The Property Tax As a Tax on Durability

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sation for education, experience, and marital status that is labour-market oriented. However, even for males and females who are likely to have similar work histories (single, forty-five years old) most of the earnings gap remains. In addition, even if much of their education, experience, and marital status is not conducive to comparable returns in the labour market, this may simply reflect discrimination in the educational institutions and household.

The earnings equations also indicate other interesting results. Bilingualism does not appear to be rewarded in the labour market, and those who speak French only earn considerably less than those who speak English only, even after controlling for the influence of other wage-determining characteristics. In addition, workers in the government sector tend to earn more than workers in other sectors, the advantage being about 10 per cent for females and 6 per cent for males.

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The property tax as a tax on durability

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To date the property tax has typically been analysed as a tax on flow variables. In the classical model the property tax on housing is decomposed into a tax on the rent from structures and another on the rent from land.[1] In the revisionist model the property tax is treated as falling on the income from capital in those

Young's work on the paper was carried out while he was on the staff of the Ontario Economic Council. We would like to thank John Bossons for very helpful comments. The responsibility for remaining errors rests solely with us.

1 The best-known modern work associated with the classical view is Netzer (1965). The view has a long tradition, having been expounded by Marshall (1902), Pierson (1902), and Simon (1959), among others. In its naïve form the classical analysis assumes that land is in inelastic supply, so that the portion of the tax falling on land is borne by the landlord, and that structures are perfectly elastic in supply, so that the portion of the tax falling on structures is shifted fully forward to tenants.

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sectors subject to the tax.[2] But the property tax is in fact a tax on a stock variable, property value.

This note explores an implication of treating the property tax as a value tax, that it encourages the construction of less durable housing. We consider first the case where the property tax is imposed in isolation and subsequently the case where it is imposed in conjunction with other taxes that affect housing decisions.

THE PROPERTY TAX IN ISOLATION

Let $r(t)$ be the rent per unit of housing of age t, net of (profit-maximizing) maintenance and operating costs, for a structure of given initial quality. We assume that $r(t)$ belongs to the class of functions $r(t) = re^{-\delta t}$, where $r = r(0)$, in which case δ is an index of durability, larger δ indicating less durability. The producer's durability decision reduces to the choice of the profit-maximizing δ. Durability, so defined, reflects obsolescence, depreciation, the maintenance technology, and the future state of the housing market.[3] For the moment (in the next section the assumption is relaxed) we assume a zero rate of inflation.

Let $C(\delta)$ be the cost of constructing a unit of housing of durability δ, π be the discounted present value (DPV) of profits, i be the interest rate (perfect capital markets are assumed), p be the property tax rate, and $V(t)$ be the market value of a housing unit of age t. We assume that r, while parametric to the producer, adjusts in the market so that efficient producers make zero profits.[4] Among housing units of the same initial quality, more durable housing is more expensive to construct: $C'(\delta) < 0$. It is assumed additionally that the cost of increasing durability an incremental amount increases with durability: $C''(\delta) > 0$.

2 This view is generally attributed to Mieszkowski (1972), although it has antecedents, for instance Richman (1967) and Orr (1968). Subsequent discussion of the new view is contained in Peterson (1973) and Aaron (1975). The classical and revisionist views differ more in their treatment of the incidence of the average property tax rate than on interjurisdictional differences in tax rates. In the simplest version of the revisionist view the property tax is treated as a tax on capital services, which are assumed to be inelastic in supply, so that the tax falls on the owners of capital.

3 This formulation treats implicitly rather than explicitly the producer's decisions concerning the height and floor-area ratio of his building, as well as the amount, type, and quality of materials to be used in its construction. Also treated implicitly is the profit-maximizing time path of maintenance and operating expenditures. The explicit treatment of all these matters would not qualitatively affect our central result, though one would have to be careful to define durability appropriately.

4 Another possible equilibrating mechanism is that the costs of constructing housing may depend on the volume of new construction. We are assuming here, and this is supported by Muth's empirical results (1973), that construction costs are insensitive to the volume of new construction.

The builder chooses δ so as to maximize the DPV of rents, less construction costs and the DPV of future property tax payments:

$$\max_{\delta} \pi = r \int_0^{\infty} e^{-(i+\delta)t} dt - C(\delta) - p \int_0^{\infty} V(t) e^{-it} dt. \tag{1}$$

The value of housing must change in such a way that the instantaneous rate of return from owning the property equals i, that is,

$$iV = \dot{V} + re^{-\delta t} - pV, \tag{2}$$

which, under the usual assumptions, implies[5] that

$$V(t) = re^{-\delta t}/(i + p + \delta). \tag{3}$$

Substituting (3) into (1) gives

$$\pi = r/(i + p + \delta) - C(\delta). \tag{4}$$

The first-order condition of the builder's maximization problem is that marginal revenue equal marginal cost:

$$d\pi/d\delta = -r/(i + p + \delta)^2 - C'(\delta) = 0, \tag{5}$$

while the second-order condition for an interior maximum, which is assumed to hold, is that the cost function C be such that

$$d^2\pi/d\delta^2 = 2r/(i + p + \delta)^3 - C''(\delta) < 0. \tag{6}$$

The equilibrium rent r and the profit-maximizing durability δ may be viewed as functions of the property tax rate p. Total differentiation of (5) with respect to p yields

$$\left(\frac{-1}{(i + p + \delta)^2}\right)\frac{dr}{dp} + \frac{2r}{(i + p + \delta)^3} + \left(\frac{2r}{(i + p + \delta)^3} - C''(\delta)\right)\frac{d\delta}{dp} = 0, \tag{7}$$

while total differentiation of the zero-profit condition (see equation 4) with respect to p gives

$$\left(\frac{1}{i + p + \delta}\right)\frac{dr}{dp} - \frac{r}{(i + p + \delta)^2} - \left(\frac{r}{(i + p + \delta)^2} + C'(\delta)\right)\frac{d\delta}{dp} = 0. \tag{8}$$

Substituting (5) into (8) results in

$$dr/dp = r/(i + p + \delta), \tag{9}$$

5 We are assuming that the market value of the housing unit equals the discounted present value of future rents less future property tax liabilities. The standard competitive assumptions imply (2), which is a linear differential equation. Equation (3) gives the solution to (2), where to obtain the constant of integration rational expectations and zero transactions costs are assumed.

which, substituted into (7), implies

$$\frac{d\delta}{dp} = \frac{r}{(i + p + \delta)^3} \div \left(C''(\delta) - \frac{2r}{(i + p + \delta)^3}\right). \tag{10}$$

Finally, with an interior maximum (6) applies, so that $d\delta/dp > 0$. Thus an increase in the property tax rate causes the producer to choose a more rapidly declining rental stream or, in our terminology, to construct less durable housing.

The intuitive interpretation of this result is as follows. In his construction decision the builder considers the tax liability per dollar of rent. Since the tax is proportional to value, he can reduce his tax liability per dollar of rent by lowering the value/rent ratio. And, from (3),

$$d\left(\frac{V(t)}{re^{-\delta t}}\right) \bigg/ d\delta = -\frac{1}{(i + p + \delta)^2} < 0, \tag{11}$$

so that the builder can lower the value/rent ratio at each point in time by constructing less durable housing.

Since the tax liability per dollar of rent cannot be reduced by altering durability when a rent tax rather than a value tax is imposed, the above argument suggests that a rent tax does not affect the durability decision. This is demonstrated in the appendix.

Two remarks are in order. First, the above model was interpreted as applying to housing. However it applies equally well to any durable good. The essential point is that a value tax distorts intertemporal choice, encouraging the construction of less durable products, while a rent tax has no effect on the durability decision. Second, one way the producer can increase δ is to lower maintenance expenditures. The argument here therefore supports the contention that the use of the property tax accelerates the creation of slums.[6]

COMPLICATIONS INTRODUCED BY OTHER TAXES

In this section we consider whether other taxes that affect housing decisions exacerbate or offset the distortionary effects of the property tax.

We shall restrict our analysis to the Canadian tax system, which has the following features. Owner-occupiers are allowed no housing-related deductions (neither depreciation, nor property tax or mortgage interest payments, nor maintenance expenditures) in computing taxable income for income tax purposes. And the implicit rental income from owning housing is not included

6 Another aspect of the property tax encourages abandonment. In most North American cities property value assessment is performed infrequently. As a result, in the short run the property tax resembles a sizeable fixed cost, and if this fixed cost plus other fixed liabilities exceed rental revenue the landlord has an incentive to abandon the property. However, if property value assessment were performed frequently, the landlord could lower his property tax payments by running down his property.

in the income tax base. Also, no capital gains tax is applied to the sale of an owner-occupied residence. Lessors' net income from housing is included in the income tax base, where net income is defined as rental revenue less allowable depreciation, property tax and mortgage interest payments, and maintenance expenditures. Allowable depreciation is typically more liberal than true economic depreciation. Determination of the tax payable upon disposition of the property is rather complex.[7]

To simplify the analysis we assume that whoever owns the house paid for it outright and owns it forever, and we define τ to be the marginal income tax rate of the property owner. More seriously, we assume also that the pre-tax rate of return is unaffected by any of the tax changes analysed.

We first consider owner-occupied housing. We interpret r to be the *imputed* rental income net of maintenance costs from the housing unit at $t = 0$. At $t = 0$ a prospective homeowner is willing to pay an amount $Z(\delta)$, equal to the DPV of imputed rental income less the DPV of property tax liabilities, for a housing unit of durability δ; i.e.

$$Z(\delta) = r\int_0^\infty e^{-(i(1-\tau)+\delta)t}dt - p\int_0^\infty V(t)e^{-i(1-\tau)t}dt. \tag{12}$$

His discount rate is $i(1 - \tau)$, his after-tax rate of return on assets. The builder maximizes $Z(\delta) - C(\delta)$ with respect to δ. Proceeding as in the previous section, we obtain

$$V(t) = re^{-\delta t}/[i(1 - \tau) + \delta + p]. \tag{13}$$

Using (13) and the result that r adjusts so that builders make zero profits gives

$$\frac{d\delta}{d(p - i\tau)} = \frac{r}{(i(1-\tau) + p + \delta)^3} \bigg/ \left(C''(\delta) - \frac{2r}{(i(1-\tau) + p + \delta)^3}\right) > 0. \tag{14}$$

Hence an increase in the property tax rate decreases the durability of housing, while an increase in the income tax rate has the opposite effect. The latter result obtains since an increase in the income tax rate decreases the discount

7 There are three cases. When sales price is less than undepreciated capital cost, undepreciated capital cost less sales price is deducted from income for tax purposes (terminal loss provision). When sales price is greater than undepreciated capital cost and less than purchase price, sales price less undepreciated capital cost is included in income (recapture provision). When sales price exceeds purchase price, purchase price less undepreciated capital cost (recapture provision) plus one-half of sales price less purchase price (capital gains provision) are included in income.

The US tax system accords more favourable treatment to home ownership than does the Canadian. The US homeowner does not include imputed rental income in computing taxable income for federal income tax purposes and may deduct property tax and mortgage interest payments. His realized capital gains are taxable, but they are subject to rollover provisions and are fully exempt if the property is held until death, a fact which renders the effective rate low. The tax treatment of lessors in the US is like that in Canada.

rate, which by causing future rental revenue to be weighted more heavily increases optimal durability. The tax system as a whole encourages the construction of less durable housing if $p > i\tau$ and more durable housing if $p < i\tau$.

Canadian tax law requires lessors to compute depreciation (capital cost allowance) using the declining balance method. Allowable depreciation equals a fixed proportion ψ of undepreciated capital cost, the book value of the property. Thus the deductibility of depreciation reduces the tax payable in year t by $\psi\tau Ce^{-\psi t}$, where τ is the marginal tax rate faced by the landlord. Note that allowable depreciation as a proportion of construction cost is independent of δ. For the moment we ignore the taxation of capital gains. Then, where i is the pre-tax discount rate of the landlord, which is again assumed to be invariant to tax changes analysed, the builder/landlord's problem is to maximize

$$\pi = (1-\tau)r\int_0^\infty e^{-(i(1-\tau)+\delta)t}dt + \psi\tau C(\delta)\int_0^\infty e^{-(i(1-\tau)+\psi)t}dt - p(1-\tau)\int_0^\infty Ve^{-i(1-\tau)t}dt - C(\delta). \quad (15)$$

The first term is the DPV of rental revenue net of maintenance expenditures and income tax; the second term is the DPV of the depreciation allowance, higher ψ corresponding to more liberal treatment; and the third term is the DPV of property tax payments net of the reduction in income tax payable as a result of the deductibility of property tax payments. Then,

$$V(t) = \frac{(1-\tau)re^{-\delta t}}{(i+p)(1-\tau)+\delta} + \frac{\psi\tau C(\delta)e^{-\psi t}}{(i+p)(1-\tau)+\psi}. \quad (16)$$

Thus the zero profit condition is

$$\pi = V(0) - C(\delta) = \frac{(1-\tau)r}{(i+p)(1-\tau)+\delta} - \frac{C(\delta)(i+p+\psi)(1-\tau)}{(i+p)(1-\tau)+\psi} = 0, \quad (17)$$

and the profit-maximization condition is

$$\frac{d\pi}{d\delta} = \frac{-(1-\tau)r}{[(i+p)(1-\tau)+\delta]^2} - \frac{C'(\delta)(i+p+\psi)(1-\tau)}{(i+p)(1-\tau)+\psi} = 0. \quad (18)$$

Equations (17) and (18) together imply that

$$[(i+p)(1-\tau)+\delta]\,C'(\delta) + C(\delta) = 0, \quad (19)$$

from which it follows that $d\delta/d\psi = 0$. The liberality of the depreciation allowance has no effect on durability, since the discounted value of the allowance to the landlord per dollar of construction expenditure is independent of δ. From (19) it follows that here too the property tax discourages durability, while the income tax encourages it. Also the tax system as a whole discourages durability if $p > i\tau/(1-\tau)$ and encourages it when the inequality is reversed. Note that these qualitative results generalize to any depreciation formula or form of investment tax credit, as long as the depreciation deduction is dependent only on initial construction cost and not on the durability chosen.

The inflation rate n affects durability as a result of the taxation of nominal rather than real interest income.[8] If the real interest rate is unaffected by inflation, then the real after-tax rate of return falls from $i(1-\tau)$ to $(i+n)(1-\tau)-n$.[9] In this case an increase in the inflation rate has the same qualitative effect as an increase in the income tax rate and hence encourages durability. It remains true with inflation that the property tax discourages durability.

The effects of the taxation of lessors' capital gains on a realization basis are difficult to treat in this model, since with perfect capital markets the lessor has an incentive to dispose of the property as far into the future as possible. This reduces the present value of capital gains taxes and involves no cost since he can borrow against the appreciated value of the property and is permitted interest deductibility on loan payments. However, a crude analysis is possible if we treat capital gains as being taxed on an accrual basis. Where ϕ is the effective rate of taxation on accrued capital gains and with zero inflation, (15) is modified by the addition of the term

$$-\phi \int_0^\infty \dot{V}e^{-i(1-\tau)}dt.$$

The equation analogous to (19) is

$$[(i+p)(1-\tau)+\delta(1-\phi)]C'(\delta)+C(\delta)=0, \tag{20}$$

from which it can be shown that sgn $d\delta/d\phi = -$sgn δ. If optimal durability is such that rents should increase (decrease) over time, capital gains taxation reduces (increases) durability.

Inflation clearly influences the effects of capital gains taxation. Letting n be the inflation rate, the builder/landlord's maximization problem, where V is denoted in nominal terms while i and δ are real values, is

$$\begin{aligned}\max_{\delta} \pi = {} & (1-\tau)r \int_0^\infty e^{-[(i+n)(1-\tau)-n+\delta]t}dt - C(\delta) \\ & + \psi\tau C(\delta) \int_0^\infty e^{-[(i+n)(1-\tau)+\psi]t}dt - p(1-\tau) \\ & \times \int_0^\infty Ve^{-(i+n)(1-\tau)t}dt - \phi \int_0^\infty \dot{V}e^{-(i+n)(1-\tau)t}dt. \qquad (21)\end{aligned}$$

8 The inflation rate also affects the value of the depreciation allowance, but this effect does not influence the durability decision.

9 The expression for the real after-tax rate of return is an approximation.

Solving, we find that the equation analogous to (20) is

$$[(i + n + p)(1 - \tau) + (1 - \phi)(\delta - n)]C'(\delta) + C(\delta) = 0, \tag{22}$$

so that sgn $d\delta/dn = -\text{sgn}\ (\tau - \phi)$. Also, the tax system encourages the construction of more (less) durable housing as $p(1 - \tau) - i\tau + n(\phi - \tau) - \phi\delta <$ $(>)\ 0$. These results concerning the effects of inflation are crucially dependent on the assumption that inflation does not affect the real pre-tax rate of return.

In sum, we have shown that other tax provisions offset the property tax's discouragement of the durability of owner-occupied housing and, given realistic parameter values, probably have the same effect for rental housing. The effect of the over-all tax system on durability is ambiguous for both tenure types.[10]

CONCLUDING COMMENTS

This note has focused on one of the effects of the property tax arising from its being a tax on value. The existing literature, which treats the property tax as a tax on flow variables, has ignored these effects or treated them clumsily. We modelled the housing producer's decision concerning the durability of housing and showed that the higher the property tax rate ceteris paribus the lower the durability of housing. The effects of this on the quality of urban areas are obvious and important.

The analysis clearly generalizes to other capital goods and provides a theoretical basis for treating one of the intertemporal distortions caused by a value tax, that associated with the producer's durability decision.

There are a number of interesting extensions to this note. First, it would be useful, though not easy, to extend the analysis to general equilibrium. This would permit investigation of the distributional effects of and the excess burden associated with alternative tax treatments of housing. Second, the model of the paper could be enriched to ascertain the effects of the tax system

10 It is well-known (Samuelson, 1964) that a tax system which taxes the rental income from a capital good at the same rate as income from other sources, which allows true economic depreciation, and in which there is no tax on asset value is neutral in the sense that it affects neither the market rent nor the market value of the asset. With this tax system the builder's problem would be to maximize

$$\pi = (1 - \tau)r \int_0^\infty e^{-(i(1-\tau)+\delta)t}dt - \tau \int_0^\infty \dot{V}e^{-i(1-\tau)t}dt - C(\delta).$$

The solution gives $r(t) = (i + \delta)C(\delta)e^{-\delta t}$ and $V(t) = C(\delta)e^{-\delta t}$, which are the same as in the no-tax situation. This tax system is neutral with respect to durability as well.

An earlier version of this note also considered the US tax system. We shall summarize the results here. The tax treatment of rental housing in the United States is essentially the same as that in Canada. Ignoring the US capital gains tax on owner-occupied housing (see n. 7 for a justification of this assumption), it can be shown that, for US owner occupied housing,

$$V(t) = re^{-\delta t}/[i(1 - 2\tau) + \delta + p(1 - \tau)].$$

Thus, the US tax system encourages the construction of less (more) durable owner-occupied housing as $p > (<)\ 2\tau i/(1 - \tau)$.

on tenure choice.[11] And third, consideration should be given to market imperfections that might, on second-best grounds, justify certain features of the current tax treatment of housing that appear distortionary in a first-best analysis.[12]

APPENDIX: PROOF THAT A RENT TAX DOES NOT AFFECT THE DURABILITY DECISION

Where ρ is the tax rate on rent, the builder's problem is to maximize

$$\pi = (1 - \rho)r \int_0^\infty e^{-(i+\delta)t}dt - C(\delta)$$

$$= \frac{(1 - \rho)r}{i + \delta} - C(\delta). \tag{23}$$

The profit-maximization condition is

$$d\pi/d\delta = -(1 - \rho)r/(i + \delta)^2 - C'(\delta) = 0. \tag{24}$$

Comparison of the zero profit and profit-maximization conditions gives

$$-(i + \delta)C'(\delta) = C(\delta), \tag{25}$$

from which it follows that $d\delta/d\rho = 0$.

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11 Using the model in this paper it is possible to treat in a naïve way the effect of the tax system on tenure choice. We say that the tax system favours rental housing relative to owner-occupied housing if, for a given rental stream, the value of rental housing is higher. Put alternatively, the tax system favours a tenure mode if, for every δ, the value/rent ratio is higher for that mode. A satisfactory treatment of tenure choice, however, requires explicit modelling of the consumer's tenure choice decision, taking into account transactions costs, imperfect capital markets, the risk associated with uncertain capital gains, and so on.

12 For instance it is by now well known that imperfect information may cause capital markets to be inefficient, in which case the favoured tax treatment accorded owner-occupied housing may be desirable.

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Pigovian taxes, polluter subsidies, regulation, and the size of a polluting industry

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A CONFLICT OF VIEWS

In the last few years two apparently conflicting views have been expressed concerning the efficiency of resource allocation under a Pigovian tax to control pollution, when account is taken of the long-run entry of firms to, and exit of firms from, a competitive polluting industry. Baumol and Oates (1975, chaps. 4 and 12) argue that if a Pigovian tax is set equal to the level of marginal damage (external cost) at the Pareto-optimal level of pollution the industry will move towards its optimal pollution level. They contrast this achievement with the higher level of pollution which the industry would generate under a polluter subsidy whose payment is contingent upon participation in the polluting activity. The clear implication of the Baumol and Oates analysis is that the Pigovian tax will induce Pareto-optimal exit and entry decisions by all competitive firms, whereas the subsidy will cause excessive entry (ibid., 179, n. 16).

Rose-Ackerman (1973, 514) on the other hand has suggested that a Pigovian tax may induce firms to leave the industry when the damage they cause does not justify this action. The implication here is that the tax leads to an inefficiently small industry. Similarly, Gould (1977, 560) says that a corrective tax based on marginal damage may, by overtaxing the polluter, drive the firm out of business, to the detriment of social efficiency.

At first it hardly seems likely that both views are correct, but this paper will attempt to show that either view may be correct, depending on the nature of the damage cost curves of the individual polluters. An important implication of the analysis is that it is incorrect to use the Pigovian tax as a general 'standard of optimality' against which to measure polluter subsidies and other pollution control instruments.[1] As we shall see, the tax need not lead to a

I am indebted to Robert Sugden for a tenacious defence of Pigovian taxes, which helped to define the limits of the main point of this paper, and to the two referees for constructive comments.

1 Baumol and Oates (1975) 179, n. 15) use the tax as such a standard without specifying the conditions under which it may be so used.

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