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Risky local tax bases: risk-pooling vs. rent-capture

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Abstract

When a jurisdiction's land or other fixed resources are owned by non-residents, its residents have an incentive to capture the non-residents' rents by imposing confiscatory taxes. When different jurisdictions are subject to less than perfectly correlated risks, such taxes destroy the benefits of risk-pooling that cross-ownership of property otherwise permits. If jurisdictions must use property taxes (i.e. taxes on both immobile land and mobile capital) instead of taxes on land alone, they will compete for mobile capital by keeping tax rates low. If capital is sufficiently substitutable for immobile factors, tax rates will be low enough to achieve greater effective diversification of risks and higher welfare.

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1. Introduction

The literature on the incidence and efficiency effects of property taxation has emphasized the fact that property taxes generally fall on two factors of production, namely, land and capital. In static settings, the tax on land is thought to be neutral in its allocative effects because land is inelastically supplied, while the tax on capital can have allocative consequences in the long run because capital is mobile

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among taxing jurisdictions. Conventionally, it is argued that the burden of a tax on land falls on landowners, reducing the rents that they would otherwise obtain. Furthermore, in an economy where the overall supply of capital is fixed, the burden of a uniform tax on capital in all jurisdictions falls on capital owners.[1] Capital mobility must be taken into account when considering the incidence effects of differences in capital tax rates across jurisdictions, and when studying how a single jurisdiction sets its fiscal policies. For instance, competition for mobile capital may lead localities to choose levels of public expenditure and taxation that are inefficiently low (Zodrow and Mieszkowski, 1986; Wilson, 1986, 1991; Wildasin, 1989). If other revenue sources are available in addition to the property tax, the mobility of capital may also influence the mix of taxes that jurisdictions will choose, and the efficiency of this mix for the system as a whole. Hoyt (1991) and Krelove (1993) show that property taxes dominate land taxes for decentralized governments that provide congestible public goods to mobile households but are unable to impose direct user fees or head taxes.[2]

The present paper explores the welfare implications of property taxation from a rather different perspective, one that has been ignored in most of the literature on the subject. We begin with the observation that the returns to labor, land and capital are subject to many types of risk. The returns to human and non-human resources allocated to different industries and occupations can vary widely due to changing market conditions, technological change, natural hazards, and many other factors. Some of these factors are inherently regional or local in their impact (e.g. climatic fluctuations, random discoveries of natural resources, natural disasters). Others, such as fluctuations in world markets, have geographically localized effects because the mix of industrial activity and employment varies among regions due to economic specialization (e.g. certain manufacturing or service industries will be disproportionately important to a given city). Not all region-specific risks are perfectly correlated, and to the extent that they are not, it is desirable for risk-averse individuals to diversify their income sources in order to achieve efficient risk-pooling. Geographical diversification of portfolios of non-human assets is one way that such risk-pooling can occur.

Whether such diversification is effectively sustainable, however, depends in part on local tax policies. To the extent that localities tax the risky returns to land or capital, their residents absorb risk that might otherwise have been shared with outsiders. Local taxation can therefore hinder efficient risk-sharing. However, precisely because some of the returns to land and capital accrue to non-residents, it

[1] Standard references on the incidence of property taxes include Mieszkowski (1972) and Bradford (1978); see Wildasin (1986), (1987) for additional references and discussion.

[2] They treat the property tax as an excise tax on housing and assume a publicly-provided private good; see Wilson (1997) for further analysis of their findings. Bucovetsky and Wilson (1991) analyze the choice between labor taxation and capital taxation, and Wilson (1995) analyzes this mix of taxes in a model with both capital and labor mobility.

may be in the interest of local governments to tax these returns. This may provide a mechanism for tax exporting, that is, for shifting the burden of local taxes to non-residents.[3] Whether decentralized governments will choose tax policies that promote or facilitate efficient risk-sharing in a world of uncertainty is therefore open to question.

To address this issue, we analyze a model of a system of jurisdictions, in each of which production occurs under conditions of uncertainty using labor, land, and interjurisdictionally-mobile capital. In Section 2, we develop this model without allowing for governments or taxation, and show how households would choose to diversify their holdings of land and capital in order to reduce the riskiness of their incomes. In Section 3.1, we assume that decentralized governments can tax the returns to land and capital differentially, if desired, and investigate what combination of taxes on land and capital they would choose. It turns out that they would find it advantageous to tax land very heavily (at a rate of 100%), while taxing capital lightly (at a rate of 0%). This outcome limits the extent of interjurisdictional risk-pooling in the economy. In Section 3.2, we consider what happens under a regime of property taxation, which we interpret as a system in which both land and capital are subject to tax at a uniform rate. Our analysis shows that property taxation can lead to preferable outcomes under some conditions, namely, when local taxation interferes less with efficient risk-pooling than would be the case under a system of unrestricted taxation with differentiated rates on land and capital. Section 4 summarizes some of the principle findings and discusses generalizations of results, including their potential application in an international context.

2. The model with no public sector

This section describes the model of the economy with no public sector and derives some important properties of the equilibrium for this case. This facilitates the exposition and establishes a benchmark for comparison with the model with governments present.

Our analysis and results are most transparent, and the notation least cumbersome, when we impose strong symmetry assumptions. Thus we assume that the economy consists of a large number of jurisdictions that are ex ante identical. Each jurisdiction contains T units of land and L households with identical preferences and endowments of labor, land, and capital.[4] A household's labor endowment is set equal to one, and this endowment is supplied to competitive firms in the

[3] The potential for such exporting is well-recognized in the literature on the taxation of natural resource rents. See, e.g., Mieszkowski and Toder (1983).

[4] However, households may differ in the distribution of their initial land endowments across jurisdictions.

household's jurisdiction of residence. These firms combine labor with the jurisdiction's land and interjurisdictionally-mobile capital to produce a single homogeneous output under conditions of uncertainty. We consider a symmetric equilibrium and denote by K the amount of capital that each of the identical jurisdictions employs in this equilibrium. All firms have access to the same neoclassical production technology, so that output Q in each jurisdiction is a linear homogeneous and concave function of the amount of labor, land, and capital employed in the jurisdiction, $Q=\theta F(L, T, K)$. The parameter θ is a random variable with $E(\theta)=1$. We assume that θ is independently and identically distributed across jurisdictions. Although alternative interpretations are possible, as described later, the parameter θ can be taken to represent any type of jurisdiction-specific production risk, attributable, for instance, to such factors as climate or technological change.

We now describe the actions of households and firms in the order that they occur. First, some (possibly all) of the land and capital endowments of households are sold to firms in exchange for shares of equity ownership. After these sales, capital becomes immobile, i.e. it cannot be reallocated across jurisdictions once the technological uncertainty is resolved. Next, households trade ownership shares in firms in order to pool risks. Because they are risk averse, households have an incentive to trade to a portfolio of ownership shares that is fully-diversified across all jurisdictions. Because there are a large number of jurisdictions, each possessing a random technology parameter with an i.i.d. distribution, a household is able to shed all risks associated with its equity holdings by purchasing a portfolio with identical ownership shares in each jurisdiction.[5] More precisely, each household will seek to own equal shares in all jurisdictions except the one in which it resides. The household will want to own no local assets at all, because the return on assets in a household's place of residence is positively correlated with its wage income in this model. Indeed, if short sales were permitted, the household would sell local assets short in order to hedge wage risk.

To demonstrate that our conclusions do not depend on the complete absence of local ownership of assets, we allow each household to possess exogenously-determined holdings of land and capital, T^0 and K^0, which it is not able to sell to firms ex ante in exchange for equity ownership. Instead, these endowments are treated in the same way as labor: they are sold to local firms on spot markets after the resolution of uncertainty. Thus there is no way to effectively insure against the risky returns associated with both labor and the 'locally-owned factors', T^0 and K^0.

[5]As explained by Judd (1985), there are potential technical problems with the assertion that aggregations of a continuum of i.i.d. variables are non-stochastic. There are also technical solutions to these problems. For our purposes, however, it is only necessary that there be 'sufficiently many' independent risks for macro-uncertainty to be negligible, and the assumption that aggregate uncertainty completely disappears is merely an idealization.

Once portfolio trades are completed, technological uncertainty is resolved, with the value of the random variable θ being realized in each jurisdiction. Labor and locally-owned land and capital are then purchased by firms at competitively-determined spot prices, which depend on the realization of θ. We assume that T^0 and K^0 are less than the total amounts of land and capital employed by a jurisdiction's firms, so that firms do purchase positive quantities of capital and land from outside investors prior to the resolution of uncertainty. As a special case, either T^0 or K^0 (or both) may be zero, corresponding to the case where all land and capital (or both) are sold to firms ex ante.

There are alternative ways to specify market transactions that are effectively equivalent to our specification. We could assume, in particular, that households directly trade land holdings in different jurisdictions to achieve a diversified portfolio, rather than sell land to firms and then trade ownership shares that include the returns on land. The outcome would be the same diversified equilibrium, where the risk associated with random returns on land is eliminated, except for the risk associated with the locally-owned land, T^0. Another possibility would be to allow households to sell their land and capital to firms at fixed prices. This corresponds to debt finance and increases the riskiness of firm profits. However, households would continue to offset this risk by diversifying their portfolios.[6] Finally, it makes no difference whether the locally-owned factors, T^0 and K^0, are sold after uncertainty is resolved or in exchange for equity before this resolution. In both cases, investors receive the same random return.

Consider now the determination of factor prices and profits. Output serves as the numeraire, so its price is fixed at one. After the resolution of uncertainty, firms purchase all of the residents' labor endowment and those portions of land and capital that are locally-owned (i.e. T^0 and K^0).[7] The equilibrium 'spot price' at which each factor is traded equals the marginal product for that factor:

$$w_i = \theta F_i(L,T,K);\ i = L,T,K. \tag{1}$$

After having purchased $T - T^0$ units of land and $K - K^0$ units of capital prior to the resolution of uncertainty, a firm receives the ex post return

$$\pi = \theta F(L,T,K) - w_L L - w_K K^0 - w_T T^0. \tag{2}$$

Since households fully diversify away the risks associated with their equity holdings, the value that they place on a firm equals expected profits, calculated net of future factor purchases (which are perfectly anticipated):

$$E\pi = F(L,T,K) - w_L^e L - w_K^e K^0 - w_T^e T^0, \tag{3}$$

[6]Our 1995 working paper, which is available upon request, contains a full description of the model under the assumption that capital is financed by debt.

[7]As described earlier, the remainder of land and capital is traded ex ante in exchange for equity shares in firms.

where w_i^e is the expected spot price for factor i, equal to the expected marginal product,

$$w_i^e = F_i(L,T,K);\ i = L,T,K. \tag{4}$$

The firm's objective is to maximize these expected profits net of the costs of equity. The expected revenue from another unit of factor i ($i = T$, K) is given by the expected spot price, w_i^e. Thus, in equilibrium, this expected spot price is the value of equity that investors demand in return for another unit of factor i, and the total cost of new equity is $w_K^e(K - K^0) + w_T^e(T - T^0)$. Subtracting this cost from (3) gives the firm's maximization problem:

$$\underset{T,K}{\text{Max}}\ F(L,T,K) - w_L^e L - w_T^e T - w_K^e K. \tag{5}$$

These maximized expected profits equal zero, but ex post profits may be positive or negative.

We consider a symmetric equilibrium for the system of jurisdictions as a whole. Each jurisdiction faces the same required return for mobile capital, w_K^e, and demands the same amount of capital, K^*, which is the average amount of capital available per jurisdiction in the entire economy. Given K^* and the fixed supplies of land and labor in the jurisdiction, the equilibrium factor prices are fully determined by (1). The competitive firms in the jurisdiction treat these prices as exogenous when solving the profit-maximization problem given by (5).

Consider finally the determination of household income in each jurisdiction. This income contains random wages and random returns on the locally-owned factors (T^0 and K^0). All other capital and land is invested in a diversified portfolio outside the jurisdiction of residence, so that it earns a sure return. Hence the total income received by a jurisdiction's residents is

$$Y(\theta) = \theta w_L^e L + w_T^e(\theta T^0 + (T - T^0)) + w_K^e(\theta K^0 + (K^* - K^0)). \tag{6}$$

The ex post utility for a household living in a jurisdiction with a technology realization of θ is equal to $u(Y(\theta)/L)$, where u is an increasing, strictly-concave utility function.

This completes the description of the model without government intervention. In summary, its notable features include (i) complete symmetry among jurisdictions, so that capital is allocated uniformly across jurisdictions and all utilities are identical ex ante, and (ii) risk-pooling through full diversification of investments made outside the household's jurisdiction of residence. We have assumed, obviously, that no markets exist through which locally-invested factors, including labor, can be insured, and we will continue to maintain this assumption.

3. Tax exporting, tax competition, and diversification

In this section, we suppose that there is a government in each jurisdiction that sets tax policies in the interest of its residents. This government is first assumed to be able to tax the returns to land and capital at any desired rates. In the second subsection, we assume instead that the rate of taxation on land must be equal to the rate of taxation on capital; this uniform tax is interpreted as a 'property tax'. In both cases, these tax rates are determined before firms make their investment decisions, so that the allocation of capital is not subject to tax rate uncertainty. However, these tax rates are imposed on the ex post realizations of factor income, and thus the amount of revenue that they yield is uncertain ex ante.

Since the main focus of the analysis is to determine the choice of the local tax bases and the structure of local tax rates, and to compare welfare levels under different tax regimes, the public expenditure side of the model is very simple. Specifically, we assume that the government faces an exogenously-fixed revenue requirement, independent of the outcome of technological uncertainty. As a consequence, there must be some tax or subsidy instrument that adjusts following the resolution of uncertainty to keep the government budget balanced. There are two equivalent ways of proceeding. First, we may introduce a lump-sum subsidy (negative for a tax) that adjusts ex post to balance the budget. Alternatively, the budget-balancing adjustments could be assigned to a subsidy (or tax) on labor income. Since residents provide labor in fixed supply, a labor subsidy is also a lump-sum subsidy, making the two methods equivalent. For concreteness, we fix the labor subsidy at zero and refer to the tax system as being set ex ante, whereas the lump-sum subsidy adjusts ex post. Note finally that this subsidy could be interpreted as expenditures on a local public good that is perfectly substitutable with private consumption.[8]

3.1. Unrestricted local taxation

Suppose now that each jurisdiction can choose separate tax rates on land and capital, denoted τ_T and τ_K, and that these tax rates are set so as to maximize the expected utility of resident households. Let w_L, w_T, and w_K now denote the gross

[8]Our results can be generalized by replacing this subsidy with an endogenous supply of an imperfectly-substitutable public good. Under our assumption of multiplicative uncertainty, local governments choose their tax rates on capital and land (or their property tax rates) to maximize the expected value of resident income. A tax or subsidy on labor can then be used to achieve an optimal ex ante allocation of this income between public and private goods. (We assume here that labor income is sufficient to finance the optimal public good supply, given the income-maximizing choices of the other tax rates.) With or without this public good, the issue of whether unrestricted taxation or property taxation yields higher welfare depends on how much of a resident's income takes the form of a sure return on equity.

(before-tax) spot prices of labor, land, and capital, as determined by (1), and let r denote the expected net return on capital:

$$r = (1 - \tau_K)w_K^e. \tag{7}$$

Substituting from (4) gives

$$r = (1 - \tau_K)F_K(L,T,K). \tag{8}$$

By the assumption of many jurisdictions, r is fixed from the viewpoint of a single jurisdiction, i.e. the jurisdiction has a negligible influence on the return that capital owners can receive by investing their capital elsewhere. Given the jurisdiction's fixed supplies of land and labor, (8) defines a capital demand function, $K=K(r/[1-\tau_K])$, which is downward-sloping by the diminishing marginal productivity of capital. In particular, the level of capital depends negatively on the tax rate on capital. In a symmetric equilibrium, each jurisdiction obtains the average amount of capital investment, so that

$$K(r/[1 - \tau_K]) = K^*. \tag{9}$$

Thus the effect of taxation of capital income at a system-wide rate of τ_K is to reduce the net return to capital by the amount of the tax. This is a standard finding in models of multi-jurisdictional capital taxation, when the economy-wide stock of capital is exogenously fixed. While individual jurisdictions treat the net rate of return on capital as fixed and the level of capital investment as variable, the reverse is true for the aggregate of all jurisdictions.

The government in a jurisdiction chooses its tax rates to maximize the welfare of residents, as measured by their expected utilities. In doing so, it faces the following budget constraint:

$$G + sL = \tau_T w_T T + \tau_K w_K K = \theta[\tau_T w_T^e T + \tau_K w_K^e K], \tag{10}$$

where G is the exogenous revenue requirement and s is the lump-sum subsidy provided to each resident household. Other jurisdictions choose identical tax policies in a symmetric equilibrium, denoted by (τ_T^*, τ_K^*), resulting in identical expected factor prices, $(w_L^{e*}, w_T^{e*}, w_K^{e*})$. The net income accruing to households in a given jurisdiction can then be written as

$$\begin{aligned} Y(\theta) = {} & \theta[w_L^e L + w_T^e T^0 + w_K^e K^0] + \theta[\tau_T w_T^e (T - T^0) + \tau_K w_K^e (K(\cdot) - K^0)] \\ & + (1 - \tau_T^*)w_T^{e*}(T - T^\circ) + r(K^* - K^0) - G, \end{aligned} \tag{11}$$

where $K(\cdot)=K(r/[1-\tau_K])$. Thus three terms contribute positively to $Y(\theta)$: random income from factors that households supply locally, a new term reflecting the random tax payments by outside investors (through their ownership of domestic firms), and the non-random income from the diversified investments that residents make outside the jurisdiction. Notice that tax payments by the jurisdiction's residents to their own government do not enter (11). The reason is that such payments are distributed back to the residents via the lump-sum subsidy.

On the other hand, residents do benefit from the tax payments of absentee landowners, and this benefit is represented by the term $\tau_T w_T^e (T - T^0)$ in (11). To maximize resident welfare, the government will therefore tax away these land rents. In equilibrium, all jurisdictions will have a 100% tax on land: $\tau_T = \tau_T^* = 1$.

In contrast, the equilibrium tax rate on capital is zero. To see this, use the conclusion that land is taxed at 100% to simplify the expression for $Y(\theta)$ as follows:

$$\begin{aligned} Y(\theta) &= \theta[w_L^e L + w_T^e T + \tau_K w_K^e K(\cdot)] + \theta r K^0 + r(K^* - K^0) - G \\ &= \theta[F - rK(\cdot)] + \theta r K^0 + r(K^* - K^0) - G, \end{aligned} \tag{12}$$

where the first equality makes use of (7) and the second equality makes use of the equality between output and factor costs under constant returns to scale. Each jurisdiction chooses its capital tax rate to maximize a resident's expected utility, $E[u(Y[\theta]/L)]$. The first-order condition for this problem is $E[u'\theta][F_K - r] = 0$. Since firms set F_K equal to ${w_K}^e$, it follows that the government should leave capital untaxed.

The intuition behind this result is straightforward. Each jurisdiction faces a perfectly elastic ex ante supply of capital at the externally-given expected rate of return. Capital taxation by any one jurisdiction drives out capital but has no (appreciable) effect on the cost of capital to the jurisdiction. Under these conditions, as long as alternative lump-sum revenue sources are available, it is in the interest of each individual jurisdiction to set a zero tax rate on capital. Precisely this result is found in models of tax competition under certainty, and the result survives here, given that localities are not constrained a priori to use only capital taxation.

To summarize the above results, we have shown —

Proposition 1. *With unrestricted taxation, each jurisdiction chooses to tax the return to land at a rate of 100% and leaves the return to capital completely untaxed.*

It might appear at first sight that the equilibrium for the economy with unrestricted taxation would be efficient, since each jurisdiction taxes only inelastically-supplied factors of production, namely, labor and land. It is certainly true that the equilibrium allocation of capital and hence the ex ante pattern of production and gross returns to all factors are unaffected by taxes in this equilibrium. Taxes nevertheless do create a type of distortion and a welfare loss. To see why, note that since $\tau_K = 0$ in equilibrium, the first equality in (12) simplifies to

$$Y(\theta) = \theta[w_L^e L + w_T^e T] + w_K^e[\theta K^0 + (K^* - K^0)] - G. \tag{13}$$

Comparing this expression with (6), showing the level of income in the no-tax case, one can see that the crucial difference between the two is that all land rents are random when each jurisdiction chooses its own taxes, whereas only the locally-owned portion of land rents is random in the no-tax case. In using taxes on land to capture rents that would otherwise accrue to non-residents, the risk-pooling benefits of diversified land ownership are lost. Households still obtain the same expected income from land but experience a pure increase in risk because the 100% land taxation effectively implies that each household holds a completely undiversified portfolio of land, through the intermediary of jurisdictional government, consisting only of land in the jurisdiction in which the household resides.

3.2. Property taxation

Suppose now that jurisdictions are able to levy property taxes, i.e. uniform taxes on the returns to land and capital, but cannot separately tax the returns to land and capital. This might reflect an inability to differentiate effectively between the returns to land and capital in the administration of taxes; alternatively, the restriction to uniform taxation of land and capital might be imposed as a matter of policy, for instance by a higher-level governmental unit.

In the light of the preceding analysis, it is clear that the use of a property tax has potential advantages as well as potential disadvantages. Since property taxes fall partly on the return to capital, they discourage capital investment, and jurisdictions therefore have an incentive to limit the rate of taxation. The competition for mobile capital can have the beneficial effect of limiting the appropriation of land rents that would otherwise accrue to non-residents. Roughly speaking, if jurisdictions find it optimal to tax land at a 100% rate and capital at a 0% rate, one would expect them to choose some intermediate rate of taxation when the two must be taxed uniformly, and any rate less than 100% would imply that the benefits of risk-pooling through diversification of land holdings are not completely lost. But while it is desirable for jurisdictions to tax land at a rate less than 100%, it is undesirable for them to tax capital at a rate greater than zero, since doing so means that some of the risk of uncertain returns on capital is then absorbed within the taxing jurisdiction. Determining whether welfare is higher with property taxation than under unrestricted (differentiated) taxation therefore requires a detailed comparison of offsetting effects, to which the following analysis is directed.

To begin the analysis, note first that since the property tax falls on the return to capital, it raises the cost of capital to a jurisdiction in the same way as a tax on capital alone. The analysis of investment behavior proceeds as before by substituting the property tax rate, τ_P, for τ_K in the equilibrium condition determining the profit-maximizing level of capital in each jurisdiction:

$$r = (1 - \tau_P)F_K(L,T,K). \tag{14}$$

As before, clearing of the capital market implies that the demand for capital in each jurisdiction must be equal to the amount of capital available per jurisdiction: $K[r/(1-\tau_P)] = K^*$.

The expression for household income under a property tax is obtained from (11) by substituting τ_P for τ_T and τ_K:

$$\begin{aligned} Y(\theta) &= \theta[w_L^e L + w_T^e T^0 + w_K^e K^0] + \theta\tau_P[w_T^e(T - T^0) + w_K^e(K(\cdot) - K^0)] \\ &+ (1 - \tau_P^*)[w_T^{e*}(T - T^0) + w_K^{e*}(K^* - K^0)] - G, \end{aligned} \tag{15}$$

where $K(\cdot) = K[r/(1-\tau_P)]$ and, recalling that this expression assumes a symmetric equilibrium, τ_P^* denotes the property tax rate chosen by all other jurisdictions.

Each jurisdiction chooses τ_P to maximize its expected utility, $E[u(Y[\theta]/L)]$. Of course, in a symmetric equilibrium, $\tau_P = \tau_P^*$, $K = K^*$, and expected utility is the same in all jurisdictions. It is clear from (15) that this common level of expected utility is higher, the lower the common value of the property tax rate imposed by all jurisdictions, since a higher property tax leaves the expected value of $Y(\theta)$ unchanged but raises its variability. Stated differently, higher values of the property tax rate imply that a larger share of non-wage income in (15) is multiplied by the random variable θ.

To compare income under unrestricted taxation with income under property taxation, use the conclusions that land is taxed at 100% and capital is not taxed under unrestricted taxation to rewrite (15) as

$$Y^P(\theta) = Y^U(\theta) + (\theta - 1)\{\tau_P[w_T^e(T - T^0) + w_K^e(K - K^0)] - w_T^e(T - T^0)\}, \tag{16}$$

where superscripts distinguish the unrestricted and property-tax regimes. Since $E(\theta) = 1$, expected income in each regime is the same, while the variability of Y^P is lower or higher than that of Y^U as the level of revenue collected on the land and capital owned by non-residents (through their equity holdings) is lower or higher under the property tax regime than under the unrestricted taxation regime, i.e. depending on whether

$$\tau_P[w_T^e(T - T^0) + w_K^e(K - K^0)] < (>) w_T^e(T - T^0). \tag{17}$$

Welfare under a property tax regime is therefore higher than under unrestricted taxation if it results in lower equilibrium levels of tax payments by non-residents.

One might expect that the direction taken by this inequality would depend on preferences, factor endowments, the production technology, and the distribution of the random variable θ, since the choice of tax policy is taken by jurisdictions in an environment that depends on all of these things. It is therefore somewhat surprising to find that conditions for the relative desirability of property taxation versus unrestricted taxation can be expressed entirely in terms of properties of the production technology and the relative amount of local ownership of capital.[9] First, as a matter of notation, let a hat (^) denote a proportional change in a variable resulting from a marginal change in the property tax rate τ_P; thus, $\hat{K} = \mathrm{d}(\ln K)/\mathrm{d}\tau_P$ and $\hat{w}_i^e = \mathrm{d}(\ln w_i^e)/\mathrm{d}\tau_P$. Then we can show:

Proposition 2. *Welfare is higher when jurisdictions use property taxes than under a regime of unrestricted taxation if and only if*

$$\frac{\hat{K}}{\hat{w}_T^e - \hat{w}_K^e} > \frac{K - K^0}{K}. \tag{18}$$

Proof. We begin by transforming (15) into an expression for $Y(\theta)$ that is similar to (12) except for the addition of terms reflecting the positive taxation of land through the property tax:

$$\begin{aligned} Y(\theta) &= \theta[w_L^e L + \tau_P w_T^e T + \tau_P w_K^e K(\cdot)] + (1-\tau_P)\theta w_T^e T^0 + \theta r K^0 \\ &+ (1-\tau_P^*)[w_T^{e*}(T-T^0) + w_K^{e*}(K^* - K^0)] - G \\ &= \theta[F - rK(\cdot) - (1-\tau_P)w_T^e T] + (1-\tau_P)\theta w_T^e T^0 + \theta r K^0 \\ &+ (1-\tau_P^*)w_T^{e*}(T-T^0) + r(K^* - K^0) - G. \end{aligned} \tag{19}$$

Each jurisdiction chooses τ_P to maximize expected utility. Differentiation of (19) gives the following first-order condition:

$$E\left[u'\left(\frac{Y(\theta)}{L}\right)\left(\frac{\theta}{L}\right)\right]\left[(F_K - r)\left(\frac{\mathrm{d}K}{\mathrm{d}\tau_P}\right) + w_T^e(T-T^0) - (1-\tau_P)\left(\frac{\mathrm{d}w_T^e}{\mathrm{d}\tau_P}\right)(T-T^0)\right] = 0. \tag{20}$$

Observing that $F_K - r = \tau_P F_K = \tau_P w_K^e$, and expressing other variables in percentage terms, we obtain

$$\tau_P \alpha_K \hat{K} + (\alpha_T - \alpha_T^0)[1 - (1-\tau_P)\hat{w}_T^e] = 0, \tag{21}$$

where α_i is gross share of factor i in total income ($\alpha_L + \alpha_T + \alpha_K = 1$), and α_i^0 is gross share of total income that goes to locally-owned factor i. (Thus, $T^0/T = \alpha_T^0/\alpha_T$ and $K^0/K = \alpha_K^0/\alpha_K$.)

[9] The values of the production variables that enter into these conditions may in general depend implicitly on preferences, endowments, and other data of the model. However, we present an example below where there is not even an implicit dependence on these data.

To simplify (21), use (14) to obtain $\hat{w}^e_K = 1/(1-\tau_P)$ and substitute this equality into (21):

$$\tau_P \alpha_K \hat{K} + (1-\tau_P)(\alpha_T - \alpha^0_T)(\hat{w}^e_K - \hat{w}^e_T) = 0. \tag{22}$$

This equation can be solved for the optimal tax rate:

$$\tau_P = \frac{\alpha_T - \alpha^0_T}{\alpha_K\left(\dfrac{\hat{K}}{\hat{w}^e_T - \hat{w}^e_K}\right) + \alpha_T - \alpha^0_T}. \tag{23}$$

Now observe from (17) that welfare is higher under property taxation than in the unrestricted taxation regime if and only if

$$\tau_P[(\alpha_T - \alpha^0_T) + (\alpha_K - \alpha^0_K)] < \alpha_T - \alpha^0_T. \tag{24}$$

Using (23), some simple algebra shows that (24) is equivalent to (18). Q.E.D.

Proposition 2 shows that the comparison of property taxation and unrestricted taxation hinges on the relative magnitudes of changes in factor employment and factor prices in response to changes in the property tax rate. More precisely, Proposition 2 indicates that the property tax is preferable to unrestricted taxation if the ratio of the proportional change in the equilibrium capital/land demand ratio to the proportional change in the equilibrium land/capital price ratio exceeds the ratio of the capital owned by non-residents (through their ownership shares in local firms) to the jurisdiction's total capital supply.

This result may be simply explained. It is the taxation of the capital owned by non-residents that inhibits efficient risk-pooling, rather than the taxation of locally-owned capital. Since capital is taxed under property taxation but not under unrestricted taxation, we therefore find that more non-resident ownership of capital reduces the desirability of the property tax relative to unrestricted taxation.

Observe that local ownership of land does not similarly enter Proposition 2. Land is taxed more heavily under unrestricted taxation, which by itself would suggest that more non-resident ownership of land increases the relative desirability of the property tax. However, (23) shows that more non-resident ownership also increases the equilibrium rate at which property is taxed. The two effects evidently offset each other.

In practice, the lower bound that Proposition 2 places on the substitutability between factors is likely to be substantially less than one; owner-occupied housing is one important example of an investment individuals make in their jurisdiction of residence. Thus Proposition 2 suggests that the degree of factor substitutability does not have to be unreasonably large for property taxation to dominate unrestricted taxation.

To develop this idea further, consider the case where the production function F satisfies the following separability condition:

Assumption A. $F(L, T, K) = G(\varphi(L, T), K)$, where $\varphi(\cdot)$ and $G(\cdot)$ are linear homogeneous.

Letting subscripts on φ denote partial derivatives, the equality between factor prices and marginal products implies

$$\frac{w_L}{w_T} = \frac{\varphi_L(L,T)}{\varphi_T(L,T)}. \tag{25}$$

Since L and T are fixed in supply, it follows that w_T/w_L is invariant to changes in tax policy. Consequently, it is possible to aggregate land and labor into a single 'non-capital' input, N, consisting of N units of land and $(L/T)N$ units of labor. In terms of the non-capital and capital inputs, the production function can be written $H(N, K) = G(N\varphi(L/T), 1), K)$. The price of the non-capital input is defined by

$$w_N = w_L \frac{L}{T} + w_T = w_T\left(\frac{\varphi_L(L,T)}{\varphi_T(L,T)} \frac{L}{T} + 1\right). \tag{26}$$

By constant returns, K/N depends only on the factor-price ratio, w_N/w_K. We can therefore define the elasticity of substitution between N and K by

$$\sigma = \frac{\mathrm{dln}(K/N)}{\mathrm{dln}(w_N/w_k)}. \tag{27}$$

We now prove that this elasticity satisfies —

Proposition 3. *For production functions satisfying Assumption A, welfare is higher when jurisdictions use property taxes than under a regime of unrestricted taxation if and only if*

$$\sigma > \frac{K - K^0}{K}. \tag{28}$$

Proof. Because of fixed factor supplies, $\hat{N} = 0$. Hence,

$$\hat{K} = \hat{K} - \hat{N} = \sigma(\hat{w}_N - \hat{w}_K). \tag{29}$$

By (26), $\hat{w}_N = \hat{w}_T$. It then follows from (29) that the left side of Eq. (18) in Proposition 2 equals σ. Proposition 3 follows immediately. Q.E.D.

To illustrate the application of this proposition, consider the case of a CES technology, $F(L, T, K) = (L^\rho + T^\rho + K^\rho)^{1/\rho}$, with $\rho < 1$. We can define a production function in terms of non-capital and capital inputs as $H(N, K) = ((L/T)N^\rho + N^\rho + K^\rho)^{1/\rho} = ((1 + (L/T))N^\rho + K^\rho)^{1/\rho}$. For this production function,

$$\frac{H_N}{H_K} = \left(\frac{K}{N}\right)^{1-\rho}.$$

It follows that the substitution elasticity, σ, equals $1/(1-\rho)$. In the Cobb-Douglas case, $\sigma=1$, and it follows that property taxation yields a higher welfare level than unrestricted taxation, assuming some local ownership of capital. In fact, for sizable levels of local ownership, σ can lie substantially below one without eliminating the desirability of property taxation. But when σ is sufficiently low, implying that inputs are poor substitutes, the competition for capital is 'less severe' and the downward pressure of this competition on the equilibrium property tax rate is not strong enough to outweigh the disadvantage of applying the tax to the combined base of land and capital rather than just to land.

4. Conclusion

In the model developed here, residents in each jurisdiction have an incentive to use local tax policy to capture land rents that might otherwise accrue to non-residents. However, when every jurisdiction pursues this strategy, all are made worse off. Ideally, a household's portfolio of ownership shares would be fully diversified across all jurisdictions. But by taxing land at a rate of 100%, each jurisdiction effectively seizes the land within its boundaries, and its residents must then absorb the risk associated with the returns to land. Sometimes, as shown in Propositions 2 and 3, welfare is improved if the tax base is broadened so that land and capital are taxed at uniform rates. If capital is highly substitutable with immobile factors of production, the competition for mobile capital will keep the overall tax rate low. While the gains from risk-pooling through diversification of ownership of assets are not fully realized under a system of property taxation, capital mobility imposes enough of a constraint on local taxing power to protect these gains to some degree.

Although our model is very stylized, the analysis presented above can shed some light on issues of taxation in an international context, as well as within the setting of local public finance. First, our analysis suggests that foreign tax credits and other international tax arrangements that encourage source taxation of capital income may be socially harmful, as they reduce the international diversification of risks. (Further analysis of international taxation from this perspective would be quite valuable but goes beyond the scope of the present paper; see, however, Nielsen, 1994.) Our analysis is also related to the literature on expropriation, debt repudiation, capital flight, and country risk.[10] A major concern in this literature is whether the prospect of debt repudiation or expropriation of privately-owned capital will limit a country's access to capital markets and thus constrain its

[10] See, e.g., Eaton et al. (1986), Eaton and Gersovitz (1984), (1989), and references therein. Noting that gross international capital flows are sometimes much larger than net flows, Slemrod (1993) develops a 'North-South' model in which risk-averse agents engage in cross-hauling of capital in order to diversify their portfolios.

investment and growth prospects. While such concerns are well-founded, our model is deliberately structured so that no capital misallocations can occur in equilibrium. Nevertheless, expropriation (represented in the model by tax rates of 100% on the returns to assets) is socially costly because it interferes with the efficient pooling of risk, and, according to Proposition 1, some expropriation does occur in equilibrium. Our analysis also suggests, however, that one should distinguish between expropriation of mobile assets (like capital) and immobile assets (like land and other natural resources).[11]

Our finding that taxation of returns to risky assets can impair risk pooling contrasts with an established tradition in the literature of public finance. A line of thought that can be traced to a seminal contribution by Domar and Musgrave (1944) maintains that taxation can be welfare-improving in a world of uncertainty: taxation makes the government a 'silent partner' in risky ventures, allowing risks to be pooled through the public sector. In the present analysis, taxation does indeed involve government participation in risky activities. However, rather than improving the social allocation of risk, taxation implies that risks are allocated inefficiently. Here, the best way to deal with risk is to have no taxation whatsoever. Then the market is able to achieve optimal diversification. Taxation limits the extent of effective diversification, so, far from achieving the risk-pooling role associated with the Domar-Musgrave tradition, it destroys market risk-pooling. Note, however, that our analysis shows only that decentralized taxation can lead to inefficient allocation of risk. If a single central government were to tax away all of the returns to land, and then distribute the proceeds on an equal per capita basis throughout the entire economy, it would replicate the efficient fully-diversified market outcome with no taxation. From the viewpoint of risk allocation, there may therefore be a stronger case for restrictions on the taxing authority of local governments than for a central government. The problem with government intervention in this case is not the problem of a 'Leviathan', but of the 'piranha'.

If our analysis runs somewhat counter to the presumption that taxes contribute to risk pooling, it may at first glance appear to support the conclusions of Brennan and Buchanan (1980), who argue that highly mobile tax bases restrict local taxation in a beneficial way. The arguments underlying our conclusions and those of Brennan and Buchanan are, however, quite different. They favor fiscal decentralization in order to limit the overall spending power of a public sector that pursues its own agenda contrary to the interests of the population it serves (or exploits). By contrast, our analysis deliberately suppresses the determination of

[11] Williams (1975) notes that ~20% of foreign assets in LDCs were nationalized during the period 1956–1972; a substantial proportion of these nationalizations were compensated, at least in part. It would be interesting to ascertain whether the amount of compensation by country and sector varies with the resource-intensity of the expropriated assets, i.e. to determine to what extent pure rents are the object of expropriation.

local spending levels in order to focus on the implications of different tax instruments. There is no disharmony of interests between local residents and local governments in our model, and mobility of the local tax base may raise welfare not because the mobility of capital 'disciplines' local governments per se, but rather the resident households whose interests those governments faithfully represent. Our analysis emphasizes potential welfare losses that are attributable not to the excessive growth of government, but to interjurisdictional externalities that arise because of the decentralization of taxing authority — externalities that would disappear under a centralized fiscal structure. Indeed, our analysis suggests several potentially useful roles for a central government. The possibility of having the central government pool local risks by taxing land rents itself has already been mentioned. A central government could also attempt to distribute centrally-collected taxes through 'equalizing' intergovernmental grants that provide additional resources to localities with unfavorable economic shocks, thus providing a form of insurance for local risks. The central government could also prevent localities from taxing the returns to immobile factors, thus limiting their ability to export local tax burdens to non-residents and increasing the scope for interjurisdictional risk-pooling through cross-ownership of immobile assets.[12]

We have not discussed the means by which a regime of property taxation could be sustained if it were in fact welfare-improving to do so. Individual jurisdictions have incentives to deviate from property taxation to differentiated taxation of land and capital, if they can. It could be that such differentiation might be difficult to achieve in practice because of the difficulties of taxing the returns to land and capital separately. In this case, our results suggest that changes in the techniques of tax administration that would facilitate more effective differentiation of the tax structure would be seen as advantageous by individual jurisdictions, but could lead to results that are unattractive from the viewpoint of the entire system. Alternatively, higher-level governments might be able to maintain a system of property taxation by restricting the taxing authority of lower-level governments.

Finally, note that while our model is very stylized, the basic insights and conclusions should hold in more general settings. The assumption that all jurisdictions have completely identical technologies and factor endowments greatly simplifies the exposition but is not crucial to the essential findings. In a world where different jurisdictions are exposed to risks that are not all perfectly positively correlated, there will be some benefits from cross-ownership of land and

[12]More precisely, the central government could attempt to restrict the ability of localities to tax immobile resources on a source basis, as for instance through local land, property, or business income taxes. It need not, however, attempt to hinder the use of residence-based taxation of the returns to immobile resources, as for instance through individual income taxes, since residence-based taxes do not prevent effective diversification of asset portfolios and thus the pooling of risk across localities. Central governments often are much better able to gather the information needed to implement such taxes and could offer significant administrative assistance to localities in this respect. We are indebted to a referee for emphasizing this point.

other risky assets. Yet individual jurisdictions will always find it advantageous to tax away any returns to immobile assets that accrue to non-residents. In doing so, they will damage the ability of the market to pool risk efficiently. Constraints on taxing power, such as broadening the tax base to include commodities (like mobile capital) with high supply elasticities may limit the harm done by such a decentralized taxing authority. These general conclusions hold even if our simplifying assumptions are relaxed.

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