflecting an intermediate-run time frame, it is possible that such factors may limit labor mobility even in the long run.

We believe that this intermediate-run case is of considerable interest. By comparison, most other studies of the excise tax effects of the property tax have taken a very long-run view of property tax incidence; these studies typically assume that labor is perfectly mobile across all jurisdictions, which generally implies that it bears little if any of the tax, and that land is perfectly mobile among all uses, implying that all landowners within a jurisdiction bear equally any part of the tax that is capitalized in land values. Although these long-run incidence results are certainly of interest, from a policy perspective, incidence results over the alternative intermediate-run period analyzed in this article are just as critical. At a minimum, these results provide insight into the nature of the effects that would occur during the (lengthy) transition to a new long-run equilibrium after an increase in a general property tax by a single taxing jurisdiction. In addition, this partial equilibrium perspective, with capital perfectly mobile, is highly relevant for a single jurisdiction considering an increase in the tax.[5]

Our results indicate that, within an intermediate-run time frame in which labor is mobile across production sectors but fixed within the taxing jurisdiction, the excise tax effects of the property tax fall primarily on labor and land; for example, in our benchmark case, 64 percent of the tax burden borne by the residents is concentrated on the sources side of incidence, and more than three-quarters of that sources-side burden is due to a decline in labor income. The reallocation of labor across sectors in response to the tax puts downward pressure on wages in all production sectors and therefore mitigates the forward shifting of the tax burden in the two nontradable sectors. In addition, a small portion of the tax burden is exported to other jurisdictions through declines in net land rents of the nonresidential sectors. These findings are robust to variations in our elasticity assumptions.

Although the excise tax effects of the property tax have been analyzed in the literature, much of which is rather dated, our article extends this literature in several ways. Importantly, most such analyses focus exclusively on the effects of the property tax within a single sector, typically residential housing,[6] or in some cases an industrial sector.[7] However, as stressed in the derivation of the capital tax view, a central feature of the property tax is that it applies to both residential and nonresidential or business property, typically at the same rate, so that its excise tax effects should be examined in a model that has at least two sectors. This is especially important because the market characteristics of the two sectors are typically quite different, as residential housing is a highly capital-intensive nontradable good with a price that is locally determined, while the nonresidential sector is likely to be more labor-intensive and to produce tradable goods that face much more price competition from national or international competitors and indeed may effectively face a fixed price.

Moreover, even a two-sector approach will miss two essential features of the property tax as it is applied in the United States. First, as shown in the two-sector model analyzed by Muthitacharoen and Zodrow (2008), the excise tax effects of the property tax differ significantly depending on whether the nontradable goods sector is relatively capital intensive (e.g., residential housing) or labor intensive (e.g., services). Indeed, the latter case may yield counterintuitive results regarding the incidence of the property tax, such as lower prices in the nontradable goods sector. Second, agricultural property, especially land, is typically taxed very lightly, implying the need to include a relatively low-tax or tax-exempt sector in the model.

Another issue is that most existing studies assume two-factor production functions, ignoring the need to model separately the effects of the property tax on capital, land, and labor, especially when focusing on the nature of the

excise tax effects of the property tax and their distribution across labor and land. Finally, most studies tend to take long-run views of property tax incidence, often with individuals mobile across jurisdictions and land mobile across production sectors; as discussed above, we consider what we believe to be a practically important ''intermediate-run'' case in which labor is only partially mobile and land is completely immobile across sectors.

In the remainder of the article, Related Studies section discusses related studies, Model and Calibration section contains a description of the model and its calibration, Simulation Results section presents the simulation results as well as some sensitivity analyses, and the final section presents our conclusions.

Related Studies

The capital tax view was developed initially by Mieszkowski (1972) as an extension of the Harberger (1962) multisector model of national tax incidence into a multijurisdictional setting. It was further extended by Zodrow and Mieszkowski (1986) to include a wide variety of the characteristics of local public service provision and property taxation stressed in the literature based on the Tiebout (1956) model, including competition among local jurisdictions with endogenous tax and expenditure policies, differing individual tastes for public services, community segregation by taste for public services, and a simple form of land use zoning. An essential element of these derivations of the capital tax view is that they assume, quite plausibly, that the property tax applies to both residential and nonresidential property and is used simultaneously by virtually all jurisdictions in the country. Within this general equilibrium context, and assuming that the national capital stock is fixed, the capital tax view implies that the incidence of the property tax has two components: (1) a profits tax component that reflects the average rate of property taxation in the nation and is borne by all capital owners as a reduction in the after-tax rate of return to capital and (2) an excise tax component that reflects the effects of local tax differentials, with above-average tax rates causing some combination of higher consumer prices and lower returns to labor and land, with offsetting effects in relatively low-tax jurisdictions.

Several papers have examined the excise tax effects of the property tax. These studies tend to fall into two camps. One suggests that the excise tax effects of the tax will primarily be reflected in higher consumer prices. For example, in his seminal contribution, Mieszkowski (1972) suggests that in a single-sector model, changes in wage rates will be relatively small as labor is partially mobile and can also be substituted for capital. In addition, he

argues that changes in land values are likely to be substantial from the perspective of landowners but will not be large in the aggregate due to the low share of land rents in total costs. Instead, Mieszkowski predicts that commodity prices will increase such that at least three-quarters of the excise tax effects of the property tax will fall on consumers. Mieszkowski's opinion is roughly consistent with the "traditional view" of the incidence of the tax, which argues from a partial equilibrium perspective that the capital component of the property tax is fully shifted forward into housing prices and the prices of nonhousing goods (Wildasin 1986; Zodrow 2001a). For example, Wildasin (1986) shows that this result obtains exactly within the context of a two-factor mobile in which capital is perfectly mobile and labor and land are both immobile when the demand elasticity for the taxed good equals the elasticity of substitution in production.[8] Wassmer's (1993) empirical analysis suggests that 87 percent of the excise tax effects of a general property tax are shifted forward as higher prices for housing and other goods. Finally, Youngman (2002) and Fisher (2009b) note that much of the concern about the regressivity of the property tax is based on the assumption that the residential portion of the tax, and perhaps much of the nonresidential portion as well, is shifted forward in the form of higher consumer prices, implying regressivity (at least when measured with respect to annual income).

In contrast, an alternative view is that forward shifting of the property tax will be much less important. For example, in the same single-sector, two-factor (mobile capital and immobile land/labor) model, Wildasin (1986) shows that the distribution of the excise tax effects in general depends on the relative magnitudes of the demand and production substitution elasticities, and in the special case in which demand is perfectly elastic, all of the excise tax effects of the property tax are naturally borne by the immobile factors. Similarly, in a study that is in some ways similar to our own, Wilson (1984) considers a general property tax imposed on perfectly mobile capital and land in both tradable and nontradable sectors, with both sectors employing capital, labor, and land. His analysis, however, considers only two production sectors and takes a long-run, general equilibrium view, as households are perfectly mobile between regions, and land is perfectly mobile between production sectors within a region. Wilson also allows individuals to differ in their demands for the nontradable good. He focuses on the excise tax effects of the property tax on the prices of the nontradable good in the presence of perfectly mobile households that are heterogeneous in nonwage income. He shows that within this context the elasticity of demand for the nontradable good is infinite, as households with different incomes and different tastes costlessly migrate between regions in response

to any difference in nontraded good prices, changing the mix of households in each jurisdiction until this difference is eliminated; that is, perfect mobility of households across jurisdictions implies the absence of excise tax effects in the form of higher prices for nontradable goods. Although Wilson does not address incidence issues directly, presumably land bears all or most of the burden of the property tax in his model. Thus, while Wilson focuses on the long-run implications of perfect household mobility, this study examines property tax incidence from the perspective of a single small taxing jurisdiction in an intermediate-run model with partial labor mobility and land supplies that are fixed across production sectors.

Model and Calibration

This article examines the excise tax effects of the property tax, in particular how they are distributed among consumers, suppliers of labor, and the owners of various types of land in the taxing jurisdiction. To focus on these excise tax effects, the analysis abstracts from the profits tax component of property tax incidence by considering the incidence of a tax imposed by a single small taxing jurisdiction that faces a fixed after-tax rate of return to capital—that is, a small open economy facing a perfectly elastic supply of capital—under the assumption that neighboring jurisdictions hold their tax policies constant. In this context, all of the local effects of the property tax can be viewed as excise tax effects, as the effect of the tax on the return to capital owned by local residents is negligible[9] and the local effects of the tax are concentrated in wages, land rents, and commodity prices (unless the price of a good is determined on a national or international market). By comparison, in the derivation of the capital tax view, all jurisdictions effectively raise their taxes simultaneously, so that the excise tax effects are calculated as differentials about the average rate of tax. The small taxing jurisdiction analyzed in this article might be interpreted as a single large city, or perhaps a large suburb with tax and expenditure authority, that raises its property tax to finance public services under the assumption that other communities that do not change their tax policies.[10]

We follow most of the literature in assuming constant elasticity of substitution (CES) production functions, as well as a CES utility function defined over consumption of the four private sector goods, with public goods assumed to be separable in the utility function. This assumption, however, is restrictive in that it requires identical elasticities of substitution between each pair of factors in a sector and between each pair of goods in the utility function. The resulting model is sufficiently complicated that our

analysis is limited to numerical simulation of the model. However, some intuition regarding the operation of the model is provided in our companion analytical incidence study (Muthitacharoen and Zodrow 2008) that examines the excise tax effects of the property tax in a two-sector, three-factor model that considers both the case in which the nontradable good is capital-intensive housing and the case in which it is labor-intensive services.

Overview

The model contains four production sectors: agriculture (A), manufacturing (M), housing services (H), and non-housing services (S). The goods produced by the manufacturing and agricultural sectors are tradable, while housing and nonhousing services are nontradable. All production sectors use capital, labor, and land as inputs, with land in each production sector fixed.

The taxing jurisdiction is assumed to be a small open economy that faces a fixed net rate of return r on capital (i.e., the supply of capital is perfectly elastic), a fixed price for the tradable agricultural good ($\bar{p}_A$), and a fixed price for the tradable manufactured good, which is the numeraire ($\bar{p}_M = 1$). Prices for the two nontradable goods (p_H, p_S) are determined endogenously. All markets are assumed to be perfectly competitive. Each production sector j uses three factors of production, capital (K_j), labor (L_j) and land ($\overline{V}_j$) with the supply of land in each sector assumed to be fixed.

Each resident of the jurisdiction owns one unit of labor, an equal share of the fixed supply of local housing land, and an equal fixed share of a national portfolio that includes all of the fixed national supply of capital and the fixed national supply of land used for production of all goods other than housing. The small open economy assumption implies that the single taxing jurisdiction can assume that its actions do not affect the aggregate value of the national portfolio.

The property tax rate is imposed on all uses of capital and land in all sectors except the agricultural sector (A) and is stated on a tax-exclusive basis. For each unit of capital, the capital owner receives the after-tax return r while capital costs producers $r(1 + T_j)$, where the property tax rate is $T_j = T, j = M, H, S$, and $T_j = 0, j = A$.

Producer Optimization

All production sectors are characterized by CES technology:

$$Q_j = \Psi_j\left(\alpha_{Kj}K_j^{\rho_j} + \alpha_{Lj}L_j^{\rho_j} + \alpha_{Vj}\bar{V}_j^{\rho_j}\right)^{1/\rho_j}, \tag{1}$$

where Q_j is the amount of good j produced within the jurisdiction, K_j is the amount of capital used in sector j, L_j is the amount of labor used in sector j, $\sigma_j \equiv 1/(1-\rho_j)$ is the elasticity of substitution in production in sector j, and α_{ij} are the weights for factor i in sector j, and Ψ_j is a scale factor for sector j, with units in each sector chosen so that prices in the initial equilibrium are one. With fixed land, the profit maximization problem can be written as

$$\text{Max}_{K_j,L_j}\left[P_j\Psi_j\left(\alpha_{Kj}K_j^{\rho_j} + \alpha_{Lj}L_j^{\rho_j} + \alpha_{Vj}\bar{V}_j^{\rho_j}\right)^{1/\rho_j} - r(1+T_j)K_j - wL_j\right].$$

Since land supplies are fixed in each sector ($\bar{V}_j, j = A, M, S, H$), it is convenient to use a restricted profit function approach. Gross returns to land, the fixed factor in sector j, can be expressed as $\Pi_j[p_j, w, r(1+T_j); \bar{V}_j]$, and net returns to landowners are $\Pi_j/(1+T_j)$. With CES production functions, gross returns to land (residual profits) are

$$\Pi_j = \alpha_{V_j}^{\sigma_j/(\sigma_j-1)}\bar{V}_j\left[\left(P_j\Psi_j\right)^{1-\sigma_j} - \alpha_{K_j}^{\sigma_j}\left(r(1+T_j)\right)^{1-\sigma_j} - \alpha_{L_j}^{\sigma_j}w^{1-\sigma_j}\right]^{1/(1-\sigma_j)}. \tag{2}$$

Differentiation of this expression with respect to output prices yields outputs

$$\begin{aligned} Q_j = \frac{\partial\Pi_j}{\partial P_j} &= \alpha_{Vj}^{\sigma_j/(\sigma_j-1)}\Psi_j^{1-\sigma_j}P_j^{-\sigma_j} \\ &\left[\left(P_j\Psi_j\right)^{1-\sigma_j} - \alpha_{Kj}^{\sigma_j}\left(r(1+T_j)\right)^{1-\sigma_j} - \alpha_{Lj}^{\sigma_j}w^{1-\sigma_j}\right]^{\sigma_j/(1-\sigma_j)}\bar{V}_j, \end{aligned} \tag{3}$$

and differentiation with respect to factor prices yields the factor demands

$$\begin{aligned} L_j = \frac{\partial\Pi_j}{\partial w} &= \alpha_{Vj}^{\sigma_j/(\sigma_j-1)}\left(\frac{\alpha_{Lj}}{w}\right)^{\sigma_j} \\ &\left[\left(\Psi_jP_j\right)^{1-\sigma_j} - \alpha_{Kj}^{\sigma_j}\left(r(1+T_j)\right)^{1-\sigma_j} - \alpha_{Lj}^{\sigma_j}w^{1-\sigma_j}\right]^{\sigma_j/(1-\sigma_j)}\bar{V}_j, \end{aligned} \tag{4}$$

$$\begin{aligned} K_j = \frac{\partial\Pi_j}{\partial[r(1+T_j)]} &= \alpha_{Vj}^{\sigma_j/(\sigma_j-1)}\left(\frac{\alpha_{Kj}}{r(1+T_j)}\right)^{\sigma_j} \\ &\left[\left(\Psi_jP_j\right)^{1-\sigma_j} - \alpha_{Kj}^{\sigma_j}\left(r(1+T_j)\right)^{1-\sigma_j} - \alpha_{Lj}^{\sigma_j}w^{1-\sigma_j}\right]^{\sigma_j/(1-\sigma_j)}\bar{V}_j. \end{aligned} \tag{5}$$

As described previously, the model is characterized by partial mobility of labor, as labor is immobile across jurisdictions, but perfectly mobile across production sectors within the taxing jurisdiction, earning wage w. Thus, the total supply of labor $(\bar{L})$ within the taxing jurisdiction is fixed, so that $L_A + L_M + L_H + L_S = \bar{L}$.

Consumer Optimization

The analysis assumes that the utility function of the single representative resident of the taxing jurisdiction is also characterized by a CES function, defined over consumption of the four goods:

$$U(X_A, X_M, X_H, X_S) = \left(\delta_A X_A^{\rho} + \delta_M X_M^{\rho} + \delta_H X_H^{\rho} + \delta_S X_S^{\rho}\right)^{1/\rho}, \qquad (6)$$

where $\sigma_D = 1/(1-\rho)$ is the elasticity of substitution between each pair of goods and δ_j is the share parameter for good j.

The utility maximization problem can be written as

$$\text{Max}_{X_A, X_M, X_H, X_S}\left[\left(\delta_A X_A^{\rho} + \delta_M X_M^{\rho} + \delta_H X_H^{\rho} + \delta_S X_S^{\rho}\right)^{1/\rho}\right],$$

subject to the budget constraint

$$\sum_{j=A,M,H,S} P_j X_j \leq Y.$$

Solving the utility maximization problem, we have the consumer demand functions

$$X_j = \left(\frac{\delta_j}{P_j}\right)^{\sigma} Y \left(\sum_{j=A,M,H,S} \delta_j^{\sigma} P_j^{1-\sigma}\right)^{-1}; j = A, M, H, S. \qquad (7)$$

The associated indirect utility function is

$$V(P_j, Y) = Y\left[\sum_{j=A,M,S,H} \delta_j^{\sigma_D} P_j^{1-\sigma_D}\right]^{1/(\sigma_D - 1)}, \qquad (8)$$

where Y is the income of the representative resident of the taxing jurisdiction, which reflects returns on the individual's supply of labor, holdings of residential land, and the portfolio of capital and land in the three nonresidential sectors, as in

$$Y = w\bar{L} + \frac{\Pi_H}{1+T} + (r\bar{K} + \bar{\Pi}_A + \bar{\Pi}_M + \bar{\Pi}_S), \tag{9}$$

where w is the wage rate, $\bar{L}$ is the total amount of labor supply provided by representative resident of the taxing jurisdiction (which can be distributed across the four production goods), and the expression in parentheses is the (assumed fixed) return on the representative resident's portfolio of capital and nonresidential land holdings. We assume for simplicity that in the initial equilibrium total income of the representative individual equals the value of aggregate production within the jurisdiction. Note, however, that once the property tax is imposed, capital services can be exported but the income generated from the exported capital is assumed to be spent by residents within the taxing jurisdiction on goods that are either produced within the taxing jurisdiction or imported from other jurisdictions.

Total property tax revenue (TR) is

$$\text{TR} = rT(K_M + K_H + K_S) + \left(\frac{T}{1+T}\right)(\Pi_M + \Pi_H + \Pi_S). \tag{10}$$

Revenues are assumed to be spent on a public good that is separable from the individual utility function, with public sector spending on the four goods in the model assumed to be proportional to private sector spending.

Measuring Utility Change in Dollar Terms

To examine the excise tax effects of the property, we note that the utility change experienced by the representative resident of the taxing jurisdiction can be decomposed and approximated as

$$\frac{\Delta U}{\lambda} = \bar{L}\Delta w + \Delta\left(\frac{\Pi_H}{1+T}\right) - (X_H \Delta P_H + X_S \Delta P_S), \tag{11}$$

where Δ denotes a finite change in variable, and λ is marginal utility of income.[11] The excise tax effects of the property tax borne by residents of the taxing jurisdiction can thus be decomposed into the burden borne by the suppliers of labor, the owners of residential land, and all residents as consumers of locally produced goods. In addition, part of the burden of the tax is borne by the owners of nonresidential land that, neglecting the small fraction of each type of land owned by local residents, can be treated as the share of the property tax burden that is exported to nonresident land owners, or $\Delta\left(\frac{\Pi_A+\Pi_M+\Pi_S}{1+T}\right)$.

Model Calibration

We calibrate production cost shares in each sector and consumer expenditure shares using the US Annual Input–Output Accounts for 2009.[12] Denoting θ_{ij} as the factor cost share of factor i in the production of good j, these data indicate that the agricultural sector is relatively land intensive ($\theta_{KA} = 0.17,\ \theta_{LA} = 0.33,\ \theta_{VA} = 0.51$), the housing sector is relatively capital intensive ($\theta_{KH} = 0.46, \theta_{LH} = 0.24, \theta_{VH} = 0.30$), the services sector is heavily labor intensive ($\theta_{KS} = 0.31, \theta_{LS} = 0.65, \theta_{VS} = 0.04$), and the manufacturing sector has relatively high labor and capital production cost shares ($\theta_{KM} = 0.40, \theta_{LM} = 0.57, \theta_{VM} = 0.04$). Consumption expenditure shares are $\beta_A = 0.13,\ \beta_M = 0.12,\ \beta_H = 0.25$, and $\beta_S = 0.49$, where β_j is the consumption share of good j.

The production substitution elasticities in the agricultural sector, manufacturing sector, and services sector are based on the estimate by Chirinko, Fazzari, and Meyer (2004), and equal 0.4. The production technology in the housing sector, on the other hand, is assumed to be Cobb-Douglas, which is consistent with Epple, Gordon, and Seig (2010).[13] The elasticity of substitution in consumption is assumed to equal one.

Simulation Results

This section provides the results of several simulations of the model. The simulations assume a marginal increase in the property tax rate from zero to 5 percent, that is, to $r(1 + T) = 1.05r$, or $T = 0.05$, with $T/(1 + T) = 0.0476$.

The Base Case

Table 1 presents the simulation results of the ''intermediate-run'' base case, which assumes intersectoral labor mobility coupled with interjurisdictional immobility. With labor immobile across jurisdictions, the imposition of the 5 percent property tax decreases wages by 1.9 percent and raises the prices of housing and services by 2.1 percent and 0.4 percent, respectively. The slightly larger increase in the price of housing, compared to services, reflects the relative capital and land intensity of that sector. Land rents fall in all taxed sectors, but especially in manufacturing, where they decrease by 25.7 percent, compared with 4.0 percent in housing and 3.5 percent in services. In the untaxed agricultural sector, however, land rents increase slightly (1.2 percent) due to inflows of both capital and labor.

Table 1. Percentage Changes in Key Variables with a 5 Percent Property Tax Increase Under the Base Case with Intersectoral Labor Mobility

Variable	Base Case (intersectoral labor mobility)
$\hat{w}$	−1.880
$\hat{P}_H$	2.075
$\hat{P}_S$	0.356
$\hat{\prod}_A^N$	1.214
$\hat{\prod}_M^N$	−25.67
$\hat{\prod}_H^N$	−4.012
$\hat{\prod}_S^N$	−3.495
$\hat{L}$	0.000
$\hat{L}_A$	1.250
$\hat{L}_M$	−8.747
$\hat{L}_H$	2.443
$\hat{L}_S$	1.296
$\hat{K}$	−3.462
$\hat{K}_A$	0.484
$\hat{K}_M$	−11.19
$\hat{K}_H$	−3.618
$\hat{K}_S$	−1.413
$\hat{Q}_A$	0.484
$\hat{Q}_M$	−9.437
$\hat{Q}_H$	−1.136
$\hat{Q}_S$	0.387

The property tax drives capital out of all taxed sectors, with the largest effect in manufacturing, where there is no forward tax-shifting by assumption, and the smallest effect in services, where the property tax burden is relatively moderate. Overall, the amount of capital employed in the taxing jurisdiction falls by 3.5 percent. Because the services sector is labor intensive, however, its output increases slightly (0.4 percent), while output levels in the other two taxed sectors decline. Both capital and labor are diverted to agriculture, where output increases.

Those results are driven by several key factors.[14] Most importantly, the tax drives up production costs in all sectors in which the property tax is imposed (i.e., all sectors other than agriculture), especially in the relatively capital-intensive sectors, manufacturing, and housing. This tends to reduce

capital demands in those sectors, especially in the tradable taxed sector (manufacturing) where forward tax-shifting is impossible; by comparison, these effects are mitigated by forward shifting of the tax burden in the two nontradable goods sectors, housing and services.

The fact that forward tax-shifting is limited to the nontradable sectors naturally has important implications for the mix of excise tax effects between forward and backward shifting. Because forward tax-shifting in the tradable manufacturing sector is impossible, wages must fall, and by a relatively large amount since land rents in that sector are relatively small. The resulting outflow of labor into the nontradable sectors puts downward pressure on wages in those sectors and thus limits the extent of forward tax-shifting that occurs before a new equilibrium is attained; this is especially true not only in labor-intensive services, but also, although to a lesser extent, in the capital-intensive nontradable sector, housing. Thus, the traditional view of the property tax, under which consumer prices go up by the full amount of the property tax, does not obtain in the four-sector model. Labor can also move to the untaxed sector, but that reallocation is limited, given the relatively small amount of labor used in agriculture. Another way of thinking about these changes is that, with respect to the two nontradable goods sectors, the potential for backward tax-shifting to labor is more limited in capital-intensive housing than in labor-intensive services, so that more forward tax-shifting is expected in housing.

The imposition of the property tax naturally tends to drive mobile capital out of the taxing jurisdiction, although this effect is mitigated somewhat by a reallocation of capital (and labor) to the untaxed sector (agriculture). Net land rents tend to decline in all the taxed sectors, especially in the tradable goods sector where forward tax-shifting is impossible, as land bears the land component of the tax and some of the capital component as well due to backward tax-shifting. This effect is mitigated to the extent that the tax is shifted to labor, or shifted forward in the nontradable sectors, which is more likely to be important in the capital-intensive nontradable sector (housing) as described earlier. Net land rents increase in the untaxed sector as capital and labor are reallocated into agriculture.

These changes suggest a very different pattern of incidence than those obtained under the traditional view. Downward pressure on wages, declines in net land rents in the housing sector, and modest increases in the prices of nontradable goods imply that the majority of the tax burden borne by the residents of the taxing jurisdiction (63.7 percent) is concentrated on the sources side of incidence, and over three-quarters of this burden is due

Table 2. Property Tax Burden as a Percentage of Total Tax Revenue with a 5 Percent Property Tax Increase under the Base Case with Intersectoral Labor Mobility

Tax burden borne by residents	
Labor	46.0%
Housing land	15.3%
Housing consumption	26.3%
Services consumption	8.7%
Total	96.2%
Tax burden borne by nonresidents	
Agriculture land	−4.1%
Manufacturing land	6.2%
Services land	3.3%
Total	5.4%

Note. Negative values indicate gains from the property tax increase. In the aggregate, total tax burden borne by both residents and nonresidents exceeds the total tax revenue as it reflects the efficiency costs of use of the property tax.

to the decline in labor income (table 2).[15] Overall, the total tax burden borne by residents accounts for 96.2 percent of total tax revenue. Declines in nonresidential land rents suggest that some portion of the tax burden is exported to residents of the other jurisdictions. This portion of the tax burden accounts for 5.4 percent of the total tax revenue. In the aggregate, the total tax burden borne by both residents and nonresidents exceeds the total tax revenue by 1.6 percent, primarily reflecting the efficiency costs of use of the property tax.

Sensitivity Analysis

In this section, we examine the sensitivity of the simulation results to variations in the major assumptions of the model regarding labor mobility and capital mobility, as well as different parameter values for the key substitution elasticities.

Labor Mobility Assumptions. First, we consider the sensitivity of the results with respect to different assumptions about the extent of labor mobility. The analysis thus far has indicated that in the case of interjurisdictional immobility coupled with intersectoral labor mobility, labor bears a significant portion of the sources side incidence of the property tax, which is in turn a significant fraction of the total burden.

Table 3. Percentage Changes in Key Variables with a 5 Percent Property Tax Increase under Different Labor Mobility Assumptions

Variable	Immobile labor	Base case (intersectoral labor mobility)	Interjurisdicional labor mobility
$\hat{w}$	n/a	−1.880	0.000
$\hat{w}_A$	0.000	n/a	n/a
$\hat{w}_M$	−3.231	n/a	n/a
$\hat{w}_H$	2.358	n/a	n/a
$\hat{w}_S$	1.813	n/a	n/a
$\hat{P}_H$	3.575	2.075	2.128
$\hat{P}_S$	2.796	0.356	1.423
$\hat{\prod}_A^N$	0.000	1.214	0.000
$\hat{\prod}_M^N$	−7.839	−25.67	−47.71
$\hat{\prod}_H^N$	−2.516	−4.012	−5.262
$\hat{\prod}_S^N$	−3.035	−3.495	−7.532
$\hat{L}$	0.000	0.000	−3.857
$\hat{L}_A$	0.000	1.250	0.000
$\hat{L}_M$	0.000	−8.747	−21.322
$\hat{L}_H$	0.000	2.443	−0.473
$\hat{L}_S$	0.000	1.296	−1.174
$\hat{K}$	−1.792	−3.462	−6.309
$\hat{K}_A$	0.000	0.484	0.000
$\hat{K}_M$	−3.213	−11.19	−22.84
$\hat{K}_H$	−2.268	−3.618	−4.749
$\hat{K}_S$	−1.225	−1.413	−3.084
$\hat{Q}_A$	0.000	0.484	0.000
$\hat{Q}_M$	−1.305	−9.437	−21.32
$\hat{Q}_H$	−1.058	−1.136	−2.342
$\hat{Q}_S$	−0.383	0.387	−1.731

Labor immobility. Suppose instead that labor, like land, is completely immobile within each production sector. This case is the four-sector, three-factor analog to the single-sector, two-factor (capital perfectly mobile and labor/land immobile) model used to generate the "traditional view" of full forward shifting of the excise tax effects of the tax (under the appropriate circumstances); it thus provides a four-sector version of the traditional view. As shown in the first column of table 3, the absence of labor mobility across sectors implies more forward shifting of the tax burden to consumers of the nontradable

Table 4. Property Tax Burden as a Percentage of Total Tax Revenue with a 5 Percent Property Tax Increase under Different Labor Mobility Assumptions

Tax burden	Immobile labor (%)	Base case (intersectoral labor mobility) (%)	Interjurisdictional labor mobility (%)
Tax burden borne by residents			
Labor	−24.0	46.0	0.0
Housing Land	9.4	15.3	20.7
Housing consumption	44.4	26.3	27.8
Services consumption	66.7	8.7	35.7
Total	96.4	96.2	84.2
Tax burden borne by nonresidents			
Agriculture land	0.0	−4.1	0.0
Manufacturing land	1.9	6.2	11.9
Services land	2.8	3.3	7.3
Total	4.7	5.4	19.2

Note. Negative values indicate gains from the property tax increase. In the aggregate, total tax burden borne by both residents and nonresidents exceeds the total tax revenue as it reflects the efficiency costs of use of the property tax.

goods. In particular, the prices of housing and services increase by 3.6 percent and 2.8 percent, respectively, whereas they increase by 2.1 percent and 0.4 percent under the base case. Wages fall significantly (3.2 percent) in the manufacturing sector, reflecting the absence of forward tax-shifting possibilities, but they increase in the two nontradable sectors (by 2.4 percent and 1.8 percent in housing and services), reflecting the greater potential for forward tax-shifting. Land rents in all taxed sectors decline, albeit by relatively smaller amounts than those under the base case, primarily because of backward tax-shifting to labor in manufacturing and more forward tax-shifting to consumers in housing and services. In the agricultural sector, the assumptions of fixed land and labor, coupled with a fixed price of capital and property tax exemption, imply that this sector is not affected by the imposition of the tax.

With labor completely immobile, the incidence results are consistent with the traditional view—the property tax burden is concentrated on the uses side of incidence (see the first column of table 4). The increases in the prices of housing and services imply that most of the tax burden is shifted forward to residents who are consumers of those nontradable goods. On the sources side, aggregate labor income increases as the wage losses experienced by labor in the manufacturing sector are offset by gains to labor employed in the housing and services sectors. The owners of housing land, on the other hand, still experience a decline in their income. This decline in

Table 5. Percentage Changes in Key Variables with a 5 Percent Property Tax Increase Under Different Capital Mobility Assumptions

Variable	Base case (perfect capital mobility)	Limiting tax-induced capital outmigration to 80% of base case
$\hat{r}$	n/a	−0.801
$\hat{w}$	−1.880	−1.374
$\hat{w}_A$	n/a	n/a
$\hat{w}_M$	n/a	n/a
$\hat{w}_H$	n/a	n/a
$\hat{w}_S$	n/a	n/a
$\hat{P}_H$	2.075	1.909
$\hat{P}_S$	0.356	0.454
$\hat{\prod}_A^N$	1.214	1.155
$\hat{\prod}_M^N$	−25.67	−24.776
$\hat{\prod}_H^N$	−4.012	−3.725
$\hat{\prod}_S^N$	−3.495	−2.964
$\hat{L}$	n/a	n/a
$\hat{L}_A$	1.250	1.018
$\hat{L}_M$	−8.747	−8.500
$\hat{L}_H$	2.443	2.245
$\hat{L}_S$	1.296	1.310
$\hat{K}$	−3.462	−2.769
$\hat{K}_A$	0.484	0.784
$\hat{K}_M$	−11.19	−10.476
$\hat{K}_H$	−3.618	−2.657
$\hat{K}_S$	−1.413	−0.878
$\hat{Q}_A$	0.484	0.460
$\hat{Q}_M$	−9.437	−9.005
$\hat{Q}_H$	−1.136	−0.725
$\hat{Q}_S$	0.387	0.569

housing land rent partly offsets the increase in labor income, but the aggregate change on the sources side remains positive. Overall, consumers of nontradable goods bear 115 percent of the total tax burden borne by the residents of the taxing jurisdiction.

Interjurisdictional labor mobility. Alternatively, suppose that labor is not only mobile across production sectors but is also sufficiently mobile across

jurisdictions so that the net wage is unchanged (but individuals maintain their residence in the taxing jurisdiction). This scenario might reflect a moderately large suburb increasing its property tax rate while its residents can relatively costlessly change employment, but not residence, by taking jobs in neighboring suburbs. In this case, the wage rate is fixed, while the amount of labor employed in the taxing jurisdiction (but not the number of residents) can vary in response to the tax.[16]

The results of this simulation are presented in the third column of tables 3 and 4. Not surprisingly, since backward tax-shifting to labor is eliminated by assumption, the excise tax effects of the property tax are significantly altered. With employment outside the jurisdiction now possible, a significant amount of labor is no longer employed in the taxing jurisdiction. Labor migration out of the taxed tradable goods sector (manufacturing) more than doubles, relative to the base case. Labor migration out of the nontradable goods sectors also occurs, although by a much smaller amount. Capital outflows from manufacturing are also far more pronounced, and the total capital stock declines somewhat more. Relative to the base case, the degree of forward tax-shifting in the labor-intensive services sector is significantly larger, because producers no longer benefit from a decline in wages. Output declines much more markedly in manufacturing, remains unchanged in agriculture (since land, the prices of capital and labor, and the output price are all fixed), and declines slightly in both housing and services.

Turning to the incidence of the tax, when labor was immobile, over 100 percent of the total tax burden borne by residents of the taxing jurisdiction was shifted to consumers, while with intersectoral labor mobility, only 36 percent was shifted forward. The interjurisdictional and intersectoral labor mobility assumptions imply no backward tax-shifting to labor. The extent of forward tax-shifting, as a result, increases dramatically. Consumers of nontradable goods bear 75.5 percent of the total tax borne by the residents, although this burden is still significantly less than in the case of immobile labor. The sources side of incidence accounts for the remaining 24.5 percent of the tax, which is borne entirely by the owners of land in the taxed sectors, especially the owners of residential land. The increase in labor mobility in these simulations is thus sufficient to restore much of the traditional view of the excise tax effects of the property tax, although the degree of forward tax-shifting is still considerably less than in the four-sector model with labor immobile. Finally, with labor mobile across jurisdictions, the total tax burden borne by residents of the taxing jurisdiction accounts for 84.2 percent of the total tax revenue (compared with 96.2 percent with intersectoral labor mobility), and the tax burden exported to nonresidents increases by

Table 6. Property Tax Burden as a Percentage of Total Tax Revenue with a 5 Percent Property Tax Increase under Different Capital Mobility Assumptions

	Base case (%)	Limiting tax-induced capital outmigration to 80% of base case (%)
Tax burden borne by residents		
Labor	46.0	33.6
Housing land	15.3	14.2
Housing consumption	26.3	24.2
Services consumption	8.7	11.0
Total	96.2	83.0
Tax burden borne by nonresidents		
Agriculture land	−4.1	−3.9
Manufacturing land	6.2	6.0
Services land	3.3	2.8
Total	5.4	4.9
Tax burden borne by capital owners		
Capital	n/a	13.2

Note. Negative values indicate gains from the property tax increase. In the aggregate, the total tax burden borne by both residents and nonresidents exceeds total tax revenue as it reflects the efficiency costs of use of the property tax.

nearly fourfold to 19.2 percent of total tax revenue (compared with 5.4 percent with intersectoral labor mobility). The increased shifting of the tax burden to nonresidents results from declines in land rents in manufacturing and services sectors, which no longer benefit from falling wage costs.

Capital Mobility Assumptions. Next we consider the sensitivity of our results to the assumption that capital is perfectly mobile. Our base case examines the excise tax effects of the property tax under the assumption that the taxing jurisdiction is a small open economy facing a perfectly elastic supply of capital. The supply of capital facing a taxing jurisdiction may be less than perfectly elastic, however, at least in the short run or if the jurisdiction is sufficiently large. In order to approximate roughly the effects of relaxing the assumption of perfect capital mobility, we simulate the model under the assumption that the capital outmigration following the introduction of the property tax is arbitrarily fixed at 80 percent of the level that occurs in the simulation with perfect mobility assumption.[17] The results of that simulation are presented in Tables 5 and 6.

As shown in the third column of table 6, limiting capital outflows in this way implies that capital owners now bear some of the property tax burden (13 percent of total tax revenue). The relative magnitudes of the remaining

excise tax effects of the property tax, however, are quite similar to those observed under the assumption of perfect capital mobility. In particular, most of the tax burden borne by the residents of the taxing jurisdiction is concentrated on the sources side of incidence (58 percent, as compared to 64 percent in the base case with perfect capital mobility), and labor still bears the majority of this sources-side tax burden (75 percent rather than 70 percent).

Assumptions Regarding the Elasticities of Substitution. Our third set of sensitivity analyses examines the effects of altering the various elasticities of substitution in production and consumption. We consider three sensitivity tests, with the first assuming that all of the production elasticities of substitution equal 0.5,[18] the second assuming that all production sectors are characterized by Cobb-Douglas technology, and the third assuming that the demand elasticity of substitution equals 0.5.

The results of these simulation exercises are presented in tables 7 and 8. They suggest that while altering the elasticities of substitution may change the relative magnitudes of the results, it does not affect our basic conclusion regarding the distribution of the excise tax effects of the property tax. For example, when all production elasticities equal 0.5, the primary changes are smaller capital outflows and labor inflows involving the housing sector, which occur because the elasticity of substitution in housing decreases from 1.0 in the base case to 0.5 in this exercise. When all production sectors are characterized by Cobb-Douglas technology, capital outflows from the taxing jurisdiction are significantly larger, especially from the manufacturing and services sectors. This is attributable to the higher production substitution elasticities in all sectors except housing (the nonhousing production elasticities increase from 0.4 in the base case to 1.0 in this simulation exercise). A similar pattern is observed for labor reallocation, as in all sectors other than housing, labor flows follow the same direction as that under the base case but are larger in magnitude. When the demand elasticity of substitution equals 0.5, the primary change is a smaller reduction in housing demand, which leads to a smaller capital outflow from, and a larger labor inflow to, the housing sector.

Most importantly for our purposes, the distributions of the excise tax effects of the property tax are virtually unchanged. The proportion of residents' tax burden that is borne on the sources side of incidence is 74 percent when all production elasticities equal 0.5, 69 percent when all production elasticities equal 1.0, and 61 percent when demand elasticity equals 0.5 (as compared to 64 percent in the base case). Similarly, the labor share of

Table 7. Percentage Changes in Key Variables with a 5 Percent Property Tax Increase under Different Elasticity Assumptions

Variable	Base case	All production elasticities = 0.5	All production elasticities = 1	Demand elasticity = 0.5
$\hat{w}$	−1.880	−2.137	−2.049	−1.866
$\hat{P}_H$	2.075	1.689	1.987	2.307
$\hat{P}_S$	0.356	0.161	0.190	0.356
$\hat{\prod}_A^N$	1.214	1.387	1.338	1.210
$\hat{\prod}_M^N$	−25.67	−22.75	−22.47	−25.74
$\hat{\prod}_H^N$	−4.012	−5.082	−4.158	−3.292
$\hat{\prod}_S^N$	−3.495	−3.926	−4.158	−3.776
$\hat{L}$	0.000	0.000	0.000	n/a
$\hat{L}_A$	1.250	1.784	3.107	1.240
$\hat{L}_M$	−8.747	−8.96	−15.34	−8.832
$\hat{L}_H$	2.443	0.916	2.462	3.120
$\hat{L}_S$	1.296	1.529	2.462	1.190
$\hat{K}$	−3.462	−3.475	−5.84	−3.293
$\hat{K}_A$	0.484	0.691	1.204	0.480
$\hat{K}_M$	−11.19	−12.11	−20.47	−11.27
$\hat{K}_H$	−3.618	−2.574	−3.750	−2.969
$\hat{K}_S$	−1.413	−1.982	−3.750	−1.511
$\hat{Q}_A$	0.484	0.691	1.204	0.480
$\hat{Q}_M$	−9.437	−9.937	−16.90	−9.516
$\hat{Q}_H$	−1.136	−1.001	−1.195	−0.674
$\hat{Q}_S$	0.387	0.357	0.399	0.288

the property tax burden borne on the sources side is 73 percent when all production elasticities equal 0.5, 76 percent when all production elasticities equal 1.0, and 78 percent when the demand elasticity equals 0.5 (as compared to 75 percent in the base case). Finally, the gain to local residents from exporting some of the property tax burden is little changed under both of these sensitivity analyses relative to the base case.

Conclusion

This study investigates the excise tax effects of the property tax in a small open economy context using a simulation model with four production sectors

Table 8. Property Tax Burden as a Percentage of Total Tax Revenue with a 5 Percent Property Tax Increase under Different Elasticity Assumptions

Tax burden	Base case (%)	All production elasticities = 0.5 (%)	All production elasticities = 1 (%)	Demand elasticity = 0.5 (%)
Tax burden borne by residents				
Labor	46.0	52.4	51.3	45.5
Housing land	15.3	19.4	16.2	12.5
Housing consumption	26.3	21.5	25.7	29.1
Services consumption	8.7	3.9	4.7	8.6
Total	96.2	97.3	97.9	95.8
Tax burden borne by nonresidents				
Agriculture land	−4.1	−4.6	−4.6	−4.0
Manufacturing land	6.2	5.3	5.3	6.2
Services land	3.3	3.7	4.0	3.6
Total	5.4	4.3	4.8	5.7

Note. Negative values indicate gains from the property tax increase. In the aggregate, total tax burden borne by both residents and nonresidents exceeds the total tax revenue as it reflects the efficiency costs of use of the property tax.

(manufacturing, services, housing, and agriculture) and three production factors (capital, labor, and land). It focuses on an intermediate-run time frame in which labor is mobile across production sectors but fixed within the taxing jurisdiction. The results of the simulations indicate that, within the intermediate-run time frame, the excise tax effects of the property tax fall primarily on labor and land; for example, in our benchmark case, 64 percent of the tax burden borne by residents is concentrated on the sources side of incidence, and over 75 percent of this burden reflects a decline in labor income. The reallocation of labor across sectors in response to the tax puts downward pressure on wages in all production sectors, and therefore mitigates the forward shifting of the tax burden in the two nontradable sectors. In addition, a small portion of the tax burden is exported to other jurisdictions through declines in net land rents in the nonresidential sectors. We show that these findings are robust to variations in key parameter values.

Our simulations also indicate that assumptions regarding labor mobility play a key role in determining the excise effects of the property tax. The traditional view of the property tax argues that the excise effects of the tax are primarily reflected in higher consumer prices; this result is obtained in a model with completely immobile labor, and can be roughly replicated in our model—with overshifting to consumers—when we assume that labor is

immobile. However, adding partial labor mobility to our four-sector model in the form of intersectoral mobility is enough to eliminate this overshifting of the tax into consumer prices, and indeed results in most of the tax burden being borne on the sources side of incidence, primarily by labor. Our result thus provides an interesting example of a case in which the partial mobility of a factor of production results in a higher tax burden than when the factor is completely immobile. However, when labor mobility is expanded to include interjurisdictional mobility so that backward tax-shifting to labor is impossible, the extent of forward tax-shifting to consumers increases substantially, with about three-quarters of the total tax burden borne by the residents falling on consumers of housing and services.

Finally, we note that the analysis in this article provides an indication of the distortions in capital allocation that can arise from local use of the property tax, and also illustrates part of its appeal, which arises from the fact that some of its burden can be exported to nonresident landowners. A natural question is whether use of the property tax is efficient from the perspective of local residents, especially when compared to a retail sales tax, as applied by states.[19] Although it is often asserted that the property tax is relatively desirable on efficiency grounds (Bahl and Wallace 2008), we have shown, within the context of a model similar to the one constructed in this article, that the two taxes are roughly equally distortionary at the margin (Muthitacharoen and Zodrow 2010).

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Notes

1. The focus of the incidence debate traditionally is on the fundamental question of whether the property tax is best viewed as a nondistortionary benefit tax or user

charge for public services received or a distortionary capital tax (Fischel, Oates, and Youngman 2011; Fischel 2001; Zodrow 2001b). This article, however, does not address this controversial issue, as it simply assumes the validity of the latter "new view" or "capital tax view" of the property tax.

2. Although this assumption is only an approximation, it is nevertheless realistic, because agricultural property typically benefits from very generous treatment under the property tax in the United States. These benefits include the valuation of agricultural property according to its current actual use, which is typically much lower than its market value, the assignment of a lower assessment ratio for agricultural property, and the provision of various tax credits or exemptions to qualified farmers (National Conference of State Legislatures 2002).
3. Note in particular that our model of local property tax incidence draws on some recent studies of the incidence of the corporate income tax in the international taxation literature, which has shown that a many-sector, many-factor approach provides important insights into tax incidence analysis that are not captured in the standard two-sector, two-factor model, especially when some goods are tradable while others are not (J. G. Gravelle and Smetters 2006; Harberger 2008).
4. See Fullerton (1983) for a justification of this assumption in the context of a closed economy. In addition, most recent empirical work suggests that international capital mobility is increasing over time (Zodrow 2008).
5. This contrasts with other studies that follow in the new view tradition and assume a fixed supply of capital, thus effectively analyzing incidence from the perspective of the nation (or perhaps a very large region), under the assumption that changes in after-tax returns have no effect on the aggregate capital stock.
6. For example, see Hobson (1986), Lin (1986), Brueckner (1981), LeRoy (1976), and Arnott and MacKinnon (1977); all of these studies take a long run perspective in which land is flexible across uses in different sectors and labor (if considered at all) is perfectly mobile across jurisdictions.
7. For example, Sullivan (1984) considers an "industrial property tax" that exempts housing.
8. In this case, the reduction in demand for the immobile factor due to tax-induced commodity price increases and the associated reductions in output demands are offset by increases in demand for the immobile factor due to substitution away from the taxed mobile factor. This leaves the price of the immobile factor unchanged, resulting in full forward shifting of the property tax.
9. The analysis thus adopts a partial equilibrium approach in that it examines tax incidence solely from the perspective of a single taxing jurisdiction that faces a perfectly elastic supply of capital, neglecting general equilibrium effects on other jurisdictions and the "profits tax" effect on the return to capital. Note, however, that Bradford (1978) shows that the profits tax effect still obtains for a tax

imposed in a single small jurisdiction when these external effects are considered, as the burden of the tax is borne by capital as a very small reduction in the return to capital that is spread over the entire capital stock. In addition, the excise tax effects that occur in the taxing jurisdiction—and are the focus of this analysis—are offset by similar but opposite effects in the nontaxing jurisdiction.

10. The analysis thus overstates the responsiveness of capital to property tax increases to the extent that such increases are matched in neighboring communities, as is consistent with the strategic property tax competition literature (Brueckner 2003).
11. This approximation is derived by differentiating the utility function and substituting from the first order conditions and the result of differentiating the budget constraint, taking into account the small open economy assumptions.
12. See Bureau of Economic Analysis, US Annual Input–Output Accounts, http://www.bea.gov/industry/io_annual.htm.
13. Chirinko, Fazzari, and Meyer (2004) estimate that the aggregate elasticity of substitution of production in the United States is in the neighborhood of 0.4, and Epple, Gordon, and Sieg (2010) argue that the elasticity of substitution between land and nonland inputs in the production of housing is in the neighborhood of one. There is, however, considerable variation in the empirical literature on these elasticities. Accordingly, we provide below the results of some sensitivity analyses for different values of the substitution elasticities in production.
14. In a related study, Muthitacharoen and Zodrow (2008) provide a more detailed analysis of a simpler two-sector, three-factor model.
15. Note that the excise tax effects of the property tax are less regressive in this case than under the traditional view, as both land ownership and wage income are more highly concentrated among the wealthy than consumption.
16. Labor is still only partially mobile, as full mobility would require a change of residence if household utility fell below an exogenously determined level.
17. Note that, as discussed in the text, the imposition of some capital immobility implies that the rate of return on capital will decrease slightly and capital owners will bear a relatively small fraction of the burden of the tax. The income effects associated with this tax burden on capital income are not captured in the sensitivity analysis; however, these income effects would have only minor effects on the relative shares of the excise tax effects of the property tax borne by consumers and other factor owners.
18. This assumption is consistent with the estimates by Jorgenson and Yun (2001) and Albouy and Ehrlich (2011). Jorgenson and Yun (2001) estimate the aggregate elasticity of substitution between capital and labor to be 0.5. Albouy and Ehrlich (2011) estimate that the elasticity of substitution between land and other factors in the housing sector equals 0.45.

19. The retail sales tax applied by the US states is far from a uniform and relatively nondistortionary tax on consumption; in particular, it exempts many services and other consumption goods and is applied to many business purchases (Zodrow 2008). Note that the tax bias favoring labor-intensive services under the property tax is reinforced by the sales tax exemption of many services.

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