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The Effect of Property Taxes on the Capital Intensity of Urban Land Development

Introduction

From many sources there is increasing interest in finding substitutes for the local property tax. A major objection to the existing general property tax is that it is a disincentive to both the quantity and quality of new construction and to maintenance of existing structures. By decreasing the supply of improvements to land, property taxes raise the price of real estate services. Since the property tax rate is relatively high in many areas, the effect of the tax in reducing the supply of improvements and thus raising the price of real estate services may be significant. Netzer (1968, p. 13) estimated that property taxes accounted for 19 percent of total annual housing costs in the United States in 1962 and that, if it can be considered as an excise tax, the tax on real property is higher than any other excise tax except those on liquor, tobacco, and gasoline. In some particularly hard-pressed cities this "excise" tax rate on housing is much higher than the national average. In remarkable contrast to, and perhaps partly necessitated by, this heavy tax on the

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services of housing are numerous federal and local aid programs intended to increase the supply of housing.[1]

The property tax is also the most important source of local government revenue, providing $40,876,000,000 or 84 percent of local tax revenue in 1971-72 (U.S. Bureau of the Census, 1973, p. 20). Thus, any proposal to reduce property taxes implies that there is an alternative tax which is preferred—one that produces comparable revenues. An alternative form of local property tax, often recommended on theoretical grounds, is a tax on unimproved land value, or "site value." The major theoretical advantage of the land value tax is that, as a tax on pure economic rent of land, it should be neutral in its effect on incentives to supply improvements to land. To the investor the land tax is a lump-sum tax that does not affect his decisions at the margin. Another theoretical advantage of the land tax is that if the benefits of some public services are capitalized in higher land values the land tax closely resembles a benefit tax for those services.

The theoretical advantages of the neutrality of the land value tax are generally conceded, but to many observers it is not clear that the advantages associated with a full or even partial shift of property taxation from improvement values to land values are sufficient to outweigh the disadvantages, which include the inevitable distribution of windfall gains and losses associated with the shift of the tax base. It seems clear that a shift of taxation from building to land value would increase the incentive to invest in greater quality, durability, and height of all improvements to land and would decrease the incentives for urban sprawl. The *direction* of the change in incentives is clear, but the *magnitude* of resulting changes in urban form is unknown. For instance, just how much more new housing would be built in response to a shift of taxation from building to land value? How much change in urban density gradients would result? Would the impact be small or large? Unfortunately, few empirical studies have measured these effects of land value taxation in jurisdictions that now practice it, nor has it been

1. When the impact of the entire national, state, and local tax system is considered, it is possible to demonstrate that owner-occupied housing is taxed at a lower average rate than is nonhousing capital because the corporate income tax and sales tax exclude the housing sector, and because owner-occupiers are granted favorable income tax provisions (Ladd, 1973, p. 40). But, rental housing and nonresidential real property are subject to a higher tax rate than is owner-occupied housing, especially if they are included in the corporate sector. In any case, the property tax does operate at cross-purposes with many housing programs, especially in areas where property tax rates are high relative to the national average.

possible to predict quantitative effects for jurisdictions that might introduce it.

Netzer believes that "the case for site value taxation is a good one," and that "in theory, there are few if any legitimate economic arguments against site value taxation," but he also says that "one may doubt the actual strength of the positive tendencies associated with a switch to site value taxation. It is, after all, a major institutional change, and major institutional changes should not be pressed unless their positive effects are also expected to be major in extent. But it should be noted that effective property tax rates in most American metropolitan areas are high and rising. The negative land use effects of the present tax are likely to become increasingly apparent in time, and the likely benefits from a change in the basis of taxation will correspondingly increase" (1968, pp. 41-42). In a study of Pittsburgh's graded property tax, which has a higher tax rate on land than on buildings, Richman concluded that "there is little evidence that the graded tax has been a significant stimulus to property improvement in Pittsburgh, or to urban renewal and re-development in particular," but noted that one of the reasons for this is that the tax rate on buildings was only about 30 percent less than that on land (1965, p. 270). In a study of the effect of property taxes on land use patterns in Australia and New Zealand, Woodruff and Ecker-Racz concluded that "at tax rate levels now prevailing in Australia and New Zealand, the economic and social impact of property taxation based on unimproved capital value is minor. No differences are perceptible between communities that use unimproved capital value rating and those with other taxation systems" (1969, p. 184). In a study of Auckland, New Zealand, where three different property taxation systems (taxation based on unimproved land value, on capital value of the improved property, and on annual rental value) exist side by side within separate parts of the same city, Clark concluded that "the taxing system has no identifiable impact on urban development" (1974, p. 110). Thus, although the theoretical advantages of site value taxation have been persuasively demonstrated by many authors, there is apparently a place for further empirical study of the probable size of the effects of a change from general property taxation to site value taxation.

The purpose of this essay is to estimate empirically the effect of property taxes on the capital intensity of land use in an urban area. First, a theoretical model for determining the profit-maximizing investment in improvements to an urban site is presented. Then the effects of land and improvement taxes on investment in construction are examined in a comparative static analysis. The parameters of the model are estimated in two ways: from hypothetical data on a planned building and from actual data on a sample of newly constructed buildings. Finally, two partial-equilibrium case studies are used to estimate the increase in investment in improvements which would follow from eliminating the property tax rate on improvements, with property tax revenue maintained by an increase in the tax rate on land value. The focus is not on the incidence or the progressivity of the property tax, but rather on its effect on the supply of improvements. Obviously, however, the effect of the tax on the supply of improvements has implications for each of these other issues.

The Optimal Capital Intensity of Urban Land Development

When considering land as a factor of production in an urban area, it is important to note that, unlike other factors of production, entrepreneurs usually cannot obtain as much land as they would like at a constant marginal cost. In urban areas land ownership is divided among a large number of separate owners, and many or all sites are already developed. The typical development decision concerns a specific site that the developer already owns or can buy, but the developer cannot increase the size of his site at a constant marginal cost per square foot; rather he must usually pay successively higher prices for discontinuous additions to the site. The discrete nature of the supply curve of urban land to a developer is caused by the need to demolish existing structures on adjacent land and to bargain with its owners and/or leaseholders. Because of the "holdout" problem, the price of contiguous land for expansion of a site can rise very sharply. Therefore, the development decision often involves determining the profit-maximizing capital input in improvements to a constrained amount of land.

On the constrained site the developer can, in his initial development decision, continously vary the amount of capital applied in the form of improvements to land. In the planning stage both the type of use (residential, commercial, and so on) and the capital intensity of use (low-rise, high-rise) are variable within bounds legally permitted by zoning regulations and building codes. But once the building is constructed, it is relatively costly to change the type or intensity of land use because of the extreme durability of most improvements. If land and capital are the only two factors of production, diminishing returns will be associated with adding capital to a given amount of land, and the profit-maximizing outlay on improvements to the site will occur where the discounted marginal revenue product of an increment in building size equals the marginal cost of the increment in size. The classic example of calculating

the marginal revenue product of improvements to land is the determination of the optimal economic height of a skyscraper. As building height increases, nonrentable space devoted to structural elements, mechanical equipment, and elevators increases as a proportion of total floor space, and this causes the construction cost per square foot of net rentable space to increase.[2] As the cost per square foot increases with height, there comes a point where the cost of additional space is just equal to the discounted value of its future rental returns. Alternatively stated, the profit-maximizing outlay on improvements occurs where the marginal rate of return on capital investment in construction equals the interest rate. Though the example is most obvious in relation to building height, the method also applies to any sort of capital expenditure for quantity or quality of improvements to land.

In addition to capital improvements and land, the third major factor in the production of real estate services is operating and maintenance inputs. Unlike land and capital, operating and maintenance inputs are easily varied after the planning stage, but the initial construction decision has obvious implications for subsequent operating and maintenance expenditures. For instance, in the planning stage, there is a trade-off between capital expenditures on durable construction materials versus subsequent expenditures on building maintenance inputs. In the planning stage, for every level of capital investment, there is an associated profit-maximizing level of operating and maintenance expenditures. In terms of annual revenues and cost, this occurs at the point where the marginal revenue product of operating and maintenance inputs equals their marginal cost. Since our emphasis here is on ascertaining the optimal capital intensity of development, it is convenient to assume that, for each amount of capital applied to a given site, the entrepreneur adjusts the level of subsequent operating and maintenance inputs to the point where their marginal revenue product equals marginal cost. Then, by deducting the annual cost of operating and maintenance inputs from annual total revenues of the developed property, we find the annual net revenue after operating and maintenance expenses. The annual net revenue is a quasi-rent for the life of the building, and includes all factor payments to capital and land.

With the above definition of annual net revenue and given both the

2. In a study of thirty-six post-World War II high-rise office buildings in Los Angeles County, Berger (1968, pp. 11-14) found that building efficiency (the ratio of net rentable area to gross building area) declines by approximately 0.5 percent for each additional story when average floor area is held constant.

demand and production functions for real estate services, it is possible to derive the optimal capital intensity of development for a specific site. Let:

K = capital (in dollars) invested in improvements to a site;
L = land area (in square feet) of the site;
M = annual operating and maintenance inputs;
w = price of operating and maintenance inputs;
q = total annual output of real estate services;
$p = p(q)$ = price per unit of output of real estate services, which is a function of q;
$A = q[p(q)] = A(q)$ = total annual revenue, which is a function of q;
$q = q(K,L,M)$, the production function for real estate services;
$R = A - wM^*$ = annual net revenue after operating and maintenance expenditures;
M^* = level of M for which the marginal revenue product of M = the marginal cost of M, for each pair of K and L;
T_k = annual tax on improvement value;
T_l = annual tax on land value;
t_k = tax rate on improvement value; and
t_l = tax rate on land value.

In the planning stage for a new building, the annual net revenue can be expressed as $R = A[q(K,L,M^*)] - wM^*(K,L) = R(K,L)$. On a given site, $\bar{L}$, annual net revenue can then be expressed as a function of the capital investment in improvements to the site, $R = R(K,\bar{L})$, as illustrated in the top panel of figure 5.1. The $R(K,\bar{L})$ curve is the envelope of a series of separate $R(K,\bar{L},M)$ curves for all separate possible fixed levels of M. The shape of the $R(K,\bar{L})$ curve depends on (1) the physical production functon, $q = a(K,L,M)$; (2) the revenue function, $A = A(q)$; and (3) the price of operating and maintenance inputs, w, assumed to be fixed. If both the production and revenue functions are continuous, the revenue production function, $R(K,\bar{L})$, is also continuous. Annual net revenue is assumed here to be constant stream of payments for the life of the improvement. From this $R(K,\bar{L})$ function can be derived two related functions, the marginal net revenue product of capital ($\partial R/\partial K$) and the average net revenue product of capital (R/K).[3] The marginal net revenue product of capital (*MNRPK*) and average net revenue product of

3. These definitions were first proposed by Robinson (1933, pp. 235-412) and were further developed by Bishop (1967). The concept used here corresponds to Bishop's long-run *MNRP* and *ANRP*.

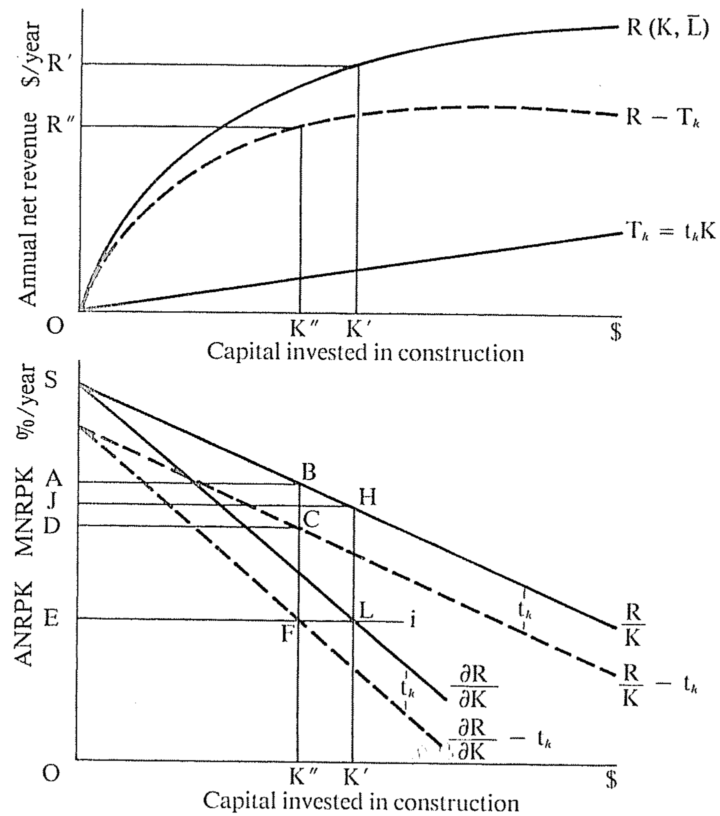

Figure 5.1. Total, average, and marginal net revenue with a tax on improvements

capital (*ANRPK*) are shown as solid lines in the bottom panel of figure 5.1.[4]

The construction of any improvement is in theory part of a dynamic choice of a sequence of successive improvements on the same site. But the development process usually involves commitment of both land and capital to a very long-lived combination, especially when high-rise con-

4. The negative slope of the *MNRPK* curve may be caused by any or all of three separate phenomena: (1) diminishing marginal returns associated with combining two variable factors (K and M) with a fixed factor (L); (2) an imperfectly elastic demand for real estate services at the site; and (3) an imperfectly elastic supply of construction, operating, and maintenance inputs. If tenants are willing to pay higher rents for upper story locations, the marginal net revenue product of capital will be less negatively sloped than in the absence of such a height premium, or may even have a positive slope within some range. Beyond some height, however, the *MNRPK* must decline for there to be an economic limit to height.

struction is involved. Thus, a developer may well not explicitly consider the remote time when redevelopment will take place.[5] If the annual net revenue of the improved property is assumed to be a level stream continuing infinitely far into the future, or at least beyond the "planning horizon" of the entrepreneur, the profit-maximizing outlay on construction occurs where the *MNRPK* equals the interest rate on borrowed funds, or the opportunity cost of equity capital.[6] In figure 5.1 this occurs where the capital investment in improvements is K'. For any investment in size or quality of building below K', the marginal rate of return on further investment exceeds the interest cost, and the reverse is true for any investment above K'.[7] The resulting annual net revenue is R' in the top panel, or the rectangle $OK'HJ$ in the lower panel of figure 5.1. This revenue must be divided among land rent for the site, interest on the capital invested in the improvement, entrepreneur's profit, and property taxes (which are assumed initially to be zero).

The interest on capital invested in improvements to land is given by the rectangle $OK'LE$ (the interest rate times the capital invested). If there is perfect competition in the bidding for vacant sites, entrepreneurs will bid up to an amount equal to the rectangle *ELHJ* (which is equal to the triangle *ELS*) in terms of annual rental payments for the right to use the site.[8] Different types of land use (for example, commercial versus residential) will result in different annual net revenue curves, and the land use which produces the largest annual rent payment in terms of the rectangle *ELHJ* will be the "highest and best" use of the land.[9] The

5. Some buildings are even built with the explicit intention of being potentially permanent. As an example when the Singer Building in New York, once the tallest building in the world and still the tallest ever to be demolished, was pulled down in 1967, it was recalled that its architect, Ernest Flagg, once stated that the building was "as solid and lasting as the Pyramids."

6. If the interest rate on borrowed funds is an increasing function of the amount borrowed, the relevant capital cost is the *marginal* rate of interest (the increase in total yearly interest payments divided by the increase in borrowed funds).

7. Quality and quantity of improvements to land are not measured separately here. Rather, the total amount spent on construction is taken as the market estimate of the two combined.

8. If there is competition among developers, all above-normal profits of development will tend to be passed on to landowners. But better informed or more optimistic entrepreneurs may often recognize demand for new real estate services where all others fail to see it, and thereby be able to capture some of the potential land rent as part of their profit of development. Of course, if the developer overestimates the demand for real estate services he may overbid for land and overinvest in construction and thereby lose money. In an uncertain world, variations among developers in estimates of demand must account for part of the observed variation in the capital intensity of contiguous land uses.

9. This normative term refers to private profit maximization and neglects positive or negative external effects of the alternative land uses. Land use regulations, which are in part intended to correct for these externalities, alter the revenue function by imposing various prohibitions and requirements on the developer, and may in some cases produce a coincidence between privately calculated and socially calculated highest and best use.

market value of the land will be the capitalized value of the expected future rent payments.

In this formulation of the profit-maximizing capital intensity of land development, all revenues, costs, and taxes have been measured on an annual basis, with the assumption that they continue as level streams infinitely far into the future. As an alternative way to formulate the problem, all revenues, costs, and taxes could be measured in terms of their present discounted values at the time the construction decision is made. For instance, R could be redefined as the present value of the net revenue for the life of the building, plus the present value of the land at the end of the building life. There is then no need to assume that the annual net revenue is a perpetual level stream and it is also possible to take into account the tax advantages of real estate investment (principally the use of the depreciation allowance as an income tax shelter in the early years of the building). It is also possible to take into account the fact that the construction cost is not expended at a single point in time; the construction of a building takes time, and the cost of the capital investment, K, can also be converted to a present value at the time of the decision to begin construction.

When all revenue and cost flows are converted to their respective present values, the curves in figure 5.1 would be expected to have roughly the same shapes, but the condition for the profit-maximizing amount of capital would then be found at the point where $\partial R/\partial K = 1$; that is, at the point where an additional dollar of capital investment in construction increases the present value of the net revenue from the building by one dollar. The rectangle *ELHJ* would then represent the market value of the site rather than its annual rent. When property taxes are introduced into the model, the conclusions to be drawn are unaffected by whether the annual value or present value version of revenues, costs, and taxes is used, and the analysis is carried out below in terms of annual values. In the subsequent empirical estimation, both forms of the model are used.

The Effect of Property Taxes on Land Development Decisions

Within the framework of this static Ricardian model, consider the effects of the two major types of property taxes: on land value and on improvement value. The general property tax is usually levied as an annual tax on the total assessed value of the property or on the combined value of the building and of the land, separately assessed. When the tax rate on land and improvements is the same, however, the assessor has little incentive to divide total property value accurately between building value and land value.[10] Assuming it possible to assess land value and building value separately, we can consider the effect of each tax in isolation. In the following analysis I will ignore the effects on the demand for real estate services of the expenditure side of the government budget. This procedure is justified by the concentration on the effects of shifting the tax base from building value to site value, with government revenues and expenditures held constant.

A Tax on Improvement Value

First, consider the introduction of an annual tax on the capital value of improvements to a site ($T_k = t_k K$), where t_k = the property tax rate on the improvement value.[11] In figure 5.1 the tax as a function of capital invested in improvements to the site is a ray from the origin. Deducting this tax from R, we obtain annual net revenue after property taxes ($R - t_k K$) shown as the dashed line in the top panel of figure 5.1. Since this after-tax revenue is the relevant one for investors, we calculate the marginal and average net product of capital *after* property taxes, $\partial(R - t_k K)/\partial K$ and $(R - t_k K)/K$. These are shown as the dashed lines in the lower panel of figure 5.2. These after-tax functions are obtained by a simple downward shift of the before-tax functions, because $\partial(R - t_k K)/\partial K = (\partial R/\partial K) - t_k$ and $(R - t_k K)/K = (R/K) - t_k$.

The profit-maximizing outlay on capital improvements now occurs when the after-tax *MNRPK* is equal to the interest rate.[12] This point is shown as K'' in figure 5.1. The resulting annual revenue after operating and maintenance expenses ($R'' = OK''BA$) is divided among interest payments ($iK'' = OK''FE$), tax payments ($t_k K'' = ABCD$), and land

10. The problems of defining and separately measuring land value for taxation purposes are discussed by Hicks (1970), Turvey (1957), and Vickrey (1970). It is interesting to note that in New Zealand, which permits local governments to tax either unimproved land value or the capital value of land and improvements, one study found the relative cost of the two types of assessment to be ($NZ) 0.6 per assessment for unimproved land value and ($NZ) 4.00 per assessment for land and improvement value (Brown, 1968).

11. The analysis has been cast in terms of a tax on improvement value alone, whereas the usual property tax is based on the total market value of real property (land and building value). In the appendix it is shown that a property tax has the same effect on incentives regardless of whether it is applied to the total market value of the property or only to the value of the building.

12. In a model very similar to the one presented here, Becker (1969) shows the equivalent result that the profit-maximizing outlay on capital improvements occurs where the before-tax *MNRPK* is equal to the interest rate plus the tax rate.

rent (*EFCD*).[13] From this it can be seen that the capital improvements tax (1) reduces the optimal investment in real estate construction from K' to K''; and (2) reduces land rent of the site from *ELHJ* to *EFCD*. The first result confirms that a tax on improvements reduces investment in construction and thus reduces both the quantity and quality of improvements supplied.[14] The second result demonstrates that part of the tax on improvement value is incident on land rent and therefore on land value.[15]

This reduction of capital investment from K' to K'' is a maximum estimate: the actual reduction in capital improvements to a site will be less than this maximum estimate of K' to K'' depending on the extent to which the property tax is shifted forward to the users of real estate services or back to the factors that enter into the production of real estate services. Three possibilities should be noted.

First, if *all* buildings are subject to the same tax rate, the reduction in new construction on all vacant sites would decrease the output of real estate services and would therefore raise the price of these services if demand is not perfectly elastic. Some of the tax burden would thus be shifted forward to the consumers of real estate services. This would have the effect of increasing net revenue as a function of capital and would shift the *MNRPK* and *ANRPK* curves upward; thus the intersection of the new *MNRPK* curve with the interest rate would occur somewhat to the right of K'' when we recognize that the tax also decreases the supply of real estate services on competing sites. If we are considering a change in the tax rate for one small local jurisdiction in a large metropolitan

13. From this diagram it can be seen that, beyond some point, an increase in the property tax rate on buildings may reduce the total property tax revenue. A higher t_k reduces K, so that $t_k K''$ may either increase or decrease as t_k increases.

14. The disincentive effect of property taxes on the elusive "quality" dimension of new construction is magnified when the tax assessment is based on construction cost rather than on the capitalized rental income or sale value of a building. For example, because of its unusual design and large landscaped plaza, the construction cost of the Seagram Building in New York City exceeded the capitalized value of its expected rental income (i.e., in figure 5.1 the builder was operating either in a region below the revenue production function or somewhere to the right of the optimum point). The New York State Court of Appeals upheld New York City in its decision to use the high construction cost figure as evidence to justify assessing the building at a value greater than the estimate of its capitalized rental income. This is a clear fiscal disincentive to construction expenditures for external amenities that produce no income (*New York Times*, June 11, 1964, pp. 35-38). This is not meant to imply that every building whose construction cost exceeds its capitalized rental income is necessarily good architecture or provides external amenities.

15. If the demand for the services of real estate were perfectly elastic, and if the supply of capital and construction services were also perfectly elastic, *all* of the tax on improvements would be incident on land rent.

area with a competitive real estate market, however, the effect of the tax on each new building in the small jurisdiction may be similar to that pictured above because the price of real estate services in the entire metropolitan area will be only slightly affected.[16]

A second reason to expect that the reduction in building size to K'' is an overestimate of the actual effect is related to the elasticity of supply of capital funds to the construction industry within the taxing jurisdiction. If capital is in less than perfectly elastic supply to the local real estate sector, the interest rate would decline when investment in construction declines, and the intersection of the *MNRPK* curve with the lowered interest rate would occur to the right of K''. Some of the tax burden would thus be shifted back to the suppliers of capital funds. This consideration is particularly relevant at the national level, where it is usually assumed that the supply of savings is interest inelastic. To the extent that there is a perfectly elastic supply of capital to one local jurisdiction in an open national economy, however, the interest rate would decline very little in response to reduced construction activity.

A third possibility that may mitigate the impact of an improvements tax on building size is the elasticity of supply of construction services. If construction services are in less than perfectly elastic supply, their price would decline if new construction contracted in response to a tax. Some of the tax burden would thus be shifted back to the suppliers of construction services, and this would raise the *MNRPK* curve. Again, the elasticity of supply of construction services depends on the openness of the taxing jurisdiction to flows of construction industry inputs across its borders.

Because of the above three tax-shifting possibilities, the reduction in construction investment from K' to K'' in response to a capital improvements tax is a maximum estimate. The magnitude of this estimated reduction depends on the values of i, t_k, and on the shape of the *MNRPK* curve, which in turn depends on the price elasticity of demand for real estate services, on the elasticity of supply of construction services, and on the elasticity of substitution between L and K in the production of real estate services. Either an inelastic demand for real estate services, an inelastic supply of construction services, or an inelasticity of substitution between L and K would lead to an inelasticity of *MNRPK* with respect to K. If the *MNRPK* curve is very inelastic with respect to K, the investment in improvements to the site is insensitive to changes in t_k; if

16. Mieszkowski (1972) emphasizes the open economy aspect of any one local government jurisdiction's decision about property tax rates and argues that the tax rate *differential* between one jurisdiction and all other relevant jurisdictions results in an excise tax effect of the sort we are discussing.

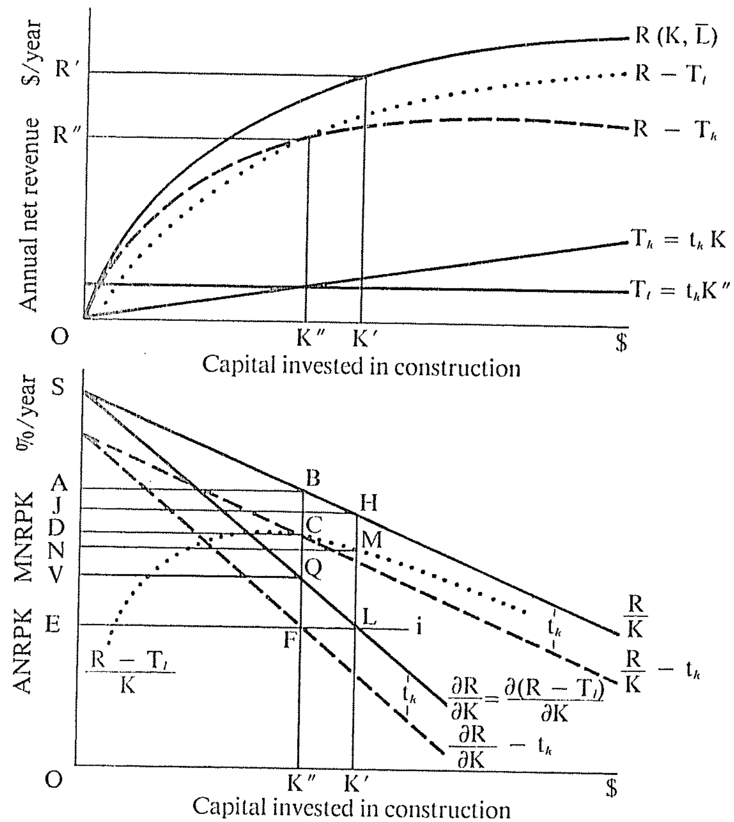

Figure 5.2. Total, average, and marginal net revenue with a tax on land

the *MNRPK* curve is very elastic within the relevant range, however, the reduction in investment from K' to K'' may be quite large, and there would be a significant reduction in intensity of development. Before turning to the evidence on this point suggested by the two case studies, I will first complete the theoretical analysis by briefly showing the effect on investment incentives of a tax on land value only, and in particular the effect of shifting the basis of taxation from improvement value to land value.

A Tax on Land Value

The improvement tax yields a revenue of $T_k = t_k K''$. A tax on site value, T_l, that raises the same revenue from the site and that does not vary with the value of the improvement to the site would therefore be represented by a horizontal line equal in value to $t_k K''$, as shown in the top panel of figure 5.2. Annual net revenue minus T_l would be represented by a simple downward shift (dotted line) of the $R(K,\bar{L})$ curve, with the slope of the curve everywhere unchanged. Since T_l is not a function of K, $\partial(R - T_l)/\partial K = \partial R/\partial K$, and the *MNRPK* curve is unchanged from the no-tax situation. The *ANRPK* will be changed by the land tax; $(R - T_l)/K$ is very low for small values of K and asymptotically approaches the no-tax *ANRPK* for larger values of K as shown by the dotted line in the lower panel of figure 5.2. Since the *MNRPK* is unaffected by the land tax, the optimal capital investment in improvements is K', the same as without the tax, and is greater than the optimal investment, K'', that results from the equal-yield improvements tax.[17] The resulting annual net revenue ($R' = OK'HJ$) is divided among interest payments ($iK' = OK'LE$), tax payments ($T_l = HJNM$), and after-tax rent (*ELMN*).

We have assumed that the switch in tax base produces a land tax revenue T_l equal to the alternative improvements tax revenue t_kK''. Thus we are applying the assumption of equal yield to a particular *site*, while the common use of the term refers to equal yield for a particular taxing *jurisdiction*. In any tax jurisdiction the ratio of improvement value to site value varies among sites and thus with uniform tax rates, an equal-jurisdiction-yield shift of the tax base from improvements to land will in general not produce equal site yields. But the incentive to invest in improvements is independent of the magnitude of the land tax. Therefore, a change in tax base from improvement value to land value produces the same effect on incentives to invest in improvements to a site *regardless* of whether the new equal-jurisdiction-yield land tax rate produces a land tax yield from the particular site greater or less than the alternative improvement tax yield.[18] If the total tax yield from a particular site *is* the same under either tax base, the after-tax land rent with the land tax is greater than the after-tax land rent with the improvements tax. This can be seen in figure 5.2. With the improvements tax, the site owner will invest K'' and the after-tax rent is the triangle *QSV*. With the land tax, the site owner will invest K' and the after-tax rent is the triangle *ELS* (the before-tax land rent) minus the rectangle *EFQV*

17. In the comparative static model I have concentrated on the effect of property taxes on the optimal capital intensity of new construction; in a dynamic model, property taxes may also have an effect on the *timing* of new construction. For a discussion of the effect of property taxes on the timing of development, see Gaffney (1973b), Neutze (1968), and Shoup (1970).

18. Although decisions concerning optimal investment in improvements are *at the margin* unaffected by a land value tax, the change from improvement value to land value taxation may, by reducing the wealth of owners of land devoted to low capital intensity uses, cause additional land to be released for development. Gaffney (1973b, pp. 81-82) believes that, in terms of stimulating development, this wealth effect accompanying a change of tax base would be at least as important as the effect on decisions at the margin.

(the improvements tax, t_kK'', which by assumption is equal to the land tax). Thus, the after-tax rent with the land tax is greater by an amount equal to *QFL*. But when we recognize that the optimal improvement value to land value ratios do vary considerably within a jurisdiction, it is obvious that some sites with low improvement value to land value ratios would experience a decrease in after-tax land rent and windfall losses in land value if the general property tax were replaced by a site value tax. Also, the incidence of a tax change may in the short run be quite different from that in the long run. Land uses existing at the time of the tax change will in general not be at the capital intensity that would be optimal after the land tax is instituted. Only after land uses have been adapted to the new tax incentives will the change in incidence be as described above.[19]

The redistribution of tax burden is of course one of the factors that may arouse opposition to a change from the general property tax to a site value tax. The only state that has in recent years moved toward site value taxation is unique in this respect. In 1964 the State of Hawaii adopted a graded real property tax law which in gradual stages will increase the tax rate on land to as high as 2.5 times the tax rate on improvements. One explanation of the political feasibility for such a change may lie in the fact that land ownership in Hawaii is unusually concentrated among a few large owners. In 1960 approximately 84 percent of all privately owned land in Hawaii, and 70 percent of all privately owned land on the highly urbanized island of Oahu, was in holdings of 5000 or more acres (Baker, 1961, p. 8). By 1962 more than two-thirds of new residential development land on Oahu was available only with leasehold tenure, and seventeen landowners accounted for 99.8 percent of all residential leaseholds on Oahu (Vargha, 1964, pp. 10-12). Thus, if the shift in tax base does cause windfall losses to some landowners, in Hawaii the losers may be relatively few compared to the number who might gain if the reduction in the tax on improvements had any effect in lowering the price of housing (or moderating its rate of price increase).[20]

19. The problems of transition from a general property tax to a site value tax are discussed by Harriss (1970). The theory of land tax capitalization is discussed in Jensen (1931, pp. 63-75) and Gaffney (1970, pp. 189-90).

20. This view corresponds to Woodruff's and Ecker-Racz's findings: "The fact that a number of Australian and New Zealand communities have been voting to change to unimproved capital value basis for property taxation has less implication for the inherent superiority of that system over others, as it generally reflects taxpayer desire to minimize tax bills. Communities vote to shift to unimproved capital value when they are on the outskirts of a developing metropolis and a majority of homeowners stand to benefit at the expense of a few. The reverse is true in older prosperous sections of metropolitan areas where the shift would be in the opposite direction and store and factory owners would benefit at the expense of the more numerous homeowners" (1969, pp. 185-86).

As noted above, the optimal investment in improvements to land is unaffected by a tax on land value because it has no effect on an investor's decisions at the margin. This neutrality in its effect on the incentive to improve land is usually cited as an advantage of land value taxation. It is sometimes also stated, however, that the *non*neutrality of a tax on improvement value is actually an advantage in that it discourages "too intense" development of urban areas. Certainly, if land value taxation were instituted, some low intensity uses of land might thereby become unprofitable and yet deserve preservation on the basis of their external benefits. For instance, some historic single-family residential areas which have a low building value to land value ratio might experience an increase in taxes if site value taxation were introduced, and this tax increase might lead to a replacement of the older buildings by new and larger structures. In this sense the general property tax may "preserve" some desirable low intensity uses. Not *all* low intensity uses deserve such preservation (some may have net external costs), however, nor should *all* urban renewal be discouraged, and the current general property tax makes no distinction between "good" and "bad" low capital intensity uses in conferring a low property tax. Taxation of the market value of improvements is in general not the best way to handle the external costs and benefits associated with improvements to land. User charges for specific municipally supplied building-related services combined with appropriate land use planning and building regulations would seem preferable to the general property tax as methods of accounting for externality problems.[21] This is especially evident when it is noted that the improvement value component of the general property tax base refers to quality as well as quantity of improvements.

Estimation of the Impact of Taxes: Two Examples

As noted above, the magnitude of effect of the general property tax on the supply of improvements depends crucially on the elasticity of the *MNRPK* curve. Thus, in order to estimate the impact of the property tax it is important to have an estimate of the revenue production function $R(K,L)$, and its derivative with respect to capital investment in construction. There is, however, no reason to believe that the function relating yearly net revenue to the capital and land inputs is the same for

21. Land use regulations could take the form of taxes on specific features of improvements that are thought to produce external costs. For instance, if building height or site coverage is per se thought to be undesirable, there could be a tax on these features.

all types of real estate, and therefore one would not expect the effect of a property tax on the supply of improvements to be the same in all uses. For instance, one would expect that real estate services with a low price elasticity of demand would also have an inelastic *MNRPK* schedule, and therefore a property tax would have little effect on the quantity supplied; for those services with a greater price elasticity of demand, the effect of a tax on the quantity supplied should be greater. Thus, the impact of a property tax on the supply of improvements to land will vary according to type of property use, and in the framework of our model it is difficult to make a single overall estimate of the effect of a property tax on the supply of improvements. Within more narrowly defined categories of real estate, however, it should be possible to estimate the relevant revenue production functions and from these predict the effect of a property tax on the supply of improvements within each category.

An Example Using Ex Ante Data

One method of estimating a real estate revenue production function is to use the actual ex ante calculations made by a developer. By using architectural and engineering data to make estimates of the construction costs of several alternative quantities of rental space on a given site, and then using market research data to make estimates of the resulting alternative rental revenues, it should be possible to quantify the functional relationships that are implied by the schedules drawn in figure 5.1. Such data are unfortunately difficult to obtain and when available are necessarily specific to a particular project and site. This method does have the important advantage of concentrating directly on the decisions of individual entrepreneurs, however, and on the way property taxes enter into these decisions.

Partly as a matter of historical interest, the early research of Clark and Kingston (1930) on the economic (that is, profit-maximizing) height of skyscrapers provides an example of the way property taxes affect ex ante profitability calculations in the framework of our model. Clark (an economist) and Kingston (an architect) collaborated in an examination of the rate of return to capital invested in the construction of eight hypothetical sizes of office buildings on a one-block site in the Grand Central Terminal area of New York City in the late 1920s. Their investigation resulted in the design of "eight different buildings, varying in height from 8 to 75 stories, each designed as an effective architectural solution, under the assumed building height limitations, of the problem of developing a large site in the Grand Central Zone of New York City" (Clark and Kingston, 1930, p. 11). New York zoning regulations, construction

Table 5.1. Summary of Investment Cost, Gross and Net Income, and Return upon Investment (assuming land value at $200 per square foot) (in thousands of dollars)

	8-story building	15-story building	22-story building	30-story building	37-story building	50-story building	63-story building	75-story building
Investment								
Land (81,000 sq. ft. @ $200)	$16,200	$16,200	$16,200	$16,200	$16,200	$16,200	$16,200	$16,200
Building	4,769	7,307	9,310	11,775	13,808	16,537	19,390	22,558
Carrying charges:								
Interest during construction								
Land (6% on cost for full period)	810	972	1,134	1,296	1,458	1,620	1,780	1,944
Building (6% on cost for half period)	119	219	326	471	622	826	1,065	1,353
Taxes during construction—land	292	350	408	466	524	584	642	700
Insurance during construction	3	5	8	12	21	35	65	95
Total carrying charges	1,224	1,546	1,876	2,245	2,625	3,065	3,552	4,092
Grand total cost	22,193	25,053	27,386	30,220	32,633	35,802	39,142	42,850
Total assignable to land	17,302	17,522	17,742	17,962	18,182	18,404	18,622	18,844
Total assignable to building	4,891	7,531	9,644	12,258	14,451	17,398	20,520	24,006
Income								
Gross income	1,819	2,780	3,483	4,181	4,755	5,581	6,302	6,901
Expenses:								
Operating	311	482	592	723	814	942	1,058	1,213
Taxes	479	541	591	653	705	774	846	926
Depreciation	95	146	186	235	276	331	388	451
Total expenses	885	1,169	1,369	1,611	1,795	2,047	2,292	2,590
Net income								
Gross of property taxes	1,413	2,152	2,705	3,223	3,665	4,308	4,856	5,237
Net of property taxes	934	1,611	2,114	2,570	2,960	3,534	4,010	4,311
Net return on total investment								
Gross of property taxes	6.37%	8.59%	9.88%	10.66%	11.23%	12.03%	12.41%	12.22%
Net of property taxes	4.22%	6.44%	7.73%	8.50%	9.07%	9.87%	10.25%	10.06%
Increase in investment from last addition of stories	—	2,860	2,333	2,834	2,413	3,169	3,340	3,708
Increase in net income resulting therefrom								
Gross of property taxes	—	739	553	518	442	643	548	381
Net of property taxes	—	677	503	456	390	574	476	301
Net return on increase in investment								
Gross of property taxes	—	25.84%	23.70%	18.27%	18.32%	20.29%	16.40%	10.27%
Net of property taxes	—	23.69%	21.51%	16.09%	16.16%	18.11%	14.25%	8.12%

Source: Reproduced with additions and corrections from Clark and Kingston (1930), by courtesy of the American Institute of Steel Construction, Inc.

and maintenance costs, rental levels, and tax rates of the period were assumed as the basic governing conditions. Then, using very detailed estimates of the cost and expected rental returns for each hypothetical building, they calculated the expected average and marginal rates of return on investment of each height. Although Clark and Kingston were not concerned with the effect of taxes on the economic height of buildings, their original data can be manipulated to show this effect. Table 5.1 is a presentation of the Clark and Kingston data, with modifications to show the effect of property taxes on the *MNRPK*, which is calculated both before and after deduction of property taxes (shown in the last two rows of the table). The assumed property tax rate, expressed as a percentage of the total cost of land and building, is the then-current 2.16 percent per annum.

The *MNRPK* declines for increments in size to fifteen-, twenty-two-, and thirty-story buildings, but increases for increments to thirty-seven and fifty stories before declining again thereafter. The increasing marginal returns between thirty and fifty stories in height are attributed by Clark and Kingston to the complicated set-back restrictions contained in the New York City zoning code which produced the familiar zoning-induced ziggurat structures of the period.[22]

From the data in table 5.1, the before-tax *MNRPK* is computed to be 16.40 percent per year at sixty-three stories and 10.27 percent per year at seventy-five stories.[23] Thus, if there were no property taxes and if the required rate of return on additional investment were 10 percent per year, the profit-maximizing height on this site would be approximately seventy-five stories. Given the then-existing 2.16 percent effective property tax rate, the after-tax *MNRPK* would decline to 8.1 percent at seventy-five stories and therefore the profit-maximizing height would also decline, but it would still be greater than sixty-three stories, at which

22. For lower floors of high-rise buildings, the zoning code required additional set-backs from the street line to compensate for increases in building height. Once the required set-backs had reduced the floor area of the building such that above a given level it covered not more than 25 percent of the area of the site, no further set-backs were required regardless of further increases in height. Above the thirty-seven-story height, the set-back regulations had little effect on floor areas and therefore no further zoning-induced tapering of the building with additional height was required (Clark and Kingston, 1930, pp. 13, 23). Many of the buildings built under this New York City code are convincing evidence of the maxim that "form follows money."

23. The *MNPRK* shown in the column for each height is actually the rate of return on investment in an increment from the height of the next lower design, rather than the rate of return on investment in a small further increment in height. Thus, if the *MNRPK* is declining as height increases, the actual *MNRPK* at each height is somewhat less than the marginal rate of return figure shown in the column for that height. This small discrepancy is not considered in our discussion.

height the after-tax *MNRPK* is 14.25 percent.[24] Since the before-tax *MNRPK* at sixty-three stories is 16.40 percent, if the after-tax required rate of return were 10 percent, it would take an effective property tax rate of 6.40 percent to reduce the profit-maximizing height from a no-tax seventy-five stories to the with-tax sixty-three stories; the corresponding reduction in total rentable space would be from 1,791,924 to 1,653,342 square feet, or 7.7 percent (Clark and Kingston, 1930, p. 40). Thus, if the cost and revenue data provided by Clark and Kingston are accurate, the effect of raising the property tax on this building from zero to 6.41 percent would have reduced the profit-maximizing quantity of rental space supplied on this site by only 7.7 percent, and rarely are effective property tax rates that high.[25]

The reason that even a relatively high property tax has a surprisingly small effect on building height in this particular case study is, of course, the rather sharp decline in *MNRPK* above a sixty-three-story building height. One of the most important technological factors explaining the declining *MNRPK* in high-rise construction is the increasing amount of space on lower floors that must be devoted to elevator shafts as building height increases, and this is illustrated by the Clark and Kingston data; in the eight-story design, elevators absorbed 1.9 percent of the gross floor area, while in the seventy-five-story building elevators absorbed 9.78 percent of gross floor area (Clark and Kingston, 1930, p. 66). In addition to the loss of rentable space to elevator shafts, there is also the direct monetary cost of installing and operating the elevators. Another important factor affecting the *MNRPK* schedule is the restriction on building size imposed by zoning; in this case, the zoning regulation which limited the area of the higher floors to 25 percent of the site area has an obvious influence in shifting the *MNRPK* schedule downward and thus in reducing economic height—an impact that in this particular case may be more important than that of property taxation. It should also be

24. Clark and Kingston themselves concluded that the optimum economic height was sixty-three stories on the basis that the "maximum economic return" (i.e., the highest *average* rate of return) occurred at this height (1930, p. 20). Despite calculating the marginal rate of return ("the increase in investment required to produce the last addition of stories"), they ignored it in favor of the average return on total investment criterion; the highest after-tax average rate of return on total investment is 10.25 percent for the sixty-three-story building. They chose this as the optimum height despite the fact that the net return on investment in twelve additional stories is 8.12 percent compared to their own assumed 6 percent interest cost.

25. As was mentioned above, if there is less than perfectly elastic demand for rental space, and/or less than perfectly elastic supply of capital and of construction services, this 7.7 percent figure is an overestimate of the reduction in the quantity of space supplied. The reduction in height also depends on the assumed after-property-tax required rate of return.

noted that the data in this example permit an estimate of the effect of property taxes only on the quantity of space provided on a site; there is no way to examine the possibly important effect of taxes on the harder to measure quality aspect of the improvements supplied.[26]

Of course the estimated impact of property taxes in the Clark and Kingston study is very much dependent on the assumed site, zoning regulations, building technology, and input and output prices of the time.[27] Other examples might well show much greater sensitivity of height to the tax rate. Because of the difficulty of obtaining other examples of ex ante estimates, we turn now to the study of revenue production functions estimated from cross-section analysis of ex post data.

An Example Using Ex Post Data

In the work of Clark and Kingston the relationship between building height and building cost was estimated from engineering data. In two recent studies Berger (1967, 1968) used cross-section data to estimate by ordinary least-squares regression equations the effect of building height on several building characteristics: building efficiency, construction cost per square foot of gross building area, and the length of the construction period. The data were obtained for twenty-seven post-World War II high-rise (eight or more stories) apartment buildings and thirty-six post-World War II high-rise office buildings in Los Angeles County. He then used these estimated relationships to provide the cost and revenue data necessary to determine the optimal height of a hypothetical high-rise office building. Berger assumed that in the construction decision the entrepreneur seeks to maximize the present value of profits over the life of the building and that optimum height thus occurs where the present discounted value of the annual net revenue from an additional story equals the construction cost of the additional story. The present discounted value of annual net revenue is equal to the present discounted value of the annual total revenue, minus total annual operating expenses, property taxes, and corporation income taxes, plus the present value of the land and building residual at the end of the economic life of the building. This formulation of the optimum height determination in terms of the present discounted value of net revenue has several advan-

26. Kingston did not, however, set out to design an early Seagram Building. "No money was to be wasted in needless ornamentation or in immoderate striving for grandeur or aesthetic effect but short of such extremes, the utmost endeavor was to be made to secure the maximum rental appeal . . ." (1930, p. 11).

27. The 1930 publication date of Clark and Kingston's research indicates that any entrepreneur who had actually relied on the ex ante data was in for a very big surprise.

tages over the Clark and Kingston method: (1) when there is a corporation income tax, the effect of depreciation on after-tax income can be taken into account; and (2) the effect of assuming a finite lifetime for the building can be shown.

With an assumed 15,410 square foot average floor area (the mean for post-World War II Los Angeles high-rise office buildings) and with an assumed annual rental value of $5.81 and operating cost of $2.04 per square foot of net rentable space (the means for the sample of high-rise office buildings), Berger calculated the initial construction cost and the annual revenues and costs for buildings of height varying between eight and thirty-two stories (Berger, 1968, pp. 262-64). Depreciation was calculated by the sum-of-the-years' digits method, with an expected usable building life of forty-five years. A corporation income tax rate of 50 percent and a property tax rate of 2 percent (approximately equal to the 1964 Los Angeles tax rate) were assumed, and the net cash flow (annual net revenue) for the life of the building was discounted to the date of construction with an interest rate of 4.15 percent, which was the 1964 average yield on U.S. government bonds. Berger did not intend to show the effect of property taxation on the optimal height of high-rise buildings, but his data can be extended to show this effect. Table 5.2 is an adaptation of Berger's original data.[28] This table displays the construction cost for each building height (in column 2), and the present discounted value of net cash flow, both without (in column 3) and with (in column 4) the 2 percent property tax. In column 5 is shown, for each height, the increase in construction cost (marginal investment) from the next lower height, and in columns 6 and 7 are shown the increase in the present discounted value of net cash flow (marginal net cash flow) from the next lower height, both without and with the 2 percent property tax. Marginal investment increases with building height because both construction cost per square foot of gross building area and the length of the construction period increase with height. Marginal net cash flow declines as building height increases because building efficiency declines with height. Finally, in columns 8 and 9 are shown the differences between the present discounted value of the net cash flow and the construction cost, both without and with the property tax; it is this difference that the entrepreneur is assumed to maximize. In columns 8 and 9 it can be seen that the optimal height in the absence of the property tax is thirteen stories, and that when the 2 percent annual property tax is introduced the optimal height falls to eleven stories. This corresponds to a reduction

28. I am grateful to Jay Berger for permission to use his data, and for his generous advice in making additional computations. For details of the calculations see Berger (1967, 1968).

Table 5.2. Investment Characteristics of Hypothetical High-Rise Office Buildings of Varying Height: The Effect of a 2 Percent Property Tax on Building Value

Height in stories (1)	Total investment (2)	Total net cash flow (no tax) (3)	Total net cash flow (2% tax) (4)	Marginal investment (5)	Marginal net cash flow (no tax) (6)	Marginal net cash flow (2% tax) (7)	Net present value (no tax) (8)[a]	Net present value (2% tax) (9)[b]
8	$3,641,460	$4,144,758	$3,875,755	$ —	$ —	$ —	$503,298	$234,295
9	4,070,415	4,655,199	4,345,400	428,955	510,441	469,645	584,784	274,985
10	4,516,599	5,164,505	4,812,277	446,184	509,306	466,877	647,906	295,678
11	4,979,810	5,672,533	5,276,246	463,211	508,028	463,969	692,723	296,436
12	5,460,198	6,179,334	5,737,358	480,388	506,801	461,112	719,136	277,160
13	5,957,993	6,685,017	6,195,698	497,795	505,683	458,340	727,024	237,705
14	6,472,286	7,189,392	6,651,161	514,293	504,375	455,463	717,106	178,875
15	7,003,954	7,692,627	7,103,830	531,668	503,235	452,669	688,673	99,876
16	7,552,834	8,194,639	7,553,640	548,880	502,012	449,810	641,805	806
17	8,118,554	8,695,357	8,000,599	565,720	500,718	446,959	576,803	—117,995

Source: Reproduced with additions from Berger (1968, p. 36).
[a] Equal to column 3 minus column 2.
[b] Equal to column 4 minus column 2.

of net rentable space from 155,095 square feet to 132,828 square feet, a reduction of 14 percent.

This 14 percent reduction in rentable space in response to a 2 percent property tax is, as mentioned in the second section of this chapter, a maximum estimate which depends on specific assumptions concerning the incidence of the property tax. These assumptions were that the demand for rentable space is perfectly price elastic, that the supply of capital funds is perfectly interest elastic, and that the supply of construction services is perfectly price elastic. Other more plausible and conventional shifting assumptions would reduce the estimated impact of the tax on the supply of rentable space.

The estimate of the impact of property taxes also depends on the assumption that investors in their construction decision employ marginal analysis to determine the profit-maximizing outlay on building construction. In interviews with a sample of twenty-eight investors in high-rise buildings in Los Angeles County, Berger did not find evidence that investors explicitly utilized marginal analysis of the sort that underlies the model of optimal investment in construction, at least as far as the decision on height is concerned (Berger, 1967, pp. 156-64). A major reason is that the information and information processing requirements for accurate estimation of the revenue production function greatly exceed the typical real estate investor's capabilities. Thus, the true impact of taxes on Berger's sample of buildings may well be quite different from what the model predicts.[29] This finding concerning the limited applicability of marginal analysis in practice may provide some support for Gaffney's statement that "wealth effects [of changing from a general property tax to a land tax] are at least as important as the marginal trade-off effects" (1937a, p. 82). It is difficult, however, to make estimates of the response to property taxes when profit-maximizing behavior is not assumed. Within the framework of a profit-maximization model, Berger's data do have advantages over the Clark and Kingston data since the effects of both the corporation income tax and depreciation allowances are included. The major limitations of both sets of data are the assumption of constant rental values per square foot for the life of the building (investors may expect increasing rent) and the assumption that the investment is financed entirely with equity funds, with no mortgage debt. These assumptions represent further qualifications to the empirical results in both examples.

29. Although the net present value of the building is maximized at a height of thirteen stories without a property tax, and at a height of eleven stories with a 2 percent property tax, the net present value of several alternative heights is also very close to the maximum in each case. Since a failure to choose exactly the correct profit-maximizing height may not greatly reduce profits, Darwinian "survival of the maximizers" may not weed out entrepreneurs who fail to select the exact optimum height. Thus, a model that assumes perfect profit maximization may not accurately predict the height that a "satisficing" entrepreneur will choose or the effect of a property tax on that choice. Furthermore, in any field of investment where the product is so heterogeneous and where major decisions by any one developer are relatively infrequent, economic "natural selection" may fail to eliminate non-maximizing entrepreneurs (Winter, 1964).

Conclusion

It is tempting to draw conclusions from these two case studies about the impact that a change from general property taxation to site value taxation would have on land development decisions. A surprising finding was that a complete elimination of taxes on improvements would have, at most, resulted in an 8 percent larger building in the first case and a 17 percent larger building in the second. But the temptation to make any general statement from this finding should be resisted, for the cases are very limited approximations to reality. Both cases referred only to the effect of property taxes on the supply by profit-maximizing entrepreneurs of office space in high-rise buildings. Even if the estimates are accurate for the type of use assumed, the effect of a tax base change on the supply of office space in other locations might be quite different, and the effect on the supply of other types of land uses, such as residential or industrial uses, might be even more different.[30] Thus any general statement about the magnitude of the effects that would accompany a change of property tax base from improvement value to land value is also subject to qualification regarding the mix of affected land uses. One way to obtain a better idea of the impact of such a tax change on various land uses might be to conduct more studies with a micro-data basis, perhaps working more closely with land developers to see how capital-intensive decisions are made in practice and how taxes enter into these decisions.

Appendix

It can be shown that a property tax rate has the same effect on incentives regardless of whether it is applied to total market value of improved property (land value plus building value) or to the value of the

30. Richard Pollock and I (1977) estimated a revenue production function, using data on capital input, land input, and annual revenue collected for a sample of twenty-eight hotels recently built in Honolulu. The results indicate that the *MNRPK* schedule estimated from this sample is quite elastic and that the optimal investment in hotel construction, if based on marginal analysis, appears quite sensitive to the tax rate and interest rate, much more so than in the two case studies reported here.

building alone. Let: $R = R(K,\bar{L})$ = annual net revenue after operating and maintenance expenditures; T_p = property tax on market value of improved property (land and building); t_p = property tax rate on market value of improved property (land and building); and $R_n = R(K,\bar{L}) - T_p$ = annual net revenues after property taxes.

The market value of improved property is the capitalized value of after-tax annual net revenues. For a constant stream of revenue and a constant interest rate, this is R_n/i. Hence,

$$T_p = t_p\left(\frac{R_n}{i}\right) \quad \text{and} \quad R_n = R(K,\bar{L}) - t_p\left(\frac{R_n}{i}\right).$$

The after-tax $MNRPK = \frac{\partial R_n}{\partial K} = \frac{\partial R}{\partial K} - \left(\frac{t_p}{i}\right)\left(\frac{\partial R_n}{\partial K}\right)$. Therefore,

$$\left(1 + \frac{t_p}{i}\right)\left(\frac{\partial R_n}{\partial K}\right) = \frac{\partial R}{\partial K}, \text{ and } \frac{\partial R_n}{\partial K} = \frac{\frac{\partial R_n}{\partial K}}{1 + \frac{t_p}{i}} = \left(\frac{i}{i + t_p}\right)\left(\frac{\partial R}{\partial K}\right).$$

The profit-maximizing capital investment in construction occurs where the after-tax $MNRPK$ is equal to the interest rate, $\partial R_n/\partial K = i$. Therefore,

$$\left(\frac{i}{i + t_p}\right)\left(\frac{\partial R}{\partial K}\right) = i \quad \text{and} \quad \frac{\partial R}{\partial K} = i + t_p.$$

Thus, in the presence of a general property tax on land and building value, the profit-maximizing investment in construction occurs where the before-tax $MNRPK$ is equal to the interest rate plus the tax rate. This is the same result that was found in the presence of the tax rate applied to building value alone. This result seems reasonable, since the general property tax is, conceptually, two separate taxes: a tax on land value and a tax on building value. If the land value component of the general property tax has no effect on incentives, the total effect on incentives of the general property tax is the same as that of a tax of the same rate on building value alone. Of course, the same tax rate on the two different bases would not produce the same tax yield. If a tax on building value alone is to raise the same revenue as a general property tax, the tax rate on building value alone would have to be higher than the equal-yield general property tax rate.

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6

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Toronto Metropolitan Finance: Selected Objectives and Results

Introduction

Both the academic and popular literature have expressed considerable interest in topics relevant to analyzing the advantages and disadvantages of political fragmentation and various forms of consolidation in metropolitan areas. The most recent academic literature has attempted to illuminate such questions as the potential trade-off between jointness and distributional efficiency and whether redistribution is a local public good. The popular contributions, on the other hand, examine major metropolitan reorganizations in both Canada and the United States, evaluating them primarily in administrative and political terms and making superficial, if any, economic assessments on the basis of limited evidence.

These recent academic and popular approaches leave out a major potential contribution of economic analysis to the evaluation of the economic impact of alternative types of organization. This has happened, in part, because the academic literature has been normative in nature while the popular literature has tended to deify any form of rationalization of public service provision in metropolitan areas. This is to some

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