Effects of Property Taxation on Development Timing and Density: Policy Perspective [with Comments]

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Source: *Brookings-Wharton Papers on Urban Affairs*, 2006, (2006), pp. 189-230
Published by: Brookings Institution Press
Stable URL: https://www.jstor.org/stable/25067431

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Effects of Property Taxation on Development Timing and Density: Policy Perspective

DIFFERENT FACETS OF THE property taxation policy debate move in and out of focus according to current policy concerns and academic interests. Recently, the property tax has been discussed as a factor contributing to suburban sprawl, exclusionary zoning, the current crisis of housing affordability in coastal U.S. metropolitan areas, and housing market volatility. In the context of local government, the thriving literature on capital tax competition treats property taxation implicitly. A generation ago, debate focused on the extent to which the property tax, in the presence of local zoning, is a benefits tax. This followed soon after another debate concerning the general equilibrium incidence of the tax, pitting the orthodox view that the tax is regressive against the revisionist view that the tax burden falls on the owners of land and capital.

This paper looks at yet another facet of the policy debate over property taxation that harkens back to an even older literature—the property tax's discouragement of density. According to the classic view, the property tax is an equal-rate, *ad valorem* tax on the land and capital services used in the production of structure services.[1] Land services are inelastically supplied, so

I would like to thank: Sheila Campbell, Eren Inci, Luigi Pascali, and Andrei Zlate for excellent research assistance; Robert Nail, assistant assessor for the City of Newton, Massachusetts, for information about current assessment practice; Petia Petrova for collaboration on work from which this paper draws (Arnott and Petrova, 2006); conference paper discussants Jan Brueckner and Robert Schwab as well as conference participants for useful comments; and conference organizers for urging me to provide clear intuition for the economic theory underlying the paper's arguments.

1. Ascribed to Marshall (1961).

that the property tax component that falls on land generates no distortion and is shifted back to landowners. Capital services, in contrast, are elastically supplied, so that the property tax component that falls on capital discourages capital, generates distortion, and is borne by the consumer. Property taxation therefore discourages density (capital intensity) while land taxation does not.

This classical theme is revisited here from the perspective of a relatively recent theoretical literature on property development that takes into account the durability and immobility of structures and examines property taxation effects using deterministic capital asset pricing theory. This literature examines the profit-maximization problem of an owner of vacant land who must decide when and at what density to develop the land.

This paper has two overriding objectives: 1) to urge those who suggest property tax reforms not to ignore how their proposals affect the efficiency of development timing and density, and 2) to provide a more sophisticated (yet still intuitive) framework for thinking about the proposed reforms' effects on the efficiency of property development and redevelopment.

Setting the Stage

Over the past thirty years, the literature on taxation's effects on the timing and density of development has greatly expanded.[2] The recent literature's distinguishing feature is its explicit treatment of the durability and immobility of structures. The basic model looks at a competitive landowner who owns undeveloped land. Once he or she develops the land at a certain density, it remains at that density forever. The landowner chooses development timing and density under perfect foresight. Taxation affects these margins of choice. This model has been extended to treat redevelopment (but without taxation), uncertainty, and the general equilibrium of a growing city.[3] This paper develops the partial equilibrium model without uncertainty and without redevelopment.[4]

2. Earlier contributions include Shoup (1970); Arnott and Lewis (1979); Skouras (1978); Bentick (1979); Mills (1981); Tideman (1982). More recent contributions include Turnbull (1988); Arnott (2005); Arnott and Petrova (2006).

3. See Wheaton (1982); Capozza and Li (1994); Turnbull (1988), respectively.

4. An earlier version of this paper extended the model to treat redevelopment. The extended model was excluded from this version since it generated more heat than light. The principal qualitative result was that property taxation discourages the density of redevelopments in essentially the same way that it discourages the density of initial development. Comments will be inserted indicating how results are modified by the treatment of redevelopment.

Model without Taxation

Consider an atomistic landowner who owns a unit area of vacant land and has perfect foresight concerning the future time path of structure rents. Once a structure is built on the land, it remains there as it is forever; the structure does not depreciate, nor is redevelopment possible. To simplify, it is assumed that the interest rate, construction technology, and price of capital remain constant over time, and that rents increase over time. The following notation is employed:

T: development time;
k: capital applied to the land;
$r(t)$: rent per unit floor area of structure at time t;
$q(k)$: the floor-area ratio as a function of capital applied to the land;
p: price per unit of capital;
i: interest rate.

$q(k)$ is termed the structure production function and exhibits positive but diminishing returns to capital. The landowner chooses development time and density so as to maximize the present value of rents minus the present value of construction costs:

$$\max_{T,k} \int_T^\infty r(t)q(k)e^{-it}dt - pke^{-iT} \tag{1}$$

The timing first-order condition is

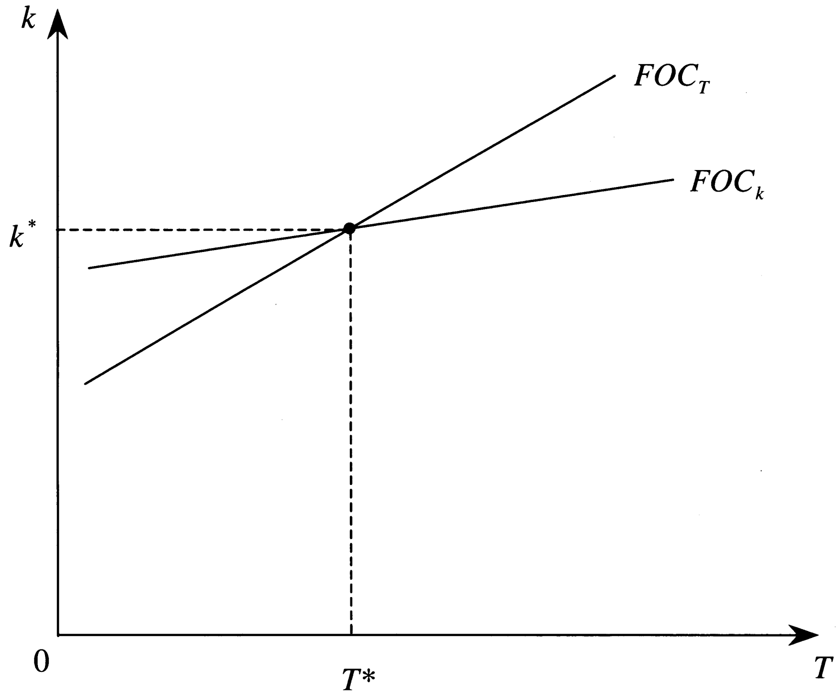
$$-r(T)q(k) + ipk = 0, \tag{2}$$

which states that it is profit-maximizing to develop the site when the benefit from postponing development one period equals the cost. The benefit from postponing development one period is the interest earned on the construction funds; the cost is the rent forgone. The density first-order condition is

$$\int_T^\infty r(t)q'(k)e^{-it}dt - p = 0, \tag{3}$$

which states that capital intensity should be such that the marginal revenue from the last unit of capital discounted to development time equals its cost. A more intuitive way of stating the condition is that floors should be added to the structure until the top floor pays for itself (in discounted terms). To simplify, it is assumed that there is a unique solution to the landowner's problem, which occurs at the unique point of intersection of the two first-order conditions.

Figure 1. First-Order Conditions of the Landowner's Profit-Maximization Problem without Taxation



Source: Authors calc ulations.
k = capital-land ratio. T = development time. k^* = profit-maximizing capital-land ratio. T^* = profit-maximizing development time. FOC_k = first-order condition for k. FOC_T = first-order condition for T.

Figure 1 plots the two first-order conditions in T-k space. FOC_T is the timing first-order condition, and FOC_k the density first-order condition. The assumptions made imply that both first-order conditions are positively sloped,[5] and that the timing first-order condition is more steeply sloped than the density first-order condition (otherwise, profit is maximized with development infinitely far in the past or in the future). T^* and k^* denote the profit-maximizing T and k.

On the assumption that the site development does not affect distortion elsewhere in the economy, T^* and k^* are also the socially optimal development time and density. Before development, the social surplus from the site

5. An increase in k causes the time at which the timing first-order condition is satisfied to increase. Similarly, an increase in T causes the density at which the density first-order condition is satisfied to increase.

with optimal development, or the social value of the site, is the social benefit from its development minus the social cost of its development:

$$(4) \qquad SS^* = \int_{T^*}^{\infty} r(t) q(k^*) e^{-it} dt - pk^* e^{-iT^*}.$$

With a competitive market for land development, the market value of land is bid up to the point where landowners make zero profit, and therefore equals social surplus.

Property taxation typically will cause one or both of the first-order conditions of the landlord's profit-maximization problem to shift, changing the profit-maximizing development time to $\hat{T}$ and density of development to $\hat{k}$. The corresponding social surplus generated by the site, $\hat{SS}$, is given in equation (4), but with $\hat{T}$ and $\hat{k}$ replacing T^* and k^*. Since social surplus is maximized with T^* and k^*, taxation will generally cause a loss in social surplus. The efficiency cost, or deadweight loss, of taxation is simply the loss in social surplus generated. Thus $DWL = SS^* - \hat{SS}$.

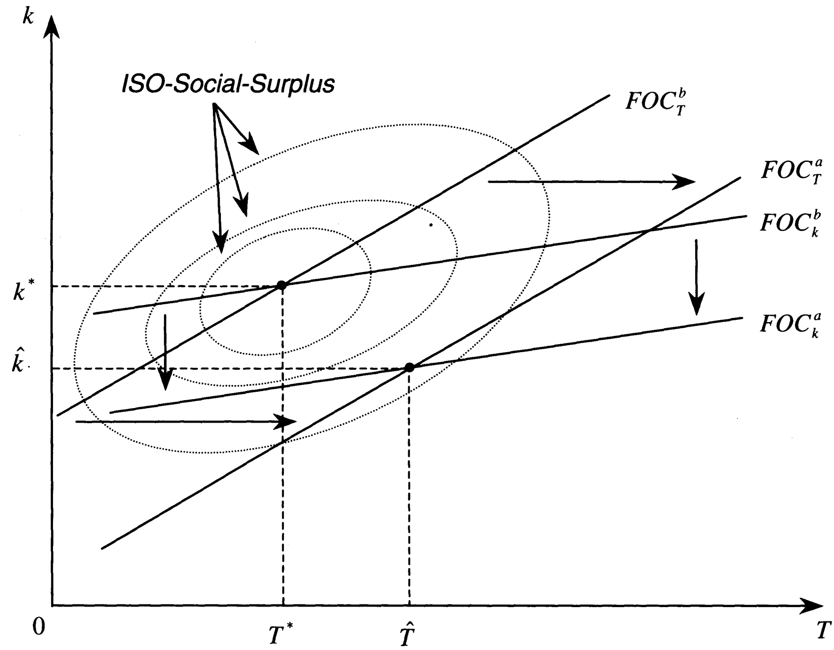
Figure 2 displays these results, showing the first-order conditions before (FOC^b) and after (FOC^a) taxation. It also plots iso-social-surplus contours, each of which gives the locus of (T,k) that generates a particular level of social surplus. (T^*,k^*) is at the top of the social surplus hill.

If application of a property tax system does not alter a landowner's choices of development time and density, it is said to be neutral and generates no distortion. If the property tax system alters the landowner's development decisions, it is distortionary and non-neutral.

Figure 2 ignores that the tax revenue collected from property taxation is spent on local government goods and services. Imposing a property tax when previously property was untaxed would then increase the property's attractiveness, causing rent to rise. Therefore it is appropriate to interpret the exercise being performed as one of differential incidence. Neutral property taxation is replaced by distortionary property taxation, holding fixed the revenue from taxation and level of local government goods and services. Thus what was referred to earlier as the situation without taxation should instead be interpreted as the situation with neutral taxation.

The discussion above also ignored land use controls, which may substantially affect the distortion created by taxation. At the extreme, one can imagine a situation where land use controls are so strict that they alone determine development timing and density, both before and after the change from a neutral to non-neutral tax regime. Since taxation then has no effect on development timing and density, it also has no effect on the efficiency of

Figure 2. Effects of Property Taxation on Development Time (*T*) and Capital Applied to the Land (*k*)



Source: Author's calculations.
k = capital-labor ratio. T = development time. * = profit-maximizing value before taxation. ^ = profit-maximizing value after taxation. FOC_k = first-order condition for k. FOC_T = first-order condition for T. a = after taxation. b = before taxation.

development. Land use controls are ignored through most of this paper, not because they are unimportant but because it is so difficult to ascertain where a particular system of land use controls would be on the continuum between being rigidly binding and completely accommodating. In a particular situation, one can observe what land use controls are in place, but not how responsive a zoning board is to a landowner's pressure to have the controls modified so he or she is allowed to develop at a more profitable time and density.

Other taxes (also ignored in the discussion above) are potentially significant for two reasons. First, they may interact with property taxation in important ways. Most obvious, it is the aftertax cost of property taxes paid that matters to the property owner, and this depends on their deductibility from income in computing local, state, and federal personal income tax liabilities. In addition, the treatment of interest income and the interest on personal debt under the personal income tax affects the individual's rate of discount. No doubt there are also complicated interactions between the corporate income tax and property tax payments made by corporations. Second, other taxes introduce distortions, and how property taxation affects the corresponding efficiency losses should be taken into account in computing the deadweight loss due to property taxation. Despite its potential importance, the interaction between property taxation and other aspects of the tax system has received little attention in the literature, and shall be ignored in this paper as well.

Property Tax Systems Typology

In the United States assessment offices administer local property tax. There are some 16,000 assessment offices in the country, each subject to relevant state and local regulations. In addition, each may follow its own assessment practices, employ its own land use classification system, decide which property classes are exempt from taxation, and set its own tax rates for the remaining property classes. Local property tax systems therefore show considerable variation. This paper's analysis abstracts from most of the variation details and works with a simple typology of property tax systems. It does not distinguish between property classes and therefore should not be interpreted as applying to a particular property class.[6]

Most U.S. property tax systems assess developed properties on the basis of their estimated market value, P, independent of what portion of that value is attributed to land or structures. Such property tax systems are here termed *conventional property tax systems.* To simplify, a conventional property tax system is treated as having two effective tax rates, one on predevelopment land value, τ_V, the other on postdevelopment property value, τ_P.

A few U.S. jurisdictions employ two-rate (or split-rate) property tax systems that tax postdevelopment land (or site) value and structure value at different rates. The sales of developed properties provide a basis for estimating the property value of developed properties. But because structures are durable and immobile, the market provides relatively little information concerning how to estimate the postdevelopment land value and structure value of developed properties. All U.S. jurisdictions that employ two-rate taxation assess

6. Property taxation may alter a landowner's choice of property class when deciding how to convert his or her vacant land. It may also give him or her incentives to modify the property in ways that permit its reclassification to a property type with a lower effective tax rate and to lobby for a reduction in the tax rate. All these behaviors, which affect the efficiency costs of property taxation, are ignored in this paper.

postdevelopment site value and structure value so their sum equals assessed property value. Therefore there are two general methods of imputation. The first directly imputes a site value and then imputes structure value as the residual (estimated property value minus imputed site value). The second imputes a structure value and then imputes site value as the residual (estimated property value minus imputed structure value.)[7]

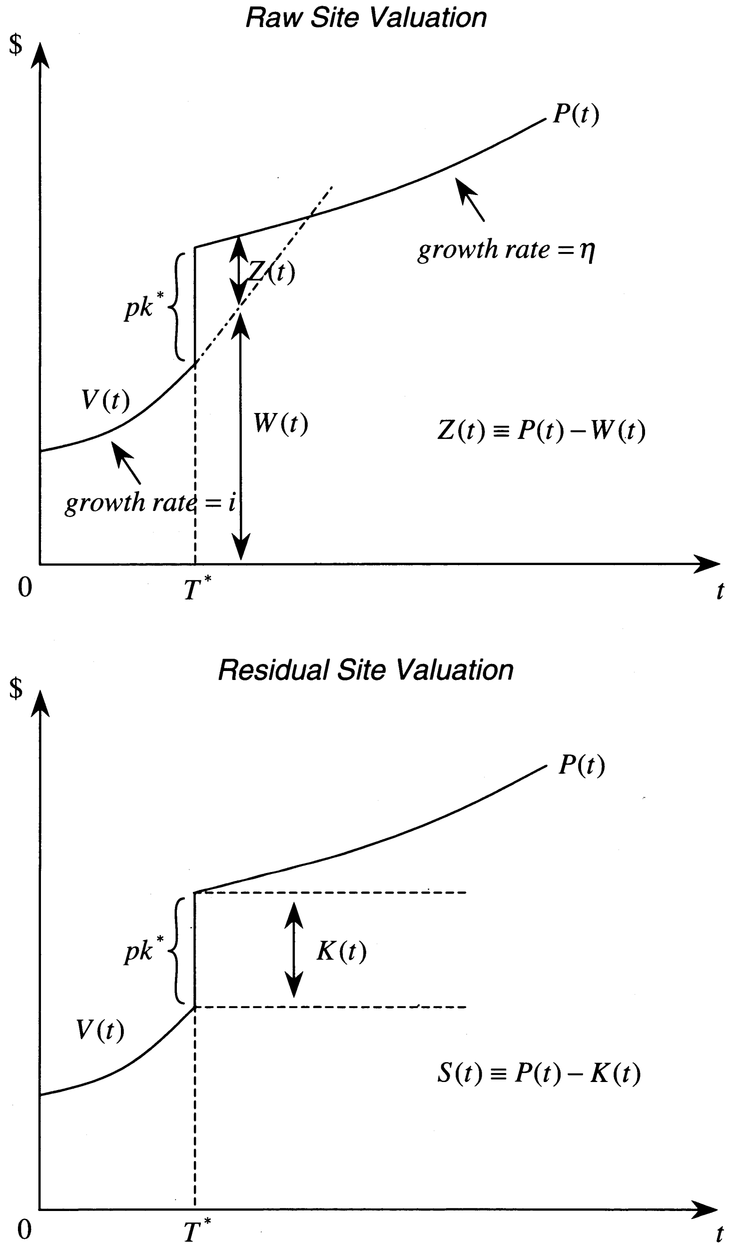
Two classes of two-rate property tax systems are considered here. The first, *raw site value property tax systems,* imputes postdevelopment site value as raw site value, W, defined as what the site would be worth if there were no structure on it, even though in fact there is. Residual structure value, Z, is then calculated as $Z = P - W$. A raw site value tax property tax system has three tax rates, the first on predevelopment land value, second on imputed raw site value, τ_W, and third on residual structure value, τ_Z. The second class, termed *residual site value property tax systems,* imputes postdevelopment structure value as its (depreciated or replacement) construction cost, K, and then calculates postdevelopment residual site value as $S = P - K$. A residual site value tax system has three tax rates, on the value of: 1) predevelopment land; 2) imputed structure, τ_K; and 3) residual site, τ_S. Raw site value and residual site value property tax systems are ideal types. Since assessors employ information on both construction costs and land values when decomposing estimated property value into imputed site and imputed structure value, actual two-rate systems are a hybrid of the two ideal types.

Figure 3 illustrates the distinction between the two alternative imputation procedures in the absence of taxation. It plots various values against time. To simplify, it is assumed that rents grow at a constant exponential rate, η. For landowners to make the competitive rate of return, i, it is necessary that predevelopment land value, $V(t)$, grow exponentially at the rate i. After development, property value, $P(t)$, grows at the rate η;[8] rents provide a return equal to a proportion $i - \eta$ of property value, with the remainder of the required rate of return coming in the form of capital gains. The first panel of figure 3 presents the diagram for raw site valuation, along with residual structure valuation. Development occurs at time T^* at density k^*. Property value immediately after T^* equals land value immediately before T^* plus the costs of construction at density k^*. At development time, raw site value equals land value.

7. Actual assessment practice is some hybrid of these two general approaches (see discussion below).

8. Simple asset valuation theory gives that $P(t) = r(t)q(k) \div (i - \eta)$ so that $\frac{\dot{P}}{P} = \frac{\dot{r}}{r} = \eta$.

Figure 3. Decompositions of Postdevelopment Property Value: Raw Site and Residual Site



Source: Author's calculations.

t = time. p = price per unit of capital. k^* = profit-maximizing capital-land ratio. T^* = profit-maximizing development time. i = interest rate. η = growth rate of rents. $V(t)$ = predevelopment land value at time t. $P(t)$ = postdevelopment property value at time t. $W(t)$ = postdevelopment raw site value at time t. $Z(t)$ = postdevelopment residual structure value at time t. $K(t)$ = depreciated construction costs at time t. $S(t)$ = postdevelopmental residual site value at time t.

After development time, raw site value, $W(t)$, is calculated as what the land would be worth if there were no building on it. Since, under the stated assumptions, the land would then be developed right away, raw site value is what the land would be worth if it were vacant and developed immediately. The raw site value expression is complicated, but raw site value clearly increases over time and in due course exceeds property value.[9] Residual structure value is calculated as $Z(t) \equiv P(t) - W(t)$.

The second panel of figure 3 presents the diagram for residual site valuation. Under the assumption that the structure does not depreciate, imputed structure value is $K(t) = pk^*$, so that residual site value is $S(t) \equiv P(t) - K(t) = P(t) - pk^*$.[10]

Analysis

Whatever the property tax system employed, a profit-maximizing landowner will choose development time and density to maximize the present value of rents, less the present value of construction costs, less the present value of tax payments. With a competitive land market, the value of land before development equals this maximized present value. After development, the market value of a property equals the present value of rents less the present value of tax payments. Drawing on these principles, one can determine how the various property tax systems affect the timing and density first-order conditions, and from this one can determine the profit-maximizing development time and density as well as the deadweight loss generated by the tax system.

This section investigates only conventional property tax systems since they are the easiest to treat. Recall that a conventional property tax system is characterized by two tax rates: on predevelopment land value, τ_V, and on postdevelopment property value, τ_P. With conventional property taxation, the timing first-order condition becomes

9. Consider extending the model to include redevelopment. Since land is vacant between redevelopments, by definition raw site value equals the market value of land at redevelopment times.

10. Consider extending the model to treat redevelopment. Just before a redevelopment, residual site value equals property value minus the (depreciated) construction cost of the site's existing structure. However, the land's market value at that time exceeds property value by the cost of demolishing that structure. With profit-maximizing redevelopment, property value immediately after development equals the market value of land plus the cost of constructing the new structure on the site, so that residual site value immediately after development equals the market value of the land. Thus residual site value jumps up discontinuously at a redevelopment time.

(5) $$-r(T)q(k)+\tau_p P(T;k)+ipk-\tau_v V(T)=0,$$

where

$P(T;k)$: the property value immediately after development, conditional on development at density k,
$V(T)$: the land value immediately before development.

This first-order condition is easily interpreted. The profit-maximizing time to develop at density k occurs when the gain from postponing development for one period equals the cost. At time T, the gain from postponing development is $ipk + \tau_P P(T;k)$. The first term is the interest earned on construction funds; the second term is the property tax payment that need not be paid as a result of postponing development. The cost of postponing development is $r(T)q(k) + \tau_V V(T)$. The first term is the rent forgone, the second is the tax payable on predevelopment land value. Thus the net benefit from postponing development is

$$ipk-r(T)q(k)+\left[\tau_p P(T;k)-\tau_v V(T)\right].$$

The term in square brackets is the addition to the net benefit from postponing development due to property taxation. It is positive if, as is typically the case, the property tax payable immediately after development exceeds that immediately before development. Under this condition, in terms of figure 2, conventional property taxation causes the timing first-order condition to shift to the right.

Equation (5) is intuitive, but provides an incomplete characterization of the profit-maximizing development time conditional on development density since it depends on the land value before development and property value after development, which are both affected by the tax system. Asset valuation functions for $P(T;k)$ and $V(T)$, which depend on the tax rates, can be derived, and insertion of these into equation (5) provides a characterization in terms of only exogenous parameters and functions.

The density first-order condition is

(6) $$\int_T^{\infty} r(t)q'(k)e^{-(i+\tau_P)(t-T)}dt-p=0.$$

The conventional property tax system therefore affects development density by increasing the rate at which structure rents are discounted. Since this result is important, two alternative intuitions are presented. First, since the asset market for property is competitive, the property owner must make the competitive rate of return. This condition is written as

$$iP(t) = r(t)q(t) + \dot{P}(t) - \tau_P P(t).$$

The equation's left-hand side gives the required return from owning the property at time t. This equals the rent received plus the capital gain minus the tax liability. From this equation, it can be seen that i and τ_P enter as $i + \tau_P$. Thus the property owner is indifferent between a 7 percent interest rate or a 5 percent interest rate plus a 2 percent property tax rate. Second, one may ask what the value is today of an extra rent dollar received from the property a year from now. The extra rent dollar received will increase the value of the property today by, say, Δ, and result in an increase in tax liability of $\tau_P\Delta$. Since the property owner can sell the property immediately after it becomes known that an extra dollar will be received a year from now, Δ is the value today of the extra dollar in rent. If the property owner chooses to sell the title to this extra dollar and puts this amount in the bank, he will obtain $\Delta(1 + i)$ a year from now. If he or she chooses to retain the title to this extra dollar, the property owner will receive $1 - \tau_P\Delta$ a year from now. Under competitive asset pricing, he or she should be indifferent between the two courses of action. Thus $\Delta = 1/(1 + i + \tau_P)$. The first term in equation (6) therefore is the increase in property value from increasing the capital applied to the property at development time by one dollar, which is the marginal benefit of capital. The second term is the price of the extra capital unit, which is unaffected by taxation, and is the marginal cost of capital.

By the same line of reasoning, the tax on predevelopment land value causes the predevelopment discount rate to increase from i to $i + \tau_V$, and hence predevelopment land value to appreciate at the rate $i + \tau_V$.

Since imposition of conventional property taxation increases the rate at which rents are discounted, it causes the marginal benefit of capital to fall. The marginal cost of capital is unaffected by the tax. Thus holding fixed development time, conventional property taxation causes the profit-maximizing amount of capital to fall. In this sense, conventional property taxation discourages density.[11] In terms of figure 2, the tax system causes the density first-order condition to shift down.

11. When the model is extended to treat redevelopment, property taxation still increases the rate at which rents are discounted, and therefore still discourages density.

Thus the conventional property tax system causes the timing first-order condition to shift to the right and density first-order condition to shift down. How the combined shifts alter the profit-maximizing timing and density of development is ambiguous. Two possibilities, however, can be ruled out—earlier development at higher density and no change in development timing and density. By how much the two curves shift (and which shifts more) depends on the property tax rates, growth rate of rents, interest rate, and form of the structure production function.

More specific results can be obtained under particular assumptions. There are two reasonable assumptions that considerably simplify the algebra. First, the elasticity of substitution between land and capital in the production of structures, denoted by σ, is constant. Since there is still no consensus on even the approximate magnitude of this elasticity of substitution, the assumption that it is constant hardly can be falsified.[12] Second, rents grow at a constant rate. Under these assumptions, closed-form solutions can be obtained for profit-maximizing timing and density, as a function of the tax rates. How tax rates affect density is expressed most simply in elasticity terms:

$$E(q, i + \tau_V) = -\sigma/(1 - \sigma) \text{ and } E(q, \tau_P) = 0, \tag{7}$$

where $E(a,b)$ denotes the elasticity of a with respect to b. The tax rate on postdevelopment property value has no effect on development density—it affects only the timing. The tax rate on predevelopment land value, however, does affect development density; in particular, the elasticity of the floor-area ratio with respect to the predevelopment discount rate, $i + \tau_V$, is $-\sigma/(1 - \sigma)$. If the construction technology is fixed-coefficients, implying $\sigma = 0$, property taxation has no effect on development density. If the elasticity of substitution is 0.5, which is at the low end of empirical estimates, the elasticity of the floor-area ratio with respect to the predevelopment discount rate is -1.0. If the elasticity of substitution is 0.75, which is at the high end of empirical estimates before Thorsnes (1997), the elasticity of the floor-area ratio with respect to the predevelopment discount rate is -3.0.

The optimal time of development can be written as

$$T - T^* = \eta^{-1}\{\ln[(i + \tau_P - \eta)/(i - \eta)] - \ln f(\tau_V)\}, \tag{8}$$

12. Thorsnes (1997) finds that this elasticity of substitution is insignificantly different from one. All prior estimates, however, find it to be significantly less than one. See McDonald (1981) for a survey of empirical estimates before that date.

Table 1. Numerical Example for the Simple Property Tax[a]

τ	k	q	T	V	R	D	MD
0.00	1.00	1.00	50.0	1.0	0.00	0.00	0.00
0.01	0.125	0.422	3.56	0.243	0.512	0.245	–4.99
0.02	0.037	0.216	–12.63	0.081	0.404	0.515	–1.51

Source: Arnott and Petrova (2006).

a. Production function is $q(k) = c_0(1 + c_1k^{\rho})^{1/\rho}$. Parameter values are $p = 2.2408$, $r(0) = 0.24731$, $c_0 = 3.375$, $c_1 = 0.5$, and $\rho = -0.3333$ (corresponding to an elasticity of substitution equal to 0.75).

τ = simple property tax rate. k = capital-land ratio. q = floor-area ratio. T = development time. V = land value at $t = 0$ (or land value at development time brought forward to $t = 0$ if T is negative). R = tax revenue discounted or brought forward to $t = 0$. D = deadweight loss discounted or brought forward to $t = 0$. MD = marginal deadweight loss.

where $f(\tau_V) = q'(k(\tau_V))/q'(k(0))$, with $f' > 0$.[13] Thus an increase in τ_P causes development to be postponed, while an increase in τ_V causes development to be brought forward.

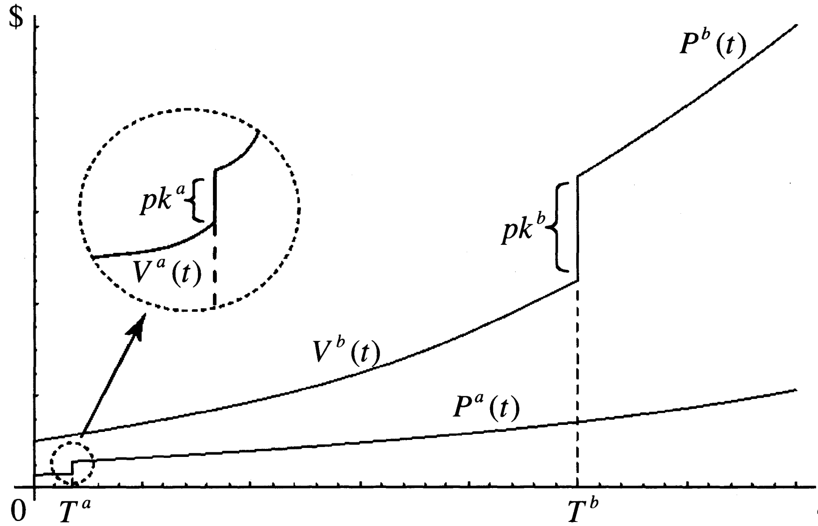
Numerical Example

Instead of the explicit formula being presented for the deadweight loss, a numerical example is presented in table 1. The example considers what is termed the *simple property tax,* under which the tax rates on predevelopment land value and postdevelopment property value are the same, τ. This is what comes to mind when most people think of the property tax. It is assumed that the interest rate is 3 percent, the growth rate of rents is 2 percent, and the elasticity of substitution between land and capital in the production of structures is 0.75. The other parameters are chosen so that in the base case, with a zero tax rate, $k = q = 1.0$, development occurs fifty years into the future, and the value of land today ($t = 0$), denoted by V, equals 1.0.[14] R is the tax revenue raised, discounted, or brought forward (as the case may be) to today, D is the deadweight loss due to the tax discounted to today, and MD is the corresponding marginal deadweight loss, the increase in deadweight loss per extra dollar of revenue raised. In calculating R, it is necessary to make an assumption about when the tax rate on undeveloped land was first introduced. The figures are calculated on the assumption that the tax on undevel-

13. The function f gives the ratio of the marginal product of capital with a tax rate on predevelopment land value of τ_V to that with a zero tax rate. Since the floor-area ratio decreases with τ_V, the marginal product of capital is increasing in the tax rate.

14. There is a hurdle development rent at which development occurs. Thus at another location where rent is twice as high, development would occur $(\ln 2)/\eta$ years earlier.

Figure 4. Effects of Simple Property Tax on Asset Values over Time



Source: Author's calculations.
t = time. p = price per unit of capital. k = profit-maximizing capital-land ratio. T = profit-maximizing development time. a = after taxation. b = before taxation. $V(t)$ = predevelopment land value at time t. $P(t)$ = postdevelopment property value at time t.

oped land was first introduced either today or at the time of development, if this is in the past.

The tax effects are shown another way in figure 4, which plots predevelopment land value, construction costs, and property value, both before (b) and after (a) the imposition of the tax. Note that the tax causes predevelopment land value to grow at the rate $i + \tau$, but does not alter the growth rate of postdevelopment property value.

One should view with skepticism a numerical example based on such a simple model. The model treats the taxation of a single site. If the tax were applied to a jurisdiction or an entire metropolitan area, results would be altered by general equilibrium effects. Most important, by altering the rate at which land is developed, the tax would alter the time path of rents. These qualifications notwithstanding, the numerical results provide the important insight that a simple property tax with a tax rate as low as 1 percent has substantial effects. Imposition of the property tax at this rate causes development to be brought forward by forty-six years and the floor-area ratio to be reduced to only 42 percent of its pretax level. The tax causes 51 percent of the social surplus associated with the property to be transferred from the landowner to the government, and 25 percent to be dissipated in deadweight loss. Even at this low taxation rate, the marginal deadweight loss is negative, indicating that taxation is on the wrong side of the Laffer curve—a rise in the tax rate causes deadweight loss to increase and revenue to decrease.

The example illustrates one of this paper's major themes, namely that even though the recent property tax policy literature tends to neglect the tax effects on the timing and density of development, property tax reform proposals should take the effects into account since the deadweight losses from distorting development timing and density—at even modest tax rates—can be substantial.

Neutral Property Taxation

The example given above indicates (at least in the context of the model developed and with the chosen parameters) that simple property taxation with a low property tax rate of 1 percent creates considerable distortion with respect to development timing and density. This suggests that it is important to employ a property tax system that is neutral or close to neutral with respect to development time and density. What property tax systems have this characteristic?

As demonstrated, no conventional property tax system (one tax rate for predevelopment land value and another for postdevelopment property value) is neutral. One set of neutral property tax systems are those that are *lump sum*—those for which the tax payable is independent of the landowner's actions. Any lump-sum tax achieves neutrality, but most lump-sum taxes would be deemed unfair on the basis of both ability-to-pay and benefit principles. A lump-sum tax that has widespread support is a land value tax, or a *raw site value tax.* This tax applies the same tax rate to predevelopment land value and postdevelopment raw site value. After development, the tax is based on what the land's market value would be were the site vacant, which is independent of the landowner's choice of density and type of use. Before development, the tax is based on the land's market value, which the landowner cannot influence. Since the tax rate on predevelopment land value is the same as that on postdevelopment raw site value, and since predevelopment land value right before development is the same as raw site value right after development, the tax does not distort development timing. This tax also scores respectably well in terms of the ability-to-pay and benefit principles, since land ownership is correlated to both ability to pay and the benefits received from public services.[15]

There are three major difficulties with the adoption of raw site value taxation in the United States. The first is that the tax, while scoring moderately well according to both ability-to-pay and benefit principles, may not score sufficiently well to be politically acceptable. Before the Industrial Revolution, most wealth was in land. Now, however, aggregate land value in the United States constitutes a considerably smaller fraction of total wealth.[16] Furthermore, the benefits from the government goods and services financed by property taxation are only loosely tied to land.

The second major difficulty is that while it might be desirable to impose a raw site value tax if there were currently no system of property taxation in place, a jurisdiction would encounter considerable opposition if it were to replace the current property tax system with raw site value taxation. Eliminating structures from the property tax base while holding the revenue yield constant would entail substantial property tax liability redistribution. Landowners holding undeveloped land or land that had been developed at low density

15. The virtues of land taxation have long been recognized. Over the last 125 years, the advocacy of land taxation has been closely associated with George (1879), which advocated land taxation as the single tax. The continuing appeal of land taxation is illustrated by the impressive list of signatories—including four Nobel Prize winners in economics—to an open letter to Chairman Mikhail Gorbachev in 1990–91, urging him to adopt land taxation in Russia (www.taxreform.com.au/essays/russian.htm).

Land taxation is neutral, whether the tax base is land rent or land value. This paper considers land value taxation, since data on land value are more generally available than data on land rent. However, as noted below, the neutral residual site value tax system is equivalent to (in the sense of generating the same time path of revenue) a tax on site rent at a constant rate over time, where site rent before development equals zero and after development equals structure rent minus the opportunity cost of capital. A tax on site rent at a constant rate over time is analogous to a tax on pure profits at a constant rate over time, and therefore neutral.

16. The U.S. Flow of Funds Accounts list the net worth of households and nonprofit organizations to be $40.7 trillion in 2001 (table B.100). The World Bank estimates the U.S. value of natural capital (which includes subsoil assets, timber resources, nontimber forest resources, protected areas, cropland, and pastureland) to be $14,752 per capita in 2000, and population to be 282,224,000, for a total value of $4.16 trillion (World Bank, 2006, appendix 2). It also estimates the value of produced capital and urban land in the United States to be $79,851 per capita in 2000, for a total value of $22.54 trillion. The document assumes that the value of urban land equals 24 percent of the value of produced capital, which implies a value of urban land of $4.36 trillion. Davis and Heathcote (2004, fig. 12), based on Flow of Funds Accounts data, give an estimate of the nominal value of the quality-adjusted stock of residential land in the United States in 2000 as approximately $2.8 trillion, which is broadly consistent with the World Bank's estimate. Thus it appears that the value of land in 2001 was slightly in excess of 20 percent of total wealth.

could face significantly higher property tax bills than under conventional property taxation. These property tax liability increases would be capitalized into land and property values, resulting in possibly substantial capital losses for owners of vacant land and low-density properties.

The third major difficulty is raw site valuation. Until recently, raw site value estimation would have been unacceptably noisy. In the last few years, however, considerable progress has been made in the estimation of land value surfaces.[17] This progress is due to more readily accessible and detailed data on vacant land parcels that have been sold and on teardowns,[18] as well as the development of improved estimation techniques. Thus soon it may be administratively practical for cutting-edge assessment offices to implement raw site valuation. However, because of their sophistication, it will likely be a long time before these valuation techniques are widely adopted.

Raw site value tax systems constitute the set of neutral raw site value property tax systems.

What about residual site value property tax systems? A series of papers published a quarter-century ago demonstrated that a property tax system that taxes the market value of land before development and its residual site value after development at the same rate is non-neutral, discouraging development (but not distorting the timing first-order condition).[19] This important result is not straightforward. One explanation, cast in the context of the model presented earlier, starts with the situation where no property tax is applied (or where the tax is lump sum). The landlord will add floors to the structure up to the point where the top floor breaks even—the discounted rents from the top floor just cover its marginal construction costs. This implies that at development time, the top floor does not contribute to the property's residual site value. After development time, however, the discounted rents from the top floor increase, while the top floor's imputed structure value remains constant or falls, so that the top floor does add to the property's residual site value. Now introduce residual site value taxation. The top floor that broke even in the absence of taxation now loses money, since it adds to the building's tax liability. Another explanation

17. For example, McMillen (1996); Plassmann and Tideman (2003).

18. A teardown is a developed property that is purchased with the intention of tearing down the existing structure and redeveloping the site. If a site is redeveloped soon after the developed property is purchased, the property was presumably purchased for its land. Thus the sales price of a teardown should give an accurate valuation of the land on which it is sited. See Dye and McMillen (2006) for a recent study of Chicago-area teardowns.

19. Skouras (1978); Bentick (1979); Mills (1981).

draws on the result that the tax on residual site value increases the postdevelopment discount rate. Before taxation, the discounted *site rent* (gross rent less the opportunity cost of capital, and therefore akin to profit, which is alternatively termed net rent) from the top floor equals zero. The site rent increases over time, being negative in the early years after development and positive thereafter. Since residual site value taxation increases the postdevelopment discount rate, in the valuation of discounted site rents it causes more weight to be put on the early years of negative site rent and less on the later years of positive site rent. Thus again, a top floor that breaks even in the absence of taxation loses money under residual site value taxation.

How can this distortion be corrected? One crude intuition is that a residual site value property tax system provides three instruments—tax rates on predevelopment land value, postdevelopment imputed structure value, and postdevelopment residual site value—which should be sufficient to achieve the three policy objectives of neutrality with respect to development time, neutrality with respect to development density, and extraction of a given proportion of the site's social surplus via taxation. A more precise intuition can be given in terms of figure 2. Residual site value taxation distorts the development density condition, causing FOC_k to shift down, but leaves unaltered the development timing condition, and hence FOC_T. The discouragement of density can be offset by subsidizing structure value. But subsidizing structure value reduces the marginal benefit from postponing development, causing the development timing condition to shift to the left. This distortion in turn can be offset by applying a lower tax rate to predevelopment land value than to postdevelopment residual site value. In earlier work, I proved that there is a neutral residual site value tax system that extracts a specified proportion of the site's social surplus via taxation.[20] In the special case where structure rents grow at a constant rate after development, I showed that neutral residual site value property taxation entails exempting predevelopment land value from taxation, taxing residual site value, and subsidizing structure value, with the ratio of the subsidy rate on structure value to the tax rate on residual site value being $\eta \div (i + \tau_S - \eta)$. Furthermore, this tax system generates the same revenue stream as a constant-rate tax on site rent, which is analogous to a time-invariant tax on pure profits—and therefore neutral. Hence in this special case, this residual site value property taxation is equivalent to a neutral land rent tax (see footnote 15).

20. Arnott (2005).

Would a neutral residual site value property tax system be practical? For buildings whose construction costs are known, structure value could be imputed as depreciated construction costs, with an empirically estimated depreciation schedule. For buildings whose construction costs are not known, structure value could be imputed as the cost of constructing a comparable, new structure commanding approximately the same rents, using construction cost handbooks. Determining the appropriate subsidy rate to apply to a particular structure would present difficulties, since it requires knowledge not only of the interest rate, but also of the growth rate of future rents. The growth rate of future rents of course is not known, but market expectations concerning the future growth rate of rents at a location can be inferred from the ratio of property value to construction costs of nearby, newly developed sites.[21] Another difficulty is that either the structure value subsidy rate would have to vary over properties, reflecting differences in properties' expected rental growth rates, or else a uniform subsidy rate would have to be applied to properties with different expected rental growth rates, resulting in deviation from neutrality. Yet another difficulty would be application of residual site value taxation to distressed neighborhoods, where some property values could be lower than the corresponding imputed structure values, resulting in negative tax liabilities. In addition, as with a switch from conventional property taxation to raw site value taxation, the redistribution of property tax liability across property types would generate considerable opposition from those land and property owners with higher tax bills.[22]

While the sudden replacement of a current property tax system with a neutral raw site value or a neutral residual site value taxation system would be politically impractical, gradual transition from the current property tax system toward a neutral property tax system merits serious consideration. Whenever a tax system is distorted, in principle it is possible to adjust the tax

21. Arnott (2005).

22. A somewhat more subtle redistribution would occur across properties according to development time. To see this, consider the replacement of a raw site value tax with the neutral residual site value property tax system that, aggregated over properties that differ in development time, generates the same discounted revenue from today forward. Since both tax systems are neutral, the switch would not alter the timing and density of properties' development. The switch, however, would alter the timing of tax revenue collected. Before the switch, revenue collected would be from both vacant land and developed properties, while after the switch all the revenue collected would be from developed properties. Thus properties that had already been or would soon be developed would find their discounted tax liabilities increased, while properties that would not be developed for a long time would find their discounted tax liabilities reduced.

system marginally such that everyone benefits. This is referred to as *Pareto-improving taxation.* If existing property tax systems are close to being as distorted as suggested by the numerical examples based on this paper's simple model, it should be possible to adjust the tax rates in such a way that, holding government revenue constant, almost all major classes of property owners benefit from reform.

Now, to debunk a popular fallacy. In property taxation discussions, one encounters the argument that while land taxation is the ideal, it would not generate enough revenue to finance the provision of an adequate level of local public services; to raise enough revenue, structure taxation (while regrettably distortionary) must be employed as well. But if the tax rates are set sufficiently high, neutral property taxation can extract the entire social surplus from land without distortion. No non-neutral property tax system can generate more revenue than this, and indeed non-neutral property tax systems dissipate surplus by introducing distortion.

Taxation of Undeveloped Land

Use value is an assessment based on the current use of land or property.[23] When agricultural land is assessed according to its use value, conceptually the assessed value of the land is what the land would be worth if it were held in agricultural use forever, in contrast to its market value. In 1956 Maryland became the first state to apply use value assessment to agricultural land. Use value assessment for agricultural land is now applied in the majority of states, and some form of preferential treatment for agricultural land is employed in all states.[24] How agricultural use is defined, and how agricultural use value is assessed, varies widely across and within states.[25] In some states, only a nominal agricultural activity on the land is required for agricultural use classification, while in others the definition is more stringent. The property tax treatment of land that is withdrawn from agricultural use for urban development varies widely across and within states. Some states apply rollback provisions that retroactively tax the land as nonagricultural,

23. The discussion of the history and practice of use value assessment in the United States applied to agriculture draws heavily on Youngman (2005).

24. Some states have extended use value assessment to forests and open space.

25. There is no national database on property tax policies and administrative practices. An incomplete picture of current policies and practices is provided in International Association of Assessing Officers (2002).

undeveloped land for a certain number of years before its withdrawal from agricultural use. Massachusetts, for example, uses a five-year rollback provision, and many other states have no rollback provision.

Standard rationales for assessing agricultural land according to its current use are to preserve the family farm, protect agricultural land, and prevent urban sprawl. Since this paper's model assumes an economy that is undistorted, it cannot address these presumed market failures.

There is, however, another rationale for this policy, based on (second-best) efficiency with respect to development timing and density, that has not previously been discussed in the literature. As discussed earlier, the conventional property tax has two tax rates, one on predevelopment land value, the other on postdevelopment property value. It was demonstrated that all conventional property tax systems are non-neutral. It seems likely that for a long time to come the vast majority of U.S. jurisdictions will continue to tax developed properties based on their assessed market value, rather than switching to raw site value taxation or two-rate property taxation, for example. What, then, is the (second-best) efficient tax rate to apply to undeveloped land?

A simple property tax system is a conventional tax system in which the tax rate on predevelopment land value is the same as that on postdevelopment property value. Thus a simple property tax is at one extreme in providing no preferential treatment to land before development. Table 1 presented a numerical example of simple property taxation's effects on timing and density. With the functional forms and parameters assumed, simple property taxation results in considerably earlier development at considerably lower density.

Look now at the other extreme case, where the tax rate on predevelopment land value is zero, so that land before development is exempt from taxation. Because of the very favorable treatment under property taxation currently accorded predevelopment land in most states, for want of a better term I refer to this as a *modern property tax system.*

The results for modern property taxation are especially simple when the structure rent growth rate is constant, which will be assumed. In terms of figure 2, modern property tax systems cause the timing first-order condition to shift to the right, and the density first-order condition to shift down, such that development occurs at the same density as in the absence of taxation, but later. This implies the discounted revenue obtained from taxation, as well as the deadweight loss it induces, is independent of the structure production function form, which considerably simplifies the algebra and calculations.

Table 2. Numerical Example for the Modern Property Tax[a]

τ	k	q	T	V	R	D	MD
0.00	1.00	1.00	50.0	1.00	0.00	0.00	0.00
0.01	1.00	1.00	84.7	0.354	0.530	0.116	1.0
0.02	1.00	1.00	104.9	0.192	0.577	0.23	∞
0.03	1.00	1.00	119.3	0.125	0.563	0.312	−3.0

Source: Arnott and Petrova (2006).

a. Parameter values are $p = 2.2408$, $r(0) = 0.24731$, $c_0 = 3.375$, $c_1 = 0.5$, and $\rho = -0.3333$ (corresponding to an elasticity of substitution equal to 0.75).

τ = modern property tax rate. k = capital-land ratio. q = floor-area ratio. T = development time. V = land value at $t = 0$. R = tax revenue discounted to $t = 0$. D = deadweight loss discounted to $t = 0$. MD = marginal deadweight loss.

Where b denotes before tax, and a after tax, it can be shown that

(9) $$R = V^b\left(\frac{i\tau}{\eta(i-\eta)}\right)\left(\frac{i-\eta}{i+\tau-\eta}\right)^{\frac{i}{\eta}},$$

and

(10) $$V^a = V^b\left(\frac{i-\eta}{i+\tau-\eta}\right)^{\frac{i}{\eta}},$$

from which the deadweight loss from taxation can be calculated easily. It follows directly from equations (9) and (10) that with modern property taxation, the revenue-maximizing tax rate on postdevelopment property value is η, and the marginal deadweight loss with property tax rate τ is $\tau/(\eta - \tau)$. The former result is so simple that there should be a simple explanation, but it has proved elusive. Tax revenue is maximized at that rate for which the elasticity of the tax base (with respect to the tax rate) equals −1.0. There are two reasons that the tax base shrinks as the tax rate is increased: property value falls as the tax is capitalized, and development is postponed.

Table 2 provides a numerical example. The parameters are the same as those employed in the numerical example of table 1 (the base case is the same, with $T = 50$, $k = q = 1.0$, and $V = 1.0$). As with the simple property tax, the modern property tax's effects are substantial. With the chosen parameters, a 2 percent tax rate, for example, causes land value today to fall to only 19 percent of pretax value, generates a deadweight loss of 23 percent of pretax value, and causes development to be postponed by fifty-five years. Since a 2 percent tax rate maximizes the discounted revenue collected from the tax, the marginal deadweight loss is infinite, indicating that taxation is at the top of the Laffer curve.

Table 3. Effective Property Tax Rates, Percentage of True Market Value, Selection of Cities with High Property Tax Rate, 2005

City	*Homestead*[a]	*Apartment*[b]	*Commercial*[c]	*Industrial*[d]
Detroit, Mich.	3.23	4.10	3.84	3.27
Buffalo, N.Y.	2.55	4.19	3.67	2.20
Milwaukee, Wisc.	2.47	2.51	2.51	1.38
Houston, Texas	2.33	2.68	2.79	3.07
Chicago, Ill.	1.50	2.49	3.26	1.96

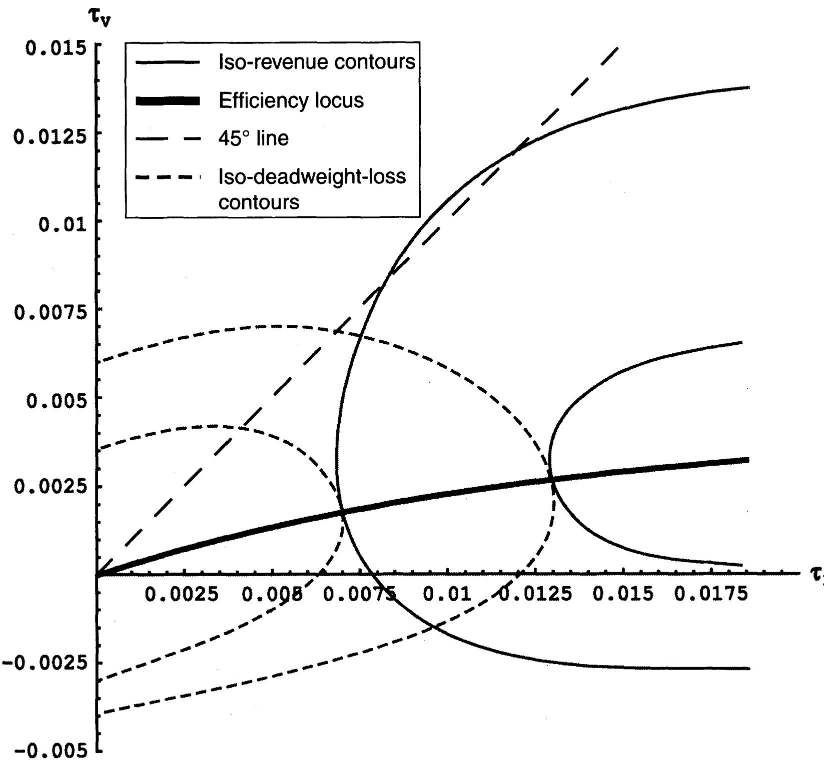
Source: Minnesota Taxpayers Association (2006).
a. Rate for a median-valued home in the city.
b. Rate for $600,000 valued property with $30,000 in fixtures.
c. Rate for $1 million valued property with $200,000 in fixtures.
d. Rate for a $1 million valued property with $500,000 of machinery and equipment, $400,000 in inventories, and $100,000 in fixtures.

Table 3 shows a selection of effective property tax rates for different classes of property in different U.S. cities. The selection is not random and is intended to show how high effective property tax rates are in some major cities, especially for property classes other than single-family, detached housing.

In both examples, the revenue-maximizing tax rate was low, less than 1 percent in the case of simple property taxation and 2 percent in the current example. How can this be reconciled with the much higher property tax rates in some states for some property classes, as shown in table 3? One possibility is that the model is unrealistic in some important respects that, if taken into account, would result in higher revenue-maximizing tax rates. But while the model is highly simplified, it is not obvious what particular realistic complication, such as a time-varying interest rate or uncertainty, would lead to systematically higher revenue-maximizing tax rates. A second possibility is that the examples' parameters are unrealistic. But the revenue-maximizing tax rate under the modern property tax equals the growth rate of (real) rents, and the assumed growth rate is on the high side; if a more representative growth rate were chosen, the revenue-maximizing tax rate would be lower than 2 percent. A third possibility is that the observed high tax rates were not anticipated at the time of development. This is plausible. The model assumes that the tax rates are constant over time. But since structures are immobile, there is a time-inconsistency problem. After development a jurisdiction has an incentive to raise the property tax rate since the structure cannot move to avoid the tax. It is hard to believe, however, that local developers would be fooled for long by this opportunistic behavior.[26]

26. I have not seen time series of effective property tax rates for particular cities. It is reasonable to conjecture, however, that in central cities and inner suburbs they arose by historical accident. The post–World War II suburbanization resulted in these cities' property tax bases shrinking, to which the local governments responded by raising tax rates.

Figure 5. Efficiency of Undeveloped Land under Conventional Property Taxation



Source: Author's calculations.
τ_V = tax rate on predevelopment land value. τ_P = tax rate on postdevelopment property value.

The fourth possibility is that high observed property tax rates are indeed on the wrong side of the Laffer curve. One recent study estimates that Houston and New York City are at the top of their property tax revenue hills, and that Philadelphia is on the efficient side of the hill but close to the top.[27]

Is either the simple or modern property tax system the most efficient in its treatment of predevelopment land, or is some intermediate, conventional property tax system that gives preferential treatment to predevelopment land but does not exempt it from taxation? Figure 5 plots iso-revenue contours and iso-deadweight-loss contours in τ_P-τ_V space, assuming the parameter values that were employed in the example of table 1. An iso-revenue curve

27. Haughwout and others (2004, fig. 1).

gives the locus of tax rate pairs that generate a given level of discounted tax revenue. An iso-deadweight-loss contour gives the locus of tax rate pairs that generate a given level of deadweight loss, associated with the tax's distortion of the landowner's development timing and density decisions. The efficiency locus gives the locus of tax rate pairs that raise a given amount of revenue with minimum deadweight loss.

Figure 5 provides two qualitative insights. First, with the assumed parameters and form of the structure production function, (second-best) efficiency entails that the tax rate on predevelopment land value be lower than that on postdevelopment property value. Second, the relationship is nonlinear, with the efficient ratio of the postdevelopment property tax rate to the predevelopment land tax rate being higher the larger the amount of revenue collected. With a property tax rate of 1.0 percent, the efficient tax rate on predevelopment land value is 0.23 percent, and with a property tax rate of 1.5 percent, it is 0.29 percent. Therefore the example provides an efficiency rationale for the preferential treatment of predevelopment land value. If the policy goal is to achieve efficiency with respect to development timing and density, and if it is property value (in contrast to separate rates on assessed structure and site value) that is taxed after development, then not only agricultural land but all predevelopment land should receive preferential treatment under the property tax.

Why should predevelopment land receive preferential treatment? This paper provides two different perspectives, one starting from neutral raw site value taxation, and the other starting from neutral residual site value taxation. First, start with the neutral raw site value tax system, and then replace the postdevelopment taxation of raw site value with the postdevelopment taxation of property value, all at the same rate, so that a simple property tax system is obtained. The switch distorts both the timing and density first-order conditions. The increased postdevelopment tax liability encourages the postponement of development, while the taxation of postdevelopment property value raises the postdevelopment discount rate, discouraging density. The combined effect leaves density unchanged. If distortion associated with the density first-order condition is high, which will tend to be the case with a high elasticity of substitution in structure production, it is efficient to lower the tax rate on predevelopment land value, even though this will lead to greater distortion with respect to the timing first-order condition. Second, start with neutral residual site value taxation (which, recall, entails exempting predevelopment land value, subsidizing assessed structure value, and taxing postdevelopment residual site value), and then switch from subsidizing assessed structure value to taxing it at the same rate as residual site value. This has no effect on the density first-order condition but introduces distortion with respect to the timing first-order condition. If potential distortion with respect to the density first-order condition is high, it is then efficient to tax predevelopment land value at only a low rate.

This argument provides a rationale for the preferential treatment of predevelopment land value in terms of second-best efficiency with respect to development timing and density. The proponents of the preferential treatment of agricultural land provide a different set of rationales: preserving agricultural land, protecting the family farm, and curbing suburban sprawl. While this paper's model provides no insight into these rationales (they derive from presumed market failures that the model assumes away), a few comments based on first principles are in order. If agricultural land indeed generates positive externalities, then on efficiency grounds it merits subsidization, and subsidization via the property tax system is sensible. However, one may challenge the rationale on distributional grounds since the scenic benefits of agricultural land accrue primarily to relatively wealthy suburbanites, and since the protection of agricultural land leads to higher urban land values and rents, which helps owners of land and property but hurts renters. If an exurban family farmer can borrow against his farmland's capital gains in perfect capital markets to pay his or her property tax bills, there is no market failure. If the farmer cannot, the appropriate way to address the market failure is to provide him or her with a loan to pay property tax bills. This is achieved by taxing agricultural land at a preferential rate but with full rollback, so that when the family farmer sells his land for urban development he effectively repays the loan. It is hard to see how curbing sprawl provides a valid justification for subsidizing undeveloped land. If the presumed market failure associated with sprawl is that development is too scattered, then property tax policy is not the appropriate tool. What is needed are land use controls that discourage scattered development. If the presumed market failure is instead the negative visual externalities of ugly strip development, then the appropriate remedy is aesthetic or architectural zoning. In addition, if the presumed market failure is that development occurs at insufficient density, then minimum lot size zoning should be replaced by maximum lot size zoning. Whatever the validity of their rationales, the proponents of use value assessment of agricultural land are correct in their reasoning that the policy slows down the transition of agricultural land to urban use.

Two-Rate Property Taxation

Under two-rate (or split-rate) property taxation, after a property is developed separate tax rates are applied to assessed structure value and assessed land or site value. Two-rate property taxation has been widely employed around the world,[28] but it has not been used widely in the United States.[29] Fourteen smaller cities in Pennsylvania, as well as a larger city, Scranton, currently use two-rate taxation.[30] Pittsburgh employed two-rate taxation from 1913 until its reversion to conventional property taxation in 2001.[31] Kaui, Hawaii, has two-rate property taxation, as do Connelsville and Washington, Maryland. Enabling legislation has been passed permitting many other jurisdictions to implement two-rate property taxation, including other counties of Hawaii, some school districts in Pittsburgh, the state of Maryland, and the cities of Fairfax and Roanoke, Virginia.[32]

The attraction of two-rate property taxation is understandable. Since raw site value taxation is neutral, two-rate taxation provides a simple way of transitioning from current distortionary property taxation to a neutral tax system. Unfortunately, implementation of two-rate property taxation in the United States has encountered two major obstacles.[33] The first is that deviation from an existing property tax system to another system that raises the same amount of revenue causes redistribution of property tax liabilities, which via capitalization results in capital gains and losses. The losers—those whose property tax bills increase and whose property values fall—object vociferously to the property tax system change. The second is that a switch from a conventional property tax system to a two-rate tax system, even if the tax rates on assessed structure value and assessed land value are set at the same level, entails a qualitative change in the method of assessment. Under

28. See Youngman and Malme (1994), and Bird and Slack (2004).

29. In many states, a property owner's assessment notice decomposes the assessed value of his property into land value and structure value. This decomposition is typically done according to a formula that has little scientific or empirical basis. And, since the tax is based on the assessed market value of the property, the decomposition employed does not affect the property owner's tax liability.

30. For a list of cities, see Hartzok (1997).

31. From 1913 to the 1979–80 period, the tax rate on buildings was twice that on land. In the 1979–80 period, the tax rate on land was raised to more than five times that on structures. Pittsburgh's experience has been explored in a widely cited study by Oates and Schwab (1997).

32. See Cohen and Coughlin (2005), and Reeb (1998).

33. One may also argue that property taxation scores better than land taxation according to both ability-to-pay and benefit principles.

conventional property taxation, a developed property's tax liability is based on its assessed market property value. Since assessment offices have vast experience in the market value assessment of developed properties, in most jurisdictions current procedures are well established, reasonably sophisticated, and acceptably accurate. Under two-rate taxation, it is necessary to adopt new valuation procedures to decompose assessed market property value into assessed structure value and assessed land value. When these new valuation procedures are first employed, many valuations are likely to be inaccurate.[34] Furthermore, the adoption of inappropriate valuation procedures can seriously undermine the potential benefits from two-rate taxation.

There are two important points to be added to the two-rate property taxation discussion—one that strengthens the case for this type of taxation, the other that weakens it. The first point is that in principle it is possible to modify most tax systems so all major stakeholders benefit. By making the tax system more efficient social surplus is increased, and by adjusting the tax rates this social surplus increase can essentially be redistributed so all taxpayers benefit, holding government revenue constant. Modifications to a tax system that achieves this goal constitute a Pareto-improving tax reform. The more distortionary the existing tax system, the broader the set of reforms that would be Pareto-improving. The simple model used here suggests that at the rates applied in many U.S. jurisdictions (particularly to property classes other than single-family residential), property taxation indeed may generate very substantial distortion with respect to development timing and density. The second point is that while a revenue-neutral movement from simple property taxation to two-rate property taxation that correctly assesses raw site value unambiguously improves efficiency, a movement from a conventional property tax system to a two-rate property tax system that assesses postdevelopment land value as residual site value or in some other way may worsen inefficiency.

Pareto-Improving Property Tax Reform

Imagine a situation where a simple property tax is applied to an undeveloped property at the rate τ that is on the wrong side of the Laffer curve (in the example presented in table 1, the rate at the top of the Laffer curve is 0.85 percent). Now lower the tax rate by a small amount. Doing so benefits both the government and landowner. Because taxation is on the wrong side of the Laffer curve, by definition lowering the tax rate increases government

34. See Reeb (1998) for the history of Amsterdam, New York, and its unhappy attempt to switch from conventional property taxation to two-rate property taxation.

revenue. But also landowners are better off from the lower tax rate. In table 1, if the simple property tax rate is lowered from 2 to 1 percent, land value increases from 0.08 to 0.24, and discounted tax revenue increases from 0.40 to 0.51. Simple property taxation on the wrong side of the Laffer curve is the first and most obvious situation where Pareto-improving tax reform is possible, and is achieved simply by lowering the tax rate.

Now imagine a situation where a simple property tax is applied to an undeveloped property at the rate τ that is right at the top of the Laffer curve, but move to a two-rate raw site value tax system in which the raw site value tax rate is held at τ (so that $\tau_W = \tau$) but the tax rate on residual structure value is lowered slightly (so that $\tau_Z < \tau$). Owners of land and property unambiguously benefit because the tax rate on residual structure value is reduced. Also, the government collects more in discounted revenue. Remember that raw site value is what the land would be worth if there were no structure on the site, even though in fact there is, and this is increased by lowering the tax rate on residual structure value. Thus the discounted revenue from the raw site value tax increases. The discounted revenue from the residual structure value tax may decrease, but if it does, it can be demonstrated that this revenue decrease is smaller than the revenue increase from the raw site value tax.[35] Now continue reducing the tax rate on residual structure value while holding fixed the tax rate on raw site value. Land and property owners unambiguously continue to benefit, and government revenue continues to increase for a while, until it reaches a maximum. The essential point is that for a range of tax rates below the revenue-maximizing simple property tax rate, reducing the tax rate on residual structure value while holding constant the tax rate on raw site value not only makes land and property owners better off, but also increases government revenue. Government revenue, of course, cannot increase without some land or property owners' tax bills increasing. But all land and property owners whose tax bill increases make capital gains exceeding their increase in discounted tax liability.

The same argument does not apply to properties that have already been developed, at least in the context of the basic model where redevelopment does not occur. Once a property has been developed, the social surplus it

35. Imagine plotting iso-revenue curves in τ_Z-τ_W space. Each iso-revenue curve must intersect the τ_W axis, since any amount of discounted tax revenue, from zero up to the entire social surplus, can be obtained from a tax on raw site value alone. Thus the top of the Laffer curve for simple property taxation occurs at a point of tangency of an iso-revenue curve and the 45-degree line. It follows from the geometry that a small reduction in τ_Z from this point, holding fixed τ_W, unambiguously increases tax revenue.

generates is fixed. Any increase in property value therefore is associated with an equal reduction in government revenue.

In an actual city, some sites are undeveloped, others just developed, and yet others ripe for redevelopment. For any particular city, there is a range of simple property tax rates for which a switch to a two-rate raw site value tax system (holding the tax rate on raw site value at the level previously applied under simple property taxation but lowering the tax rate on residual structure value) would increase government revenue and benefit most, if not all, owners of land and property.

In practice, it would be difficult for a particular city to forecast whether a switch to two-rate raw site value taxation, accompanied by a reduction in the tax rate on residual structure value, indeed would increase property tax revenue. Also, initially the decomposition of property value into assessed raw site value and assessed residual structure value no doubt would be noisy. But since no landowner or property owner would experience an increase in the effective tax rate applied to his or her property, and since all landowners and property owners would benefit by the switch, there is basis for optimism that the political cost of assessment errors would be low.

Postdevelopment Site Value Assessment

If postdevelopment site value is assessed as raw site value, a revenue-neutral move from simple property taxation to two-rate taxation unambiguously improves efficiency. If, however, postdevelopment site value is assessed as residual site value, a revenue-neutral move from simple property taxation to two-rate taxation may increase distortion.

Table 4 illustrates the latter result, which gives the revenue-maximizing two-rate residual site value property tax rates for different values of the elasticity of substitution between land and capital in the production of structures, with the interest rate (and so on) used in the earlier examples, and with the parameters of the structure production function chosen so that $T = 50$, and $k = q = 1$ in the base case. Observe that with an elasticity of substitution of 0.75, which accords with empirical estimates, the optimal tax rate on imputed structure value is higher than that on residual site value. The broad intuition for the result is as follows. Recall that the neutral residual site value tax system entails the exemption of predevelopment land value from taxation, the taxation of residual site value, and the subsidization of imputed structure value. Moving from this neutral residual site value tax system to simple property taxation entails two distortions. First, the tax rate on predevelopment land

Table 4. Two-Rate Residual Site Value Property Value Taxation, Revenue-Maximizing Tax Rates

σ	τ_L	τ_K	R	k	q	T
0.25	0.0251	0.0039	0.862	0.658	0.817	45.39
0.50	0.0150	0.0099	0.728	0.399	0.666	38.69
0.75	0.0092	0.0229	0.540	0.188	0.513	28.04

Source: Author's calculations.

σ = elasticity of substitution between land and capital in the production of floor area. τ_L = common tax rate on predevelopment land value and postdevelopment residual site value. τ_K = tax rate on postdevelopment imputed structure value. R = tax revenue discounted to $t = 0$. k = capital-land ratio. q = floor-area ratio. T = development time.

value is set equal to that on residual site value. Second, imputed structure value is taxed rather than subsidized. If distortion on the first margin is more significant than that on the second, it may be second-best efficient to lower the tax rate on residual site value relative to that on imputed structure value. Thus whether lowering the ratio of the tax rate on postdevelopment assessed structure value to that on site value improves efficiency depends critically on how postdevelopment property value is decomposed into assessed structure value and assessed site value.

Assessment practice lies between the two extremes of raw and residual site valuation. On one hand, assessors realize that the ideal is to assess postdevelopment land value as raw site value. On the other, assessment practice entails making the best use of all available information. In the absence of land value data, assessors impute structure value according to depreciated construction cost or replacement cost, and then calculate land value as the residual—they employ residual site valuation. When there are some land value data, but not for closely comparable properties, assessors use their best judgment, which presumably entails site valuation that is between raw site valuation and residual site valuation. Thus when there are few vacant land sales (or teardown sales) for comparable sites, site valuation is typically closer to residual site valuation, and when there are many, it is closer to raw site valuation. As a result, one expects that site valuation tends toward raw site valuation in locales where there is considerable development or redevelopment and toward residual site valuation where there is little development or redevelopment. Therefore it is reasonable to argue that site valuation tends toward raw site valuation close to development or redevelopment times, and toward residual site valuation in between development times. Now, the timing decision is based on valuation close to development or redevelopment time, while the density decision is based on anticipated taxation over the structure's lifetime. Consequently, in practice a move toward two-rate property taxation is likely to reduce distortion on the timing margin, but may increase it on the density margin.

Two-rate property taxation is not on the policy agenda of many U.S. jurisdictions. But at the current rate of technological improvement in land valuation, it may not be too long before the raw site valuation of developed land becomes acceptably accurate. When that occurs, modest movement toward two-rate property taxation through lowering the tax rate on residual structure value may be politically popular, especially in those jurisdictions with relatively high property tax rates for which the distortion associated with the current system is substantial. The reduction in the efficiency loss due to property taxation may be so large that lowering the tax rate on residual structure value would not only benefit landowners and all major classes of property owners, but would also generate at least as much revenue.

Conclusion

While property taxation's distortionary effects on development timing and density are generally acknowledged, they have received little attention in recent property taxation policy debates. The model presented in this paper is tailor made to examine these distortions. It considers a landowner who must decide when and at what density to develop his or her site. In the absence of taxation, the landowner makes the efficient decisions, but property taxation, in general, distorts these decisions and generates a deadweight loss. Property tax systems are characterized by a trio of tax rates: 1) on predevelopment land value, 2) on imputed postdevelopment structure value, 3) on imputed postdevelopment land value. The sum of imputed postdevelopment structure value and imputed postdevelopment land value are constrained to equal postdevelopment property value. Simple property taxation entails these three rates being equal. Conventional property taxation taxes property value after development, which entails that the same rate is applied to imputed postdevelopment structure value and land value, but may tax predevelopment land value at a lower rate. The land value tax advocated by Vickrey (1970) and others entails equal tax rates being applied to land before and after development, and structures being exempt from taxation, with land value after development defined as what the land would be worth were there no building on the site, even though in fact there is, and so on. Varying the three tax rates therefore permits the analysis of a wide variety of stylized property tax systems.

This paper demonstrated that, for realistic parameter values and tax rates, conventional property tax systems generate substantial deadweight loss with respect to the timing and density of development. Two neutral property tax systems were identified and some of the difficulties in moving from current property tax systems to less distortionary ones were discussed. Two-rate taxation is potentially Pareto improving, but can be undermined by inappropriate assessment of postdevelopment land value. Also, the preferential treatment of agricultural land may be justified on second-best efficiency grounds.

This paper's straightforward analysis of some intrinsically difficult policy issues was due to simplifying assumptions. It remains to be seen whether the basic conclusions hold up when realistic complications—such as land use controls, uncertainty, and general equilibrium effects—are introduced. Nevertheless, after reading this work, one should be persuaded of two things: first, the distortionary effects of property taxation on development timing and density are likely to be sufficiently substantial that they merit serious attention in any property tax reform proposal; and second, the paper's simple model provides a useful vehicle for thinking about the effects of alternative property tax systems on development efficiency.

Comments

Robert M. Schwab: Arnott's current paper and related recent research are very valuable contributions to the property tax literature. Together, they are excellent examples of the way economic theory can inform policy debates. I am certain that this line of research will have a profound effect on the way people think about the property tax.

This paper sets out a model where a landowner needs to make two decisions: when and how intensely to develop land. Equations (2) and (3) in the paper characterize the solution to this problem in the absence of any taxes. Equation (2) shows that the landowner should wait to develop until forgone rents just equal the cost of capital. Equation (3) shows that the optimal density requires the present value of the increase in rents from the last unit of capital to just equal the cost of purchasing that unit of capital. That is, along both the timing and density dimensions, optimality requires the landowner to balance costs and benefits at the margin. The paper then looks at how various forms of property taxation alter the landowner's timing and density decisions and investigates the necessary ingredients of a neutral tax system. The paper also examines two interesting policy questions: the taxation of undeveloped land and two-rate taxation.

At several points in the paper, Arnott argues that there are not many examples of two-rate taxes (or the most extreme case, a pure land tax) because of the difficulty of assessing land and structures separately. He suggests that some recent advances in assessment techniques may offer solutions to these assessment problems. For example, he points to Dye and McMillen's (2005) work on teardowns as an important step forward. I argue that the assessment problem is not really the key reason we see so few deviations from the traditional property tax where land and structures are taxed at the same rate. In particular, I argue that the two-rate tax and land tax will remain unpopular (even if the assessment problems were solved) for at least two reasons: they raise troubling equity concerns and are inconsistent with the prevailing view of property rights in the United States.

Land taxation has a long intellectual history. Henry George's 1879 *Progress and Poverty* is certainly an important contribution to that history. In that book, George argued that one should tax away the returns from land. Such a tax, George said, would penalize speculation and thus encourage people to develop their land. George further argued that the land tax would be just; returns to land are an "unearned increment."[1] That is, those returns are the result of public policies and the public should enjoy the benefits of those policies.

While George was very popular and influential at one time (he nearly won the New York mayoral election in 1886), it is difficult to see any current examples of his influence in the United States. Two U.S. towns—Fairhope, Alabama, and Arden, Delaware—were founded on Georgist principles. A number of small towns in Pennsylvania have a long history of two-rate taxes. But Pittsburgh is clearly the most prominent example in the United States of a graded tax. Pittsburgh instituted a two-rate tax in 1913. The tax on land was raised several times. By 1980 the tax rate on land in Pittsburgh was roughly six times as high as the tax on structures. But Pittsburgh unceremoniously abolished the two-rate tax in 2001. This was clearly a blow to Georgism; as one observer put it, "How could the shining light be doused so easily?"[2]

What can one make of all of this? It is difficult to argue that it is impossible to implement a two-rate tax. After all, a graded tax survived in Pittsburgh for nearly a century. Admittedly, the assessment of land values is undoubtedly far from perfect. But as Arnott explains in this paper, it is important to recall that from an economic perspective assessment practices do not need to be perfect. The neutrality result requires only that tax liability be independent of the way land is actually used. Random taxation, from this perspective, would work just as well as accurate assessment of the value of land in its highest and best use (though clearly, assessment errors raise a wide range of daunting legal, political, and ethical issues).

If administrative feasibility is not the key stumbling block to a land tax, then (to borrow the title of Hughes, 2005) why so little Georgism in America? As I suggested at the outset, I believe there is a good case to be made

1. George (1879).

2. Hughes (2005, p. 8). Graded taxes are much more common outside the United States. All Danish cities rely on a two-rate tax, and two-rate taxes are common in Australia and South Korea.

that the key issues here are equity concerns and the prevailing view of property rights in the United States.

Two-rate taxes involve both vertical and horizontal equity issues. The vertical equity issue arises for at least two reasons. First, there is reason to believe that a two-rate tax will shift the burden of the property tax from commercial property owners to homeowners. There is not much empirical evidence on this issue, but it is difficult to dismiss the concern that lowering the tax on downtown skyscrapers (while admittedly raising the tax on the land on which the skyscrapers sit) would not be a benefit to commercial property owners. Second, a two-rate tax might shift the burden of the property tax from high-income homeowners to low-income homeowners. Here again, there is not a great deal of empirical evidence on this issue (though England and Zhao (2005) suggests that this concern might not be well founded).

A simple example makes the horizontal equity concerns clear. Suppose A owns a home with structures valued at $200,000 and land at $100,000; B owns a home with structures valued at $100,000 and land at $200,000. Under the traditional property tax, A and B face the same property tax bill. That is consistent with many people's notion of equity; A and B are equal in the sense that they both own homes worth $300,000 and they should be treated equally. Under a two-rate tax, however, B would pay more than A (assuming that land would be taxed more heavily than structures). There are some obvious possible rebuttals to this argument. For example, the traditional property tax ignores many types of wealth (for example, stocks and bonds). Why should a person be concerned that a two-rate tax treats one particular type of wealth (structures) more favorably than a second type of wealth (land)? But in the end, it is very difficult to quickly dismiss this notion that the appropriate base of a property tax is the total value of property. This is, after all, the way property has always been taxed nearly everywhere in the United States. In many ways, this is the same sort of issue that surrounds the shift from an income tax to a consumption tax. Whatever the relative merits of the two types of taxes, it would be difficult to convince many people that taxing savers and spendthrifts (who have the same income) differently is consistent with a sensible definition of equity.

It is important to recall the land tax's intellectual roots. As I noted above, the Georgists favored the taxation of land on the grounds than landowners were not entitled to the returns from their land. Land is valuable, from this perspective, because of public policies and the decisions of other people. Certainly there is something attractive about this idea. Homes in good school districts, for example, are more valuable than homes in poor districts. Downtown land would be of little value if local governments failed to invest in police protection, public utilities, streets, roads, and public transportation.

While this argument may have seemed compelling to Henry George and his followers, it seems out of step with the prevailing views in the United States today. This is, after all, the time when the property rights movement continues to gather momentum. The strength of the property rights movement became clear once again in the uproar over the U.S. Supreme Court's 2005 decision in *Kelo* v. *City of New London,* which upheld a city's right to use eminent domain to condemn privately owned property so that it could be used as part of a comprehensive redevelopment plan. At the heart of the property rights movement is our common law and cultural heritage that ". . . affirms that individuals have rights in their property and property in their rights."[3] While the property rights movement often involves regulatory issues such as land use laws, I suspect that very much the same issues will always make it very difficult for George's intellectual descendants to ever make much headway in their efforts to institute a land tax on a broad scale.

Jan K. Brueckner: Richard Arnott's paper provides an exhaustive discussion of what is wrong with the property tax and what can be done to modify the tax in a desirable direction. It has long been understood that by taxing both land and the capital embodied in structures, the property tax reduces land-use intensity by depressing the level of capital improvements. Literature initiated around 1980, however, identified another distortion that arises in a dynamic context: alteration of development timing. The added complexity of a dynamic model means that the direction of the distortions to capital (k) and the development date (T) are ambiguous in general. However, under plausible assumptions, the property tax turns out once again to depress the level of capital improvements, and an example provided by Arnott shows the tax as speeding up development (with T falling).

These distortions can be eliminated by shifting to a land tax, which Arnott calls a *raw site value tax.* For undeveloped land, the tax would be levied on the land's market value, while for developed land, the tax would be levied on the imputed value of the land, computed as if there were no structure on it. Recognizing that implementation of a raw site value tax is impractical, mainly because of the difficulty of properly imputing land values, Arnott asks whether some less-drastic modification of the current property tax could generate the same efficient outcome.

3. Eagle (2001, p. 1).

In prior work (which he briefly summarizes in the present paper), Arnott (2005) showed that such a tax regime is feasible. The required regime is a variant of a residual site value tax, and it works as follows. Undeveloped land is taxed at the rate τ_V, which is applied to the land's market value. Following development, residual site value, denoted *S*, is computed as the value of the developed site, *P*, minus the cost of the capital in place on the site, *pk*, where *p* is capital's unit price (in practice, capital's depreciated value could be used). A second tax rate τ_S is then applied to residual site value, $S = P - pk$. Finally, a third tax rate τ_K is applied to the value of the capital on the site, *pk*. This regime is more practical than the raw site value tax given that the only new information it requires is construction cost, *pk*, which is more readily estimated than land value (and is directly observable for new construction).

Arnott shows that the efficient outcome realized under a land tax can be generated under a residual site value tax provided that the tax rates are set appropriately. First, the tax rate on undeveloped land should be set at zero, so that $\tau_V = 0$. Second, the capital tax rate τ_K should be negative, so that the tax becomes a subsidy. The tax on residual site value can then be set to raise the desired amount of revenue. The subsidy to capital is designed to offset the tendency of a residual site value regime to depress capital improvements when all the tax rates are equal ($\tau_V = \tau_S = \tau_K$). The zero tax on undeveloped land is designed to offset the tendency for too-early development under an equal-rate residual site value regime.

As shown by Arnott, this regime's practicality is enhanced once it is recognized that the regime is equivalent to one where a property tax is levied on the value of the developed site, after an appropriate deduction of capital costs, and where vacant land is untaxed. In other words, the property tax rate is applied to $P - dpk$, where *d* is an appropriate deductibility rate, rather than to *P* itself, while τ_V is set at zero.

The magnitude of *d* is a crucial question, but before considering this issue it is helpful to ask what deductibility rate for capital costs would be appropriate in a static model to offset the distortions of the property tax. In such a model, let *r* denote rent per unit of housing floor space and $q(k)$ denote floor space per acre of land as a function of capital per acre. Then, in the absence of taxation, the developer's profit per acre gross of land cost is $rq(k) - \rho k$, and the first-order condition for choice of *k* is $rq'(k) - \rho = 0$.

In this setting, the property tax can be viewed equivalently as a tax on rental income or as a tax on the inputs of capital and land. Taking the former approach and letting τ denote the tax rate, profit is then $(1 - \tau)rq(k) - \rho k$, and the first-order condition for choice of *k* under property taxation becomes

$(1 - \tau)rq'(k) - \rho = 0$. Since the term multiplying $q'(k)$ is smaller than before, it follows that the chosen k is also smaller, so that the property tax depresses capital improvements.

This distortion can be remedied by allowing the developer to deduct the appropriate share of capital costs. Letting this share be denoted d, profit is then given by

$$rq(k) - \rho k - \tau(rq(k) - d\rho k).$$

If $d = 1$, so that the developer can deduct the entire capital cost, this profit expression reduces to $(1 - \tau)(rq(k) - \rho k)$. The profit-maximizing k is then the same as in the absence of taxation, eliminating the distortion from the tax.

In contrast to this full-deductibility rule, the appropriate rate of capital deductibility under Arnott's proposed regime equals

$$d = 1 + \eta/(i + \tau + \eta),$$

where η is the rate of increase of rents and i is the interest rate. The key observation is that this deductibility rate exceeds one, so that the developer must be allowed to deduct *more* than the cost of the capital used in the structure, unlike in the static model, where the rate is unity. Moreover, the deductibility rate depends on the property tax rate itself, as well as on the interest rate and rate of increase in rents, facts that would complicate implementation of the system.

In the interests of practicality, it is interesting to appraise the error involved in using the static d value of 1 under Arnott's regime. To this end, suppose that the interest rate is $i = 0.05$, the rate of increase of rents is $\eta = 0.03$, and the property tax rate is $\tau = 0.015$, all realistic values. Then, $d = 1.32$, a value not far above 1. If rents increase at a smaller rate of $\eta = 0.02$, then $d = 1.24$. On the other hand, if τ must rise to a value like 0.025 to offset the loss of tax revenue from structures and vacant land, then $d = 1.29$ (assuming $\eta = 0.03$). In each case, the d required to ensure efficiency under Arnott's regime is not far above 1. This conclusion suggests that much of the efficiency gains from such a system might be realized by using the static rule, where $d = 1$ and a developer deducts an amount equal to capital costs.

Thus a system that involves relatively simple departures from the current property tax regime would appear to yield substantial efficiency gains. Under this system, vacant land would not be taxed, and property owners would be allowed to deduct capital costs from property value before computing their tax liability.

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