

**Taxing Land is Better than Neutral:
Land Taxes, Land Speculation
and the Timing of Development**

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Abstract

“Taxing Land is Better than Neutral: Land Taxes, Land Speculation and the Timing of Development”

There is widespread belief among economists that an ad valorem tax on land can generate economic distortions by changing the profit-maximizing time of land development. When markets are perfect, this argument is erroneous. Those who have argued that there are distortions have made mathematical errors. A correct argument is intricate, and involves definitions and distinctions in notation that have not generally been observed. One important insight that emerges from the analysis is that “the rent of land” should be defined not as the net income from optimal development, but rather as the opportunity cost of leaving unimproved land unused. When markets are imperfect, an ad valorem tax on land can change the profit-maximizing time of development. These changes can either improve or worsen economic efficiency. However, since they tend to mitigate market imperfections, the changes in land development induced by an ad valorem tax on land probably improve economic efficiency overall.

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Taxing Land is Better than Neutral: Land Taxes, Land Speculation and the Timing of Development

I. Introduction

Several writers have argued that an ad valorem tax on land can generate economic distortions by altering the profit-maximizing time of land development (Shoup [24], Skouras [26], Bentick [1]). These arguments are erroneous, but they have been widely cited (Douglas [7], Ellson [8], Fischel [10], Mathis [15], Mills [17], Noguchi [19], Pilai [21], Prest [22], Turnbull [30], Wildasin [31]). Some of the erroneous arguments analyze a tax that is levied only on undeveloped land. Others unwittingly analyze a tax that varies with how land is developed. It is not at all surprising that such taxes should alter the timing of development.

If a tax does not vary with how land is used then does not alter the timing of development when markets are perfect, because the tax subtracts a fixed amount from receipts at each point in time, so that whatever actions maximize the present value of returns before the tax continue to maximize the present value of returns after the tax (Davenport [6]). However, so many mistakes have been made in analyzing taxes on the value of land, and some of these mistakes have been copied by so many times by other writers, that it is worth identifying precisely the errors in the most prominent works in this tradition. To provide a foundation for the identification of these errors, this paper begins with a rigorous derivation of the mathematics of land development.

One of the insights that emerges from this derivation is that in a dynamic setting, “the rent of land” should not be defined as the net return to the use of land after payments to other factors, because then “the rent of land” would vary in an arbitrary way with the timing of development. Rather, “the rent of land” should be defined as the opportunity cost of leaving unimproved land unused.

While a tax on land is neutral when markets are perfect, it is generally better than neutral when markets have customary imperfections. In particular, if there are unarbitrated disparate beliefs about the optimal future use of land because of the lack of a futures market in land rent, then a tax on land helps prevent a winner’s curse from generating an artificial scarcity of land for current use. And if there is dispersion in discount rates because of capital market imperfections, a tax on land helps to put land into the hands of persons with high

discount rates, whose investments are generally more productive than those of the persons with low discount rates who would otherwise have the land.

But first to neutrality under perfect markets, and the errors that have been made in analyzing taxes on land.

II. The Mathematics of Rent, Land Development, and Land Taxation

Define the following symbols:

i, t = time

H = planning horizon

T = time of development

T^* = profit-maximizing time of development for a site

r = interest rate

a = ad valorem tax rate

$N(i, t)$ = net return for a site per year before taxes at time i , assuming that the site is developed in the way that is optimal if it is unimproved at the prior time t

$R(t)$ = rent of a site at time t , that is, the opportunity cost of leaving the site unused at time t

$S(t, a)$ = selling price of a site at time t if an ad valorem tax is levied at a rate of a

$V(t, a, T)$ = present value, discounted to time t , of net income from a site after ad valorem taxes at a rate of a , assuming that development occurs at time T

$C(T, a)$ = present value, discounted to time T , of net income from a site after ad valorem taxes at a rate of a , assuming that development occurs at time T , that is, $V(T, a, T)$.

Some of these terms represent distinctions that have not always been made in the literature, resulting in considerable confusion. Note in particular the distinction between $N(i, t)$ and $R(i)$. The net return from a site at a particular time, $N(i, t)$, depends on the time when use of the site began. The rent of a site at a particular time, $R(t)$, on the other hand, is defined to be independent of when use of the site happened to start. To achieve this independence, rent is defined not directly in terms of what can be achieved by use of a site, but rather indirectly, by what is lost from a lack of use of the site. $R(i)$ can be defined in terms of $N(i, t)$ by

$$(1) \quad R(t) = N(t, t) - \int_t^{\infty} \frac{d}{dt} N(i, t) e^{-r(i-t)} di.$$

That is, if one starts with an unimproved site at time t , the cost of leaving the site unimproved is the return that can be earned from immediate use at time t minus the present

value of change in all future returns that results from postponing the start of use of the site.

The rent of a site can also be specified in terms of the site's changing selling price, as the present value of the cost of postponing the date from which a user has use of a site:

$$(2) \quad R(t) = -\frac{d}{di} S(i, 0) e^{-r(i-t)} \Big|_{i=t} = rS(t, 0) - \frac{d}{dt} S(t, 0).$$

A discrete version of this definition was introduced in Tideman [29, pp. 342-43]. The first term of the derivative in (2) is the cost of postponing the start of a given flow of income, and the second is the cost of the change in the size of the flow that comes from postponement. It can be seen from (2) that if a site is appreciating at the interest rate, then there is no cost to postponing use, and its rent is zero.

If rent can be defined either by (1) or by (2), then the two should be equal, and they are. This emerges from manipulation of a general expression for the selling price of an untaxed site:

$$(3) \quad S(t, 0) = \int_t^{\infty} N(i, t) e^{-r(i-t)} di.$$

Differentiating (3),

$$(4) \quad \begin{aligned} \frac{d}{dt} S(t, 0) &= \int_t^{\infty} \left[\frac{d}{dt} N(i, t) + rN(i, t) \right] e^{-r(i-t)} di - N(t, t) \\ &= \int_t^{\infty} \frac{d}{dt} N(i, t) e^{-r(i-t)} di + rS(t, 0) - N(t, t). \end{aligned}$$

Substituting from (4) for $d/dt S(t, 0)$ in (2) yields (1), establishing the equivalence of (1) and (2).

When an ad valorem tax on land at a rate of a is introduced, (3) becomes

$$(5) \quad S(t, a) = \int_t^{\infty} [N(i, t) - aS(i, a)] e^{-r(i-t)} di.$$

That is, the present value of all future taxes is capitalized into the selling price of land. It is worth noting that this analysis takes no account of how the proceeds of the tax are used. In any practical application, it would be important to ask whether the rental value of land was increased by public services financed by the tax.

Equation (5) seems to suggest that the determination of a current selling price of a site would require that the selling price at every future time be determined first. However, a simplification is possible. Differentiating (5),

$$(6) \quad \frac{d}{dt} S(t, a) = \int_t^\infty \frac{d}{dt} N(i, t) e^{-r(i-t)} di + rS(t, a) - N(t, t) + aS(t, a).$$

Substituting from (1) and combining terms,

$$(7) \quad \frac{d}{dt} S(t, a) = -R(t) + (r+a) S(t, a).$$

The general solution to differential equation (7) is

$$(8) \quad S(t, a) = \int_t^H R(i) e^{-(r+a)(i-t)} di + S(H, a) e^{-(r+a)(H-t)},$$

where H represents the horizon of the time period under consideration. This may be verified by differentiating (8) and observing that (7) is obtained. When H is ∞ , (8) becomes

$$(9) \quad S(t, a) = \int_t^\infty R(i) e^{-(r+a)(i-t)} di.$$

Thus the selling price of land that is subject to an ad valorem tax can be expressed as the present value of future rent, discounted at the sum of the interest rate and the tax rate. Note that the rent employed in (9) is not the income received from use of the site, but rather the opportunity cost of leaving the site unused, as specified in (1).

The fraction of the value of land that is taken by an ad valorem tax at a rate of a can be expressed as

$$(10) \quad \frac{S(t, 0) - S(t, a)}{S(t, 0)}.$$

If $R(i)$ is constant, then (10) is $a/(r+a)$. If $R(i)$ grows at a rate of g , then (10) is $a/(r+a-g)$. Thus an ad valorem tax falls more heavily on land that is growing in value than on land that has a constant value.

III. Erroneous Arguments that a Tax on Land Is Non-Neutral

The idea that a tax on land could shift the optimal timing of development even with perfect markets seems to have originated with Donald Shoup [24, 25]. He analyzes a situation in which there is a site that yields no return prior to development, and the return that can be achieved depends on when land is developed. Considering first a situation without taxes, Shoup says [25, p. 37]:

... let $V(T)$ stand for the development value of the land at any future time T if it is developed in its highest and best use at time T ...

... If there are no operating expenses and no interim rent receivable for the use of the land in the period preceding the time of development, the present value (at time t) of the land, $P(t, T)$, for any future development date, T , is given by the formula

$$(1) \quad P(t, T) = V(T) e^{-r(T-t)}, \quad t < T$$

where r is the (instantaneous) rate of discount applicable in the real estate market.

There is an ambiguity and a possible mistake in this statement. Two true statements, in standardized terminology introduced in the previous section, are

$$(11) \quad V(t, 0, T) = C(T, 0) e^{-r(T-t)}, \quad t < T$$

and

$$(12) \quad S(t, 0) = C(T^*, 0) e^{-r(T^*-t)}, \quad t < T.$$

In other words, the present value of returns associated with future development at any specified time can be computed by discounting the present value of returns from the time of development back to the present. But the sale value of the site is found by discounting returns from the optimal time of development back to the present. For Shoup's statement to be true, he must mean by $P(t, T)$ and "the present value (at time t) of the land," the present value of returns associated with a particular plan and not the sale value of the land.

Shoup shows that at the optimal time of development, his $V(T)$ will be growing at the interest rate. This is true. Shoup [25, p. 38] then introduces

ad valorem property taxes which are (or ought to be) levied on land as a fixed proportion of its market value. Let us assume that the tax is levied each period as a fixed percentage, a , of the market value of the land in the same period, and that the development value of the land, $V(t)$ [that is, in standardized notation, $C(T, a)$], is figured after all taxes. Then equation (1) is altered to

$$(5) \quad P(t, T) = V(T) e^{-r(T-t)} - \int_t^T aP(i, T) e^{-r(i-t)} di.$$

For this to be a true statement about an ad valorem tax, the $P(i, T)$ in the integral must be $S(i, a)$ in standardized terminology, the sale value of the site at time i . However, the $P(t, T)$ on the left hand side, as indicated above, must be not sale value but rather $V(t, a, T)$ in standardized terminology, the present value of future returns associated with a particular plan. At a minimum, Shoup's terminology does not distinguish properly between these concepts, and he may have made a conceptual error.

Shoup shows that with the tax, his $V(t)$ must now grow prior to development at a rate equal to the sum of the interest rate and the tax rate, so that the after-tax return will be the interest rate. This is true. Shoup then concludes [25, p. 39]:

Thus the effect of the property taxes on vacant land is to bring development when the rate of increase of the development value, $V'(T)/V(T)$ [that is, $C'(T, a)/C(T, a)$ in standardized notation], of the bare site equals the sum of the interest rate and the tax rate. It is interesting that the difference between this optimal development timing condition and the one found previously in the absence of a land tax is one sense in which even a pure site value tax may not be perfectly neutral in its effect on resource allocation, as is frequently claimed.

It is true, as Shoup says, that when land is taxed, the rate of growth of the after-tax value at the profit-maximizing time of development is the sum of the interest rate and the tax rate. However, this does not entail a shift in the timing of development, as long as the tax is a true ad valorem tax. Shoup appears to believe that the rate of growth of value at any point in time will be the same with the tax as without it. This is not true. The introduction of an ad valorem tax on land changes the sale value and the rate of growth of sale value at each point in time; the time when the condition for profit-maximizing development is satisfied remains unchanged.

To see this, note first that the present value of future returns net of taxes can be found by subtracting taxes from the present value of future returns in the absence of taxes. Thus,

$$(13) \quad C(T, a) = C(T, 0) - \int_T^{\infty} aS(t, a) e^{-r(t-T)} dt.$$

Thus the rate of growth of C , taking account of taxes, is

$$(14) \quad \frac{\frac{d}{dT} [C(T, 0) - \int_T^{\infty} aS(t, a) e^{-r(t-T)} dt]}{C(T, 0) - \int_T^{\infty} aS(t, a) e^{-r(t-T)} dt}.$$

At T^* , $C'(T, 0)$ is $rC(T, 0)$, so (14) is

$$(15) \quad \frac{rC(T^*, 0) - r \int_{T^*}^{\infty} aS(t, a) e^{-r(t-T^*)} dt + aS(T^*, a)}{C(T^*, 0) - \int_{T^*}^{\infty} aS(t, a) e^{-r(t-T^*)} dt},$$

which is

$$(16) \quad r + \frac{aS(T^*, a)}{C(T^*, a)} = r + a.$$

Thus the rate of growth of developed value net of taxes, at the time of development that maximizes profit in the absence of taxes, is the sum of the interest rate and the tax rate. The shift of development that Shoup discusses to the time "when the rate of increase of the development value, . . . of the bare site equals the sum of the interest rate and the tax rate" is no shift at all.

If one interprets $P(i, T)$ in Shoup's equation (5) as $V(i, a, T)$ in standardized notation, to be consistent with the terminology on the left side of the equation, then what is described is not an ad valorem tax, but rather a peculiar tax that has been the subject of much inadvertent theorizing, though there is no evidence that any legislature ever sought to implement it. Under this tax, an assessor would be told to assess undeveloped land not according to its sale value, but rather according to the present value of a forecast of its price at the time when its owner plans to develop it. This means that an owner of land could change the tax that was currently owed by changing the date for which development was planned. This makes no sense. Nevertheless, because such a tax comes up so often in discussions of land taxes, it needs a name. Such a tax will be called a tax on the present value of planned net income, or PVPNI.

The assessment of developed sites on the basis of PVPNI would involve a different set of complications. An assessor would need to determine how much of the value of the combination of land and improvements should be attributed to the improvements. The residual would be the value of the site. But any attribution of value to improvements that cannot be economically removed from a site, other than what the improvements add to a previously determined value of the site, would be arbitrary. If, as in the real world, unanticipated changing circumstances generate fluctuations in the value of the combination of land and improvements, any independent attribution of value to improvements would be even more dissociated from economic meaning. Shoup avoids this problem by not modeling improvements explicitly.

Because of the conceptual problems that arise both with undeveloped land and with developed land, a tax on PVPNI is a theoretical construct that does not correspond to any real or plausibly potentially real tax.

A kernel of truth in Shoup's analysis is that a tax on PVPNI is non-neutral. With such a tax, it is possible to lower one's tax liability by selecting a plan with a lower present value of planned net income. That a tax whose magnitude can be changed by tax-payer action should be non-neutral is not at all surprising.

Athanassios Skouras [26, p. 130] has a different interpretation of Shoup's work. He analyzes a tax on undeveloped land that ceases as soon as land is developed and describes such a tax as "the concern of Shoup's analysis." This interpretation of Shoup is hard to justify. It seems clear that Shoup had in mind a tax on land that continued after land was developed, because otherwise it would be pointless for him to mention that development value was figured net of taxes. Skouras shows that the tax he analyzes brings development forward, to the time when the rate of growth of developed value in the absence of a tax is equal to the sum of the interest rate and the tax rate, thus reaching the conclusion that Shoup seems to have thought followed from his analysis.

Skouras criticizes Shoup, saying,

Shoup's conclusion that "the effect of the property tax on vacant land is to *decrease* the value of the land but to *increase* its rate of appreciation" is very misleading. There is no reason why the tax should affect the rate of appreciation which depends on development potential. What the tax does is to increase the rate of appreciation required *if a site is to remain undeveloped*. In other words, the tax accelerates land development.

This criticism would be valid if Shoup were analyzing a tax that ceased when land was developed. However, the introduction of an ad valorem tax on land does both decrease the value of undeveloped land and, while it is economical to hold it undeveloped, increase its rate of appreciation. But it does not accelerate land development.

Michael Owen and Wayne Thirsk [20] offer a model similar to Shoup's, but without referring to Shoup. They define $P(0)$ as the present value of land, $V(t)$ as "the net-of-tax expected value of land in period t in its highest and best use" and b as the tax rate. To characterize the profit-maximizing time of development, they differentiate

$$(17) \quad P(0) = \int_0^t -bP(i) e^{-ri} di + V(t) e^{-rt}$$

and show, as Shoup did, that the rate of growth of the price of land at the optimal time of development will be $r + a$. And like Shoup, they assert [20, p. 252] that this involves a forward shift in the timing of development. But then they criticize the conclusion on the ground that "it suggests that current landowners would be able to shift some of the burden of future property taxes onto future purchasers of land." To make sense out of this puzzling comment one must presume that Owen and Thirsk had been assuming (strangely) in their earlier analysis that the selling price of land would not be affected by taxes on land. In any case, Owen and Thirsk then develop an equation in which post-development taxes are subtracted from their $V(t)$. Thus it seems that they mean to define $V(t)$ not as the net-of-tax value of land, which they said, but rather as the gross-of-tax value. Thus Owen and Thirsk say that the true expression for the sale value of land is

$$(18) \quad P(0) = \int_0^t -bP(i) e^{-ri} di + V(t) e^{-rt} - \int_t^{\infty} bV(i) e^{-ri} di.$$

If $V(t)$ is a gross-of-tax value, the tax described here falls prior to development on sale price and after development on what the sale price would be in the absence of taxes. This makes no sense as a tax and it also falsifies their subsequent assertion that $P(T) = V(T)$ when T is the development date. On the other hand, if $V(t)$ is a net-of-tax value, then Owen and Thirsk have subtracted taxes twice.

Owen and Thirsk make a further mathematical error when, in differentiating (18) with respect to t , they neglect to take account of the fact that t appears in limits of integration.

The Owen and Thirsk analysis is criticized by Bentick [2]. Bentick says [2, pp. 545-46]:

[T]he model provides only one use for the land and this use does not commence until some time T . Therefore land *must* remain vacant until this time.

This interpretation of Owen and Thirsk is unjustified. While the Owen and Thirsk definition of $V(t)$ is ambiguous, it is hard to see how anything they say provides a basis Bentick's inference that they are assuming, in standardized notation, that $V(T, a, T) = 0$ for $T \neq T^*$.

In reply, Thirsk [27] says that he and Owen did not intend to assume the condition that Bentick attributed to them. He says that what they meant by $V(t)$ was the sale value of land

in the absence of taxes. This is clearly not what they said, although it does justify their assertion that taxes needed to be subtracted from their first result. However, this still leaves them with a bizarre tax and mathematical errors.

Bentick [2, p. 546] goes on to say:

Now introduce property taxation into the model: [Owen and Thirsk] do this by correctly subtracting from [1] the capitalized value of all the taxes levied between 0 and time T , and of all taxes levied from time T thereafter. They then go through the above present value maximization exercise which I have argued is inappropriate, . . .

While Bentick's words here are somewhat ambiguous, it appears that he has endorsed the double subtraction of post-development taxes.

Overcoming what he sees as the principal limitation of the Owen and Thirsk analysis, Bentick [1, pp. 861-63] develops an example of the effects of taxing land that incorporates a choice between two development possibilities:

Consider a piece of land which may be used in two alternative projects, 1 and 2. Project 1 offers the land immediate rentals of \$1.00 per year in perpetuity, while project 2 offers higher rentals of \$ c in perpetuity, but only after a gestation period of T years. . . . [P]roject 2 will be selected if

$$(1) \quad e^{-rT} c/r > 1/r$$

...

Now impose . . . an annual wealth tax, . . . at rate b , which is based on the current market value of land. Investors will now require a gross rate of return of $r + b$ in order to continue enjoying a net return of r , and capitalization of the tax will cause the present values to decline so that project 2 will have to pass the more severe test

$$(3) \quad e^{-(r+b)T} c/(r+b) > 1/(r+b)$$

...

It is incorrect for Bentick to equate a wealth tax with a tax on land. And his example of two development possibilities is more limited than the continuum of possibilities that Shoup used and Owen and Thirsk contended that they used. However, if Bentick's analysis were correct, the two possibilities might show the effect more clearly than a continuum. But the analysis is not correct. Inequality (3) is inappropriate because it assumes that the tax is not an ad valorem tax, but rather a tax on PVPNI. The tax varies, depending on which development option is chosen. If the tax is an ad valorem tax, Bentick's inequality (3) has no bearing on which project is more profitable.

Citing Bentick, Mills [17, p. 125] says:

[T]hat part of the property tax which falls on unimproved land is widely thought to be neutral. . . .

This view of the tax on land is badly mistaken. It is true that a (less than 100 percent) tax on land *income* is neutral, but this does not extend necessarily to a tax on capitalized land *value*, or changes therein.

Tideman [28] criticized both Bentick [1] and Mills [17] on the ground that they were implicitly assuming that the value of land could be something other than what it would be worth if it were unimproved. Bentick [3, p. 113] replied,

I agree . . . that . . . the current market value of a site is the price at which it would sell if it were not committed to any particular activity, and that this is the highest present value of net income streams that begin with bare land today. . . .

My original article shows that a tax on the market value of land is not neutral between uses of land which are *mutually exclusive*.

The last sentence is not true because the analysis did not follow the rule that the previous sentence endorses.

Mills [18] replied, accepting the neutrality of a true ad valorem tax, while saying, "The point of my previous note stands, however: when land value is computed (appraised) to include rent accruing to irrevocable previous commitments, the nature of induced non-neutrality is to favor land-uses with early-payoff income streams." If this is an assertion that a tax on PVPNI is feasible, it needs to be strengthened with a more complete specification of how assessors are to make their assessments. But the statement could also be interpreted as making the point that it is possible that assessors, who are supposed to assess land according to the value it would have if unimproved, are influenced by the development decisions that owners of land make, and if such a bias in assessments is predictable, it motivates inefficient development decisions.

It would not be necessary to spend so much time on erroneous theory except for the fact that these papers have become widely cited and followed. For example, after citing Bentick and Shoup, Douglas [7, pp. 291-92] says:

As previously stated, it has been (and still is) commonly believed that the site value tax is neutral. The model presented in the previous section shows this is not true as long as the pattern of development can be altered to bring rental income nearer to the present. The key to the result is that, because of the lock-in effect produced by a development project, land value in a future period may be determined in part by the existence of capital on the land in that period.

Noguchi [19, p. 20], citing Bentick, says, "Foresters have long recognized that the classical proposition that a tax on land value is neutral does not hold in an intertemporal setting."

Mathis and Zech [15, p. 3] say, "Mills [1981] . . . identifies two market distortions inherent in the real property tax: the traditional one that penalizes improvements and another which fa-

vors properties with early payoff income streams. The implementation of [land value taxation] eliminates the first distortion but enlarges the second."

Fischel [10, p. 253], citing Bentick and Mills, says, "The property tax on undeveloped land raises the holding costs of farmers and other speculators . . . and may tempt them to sell too soon for a low-density use that cannot then easily be reversed."

Prest [22, p. 102], citing Bentick, says, "The consensus would now seem to be that [land value taxation] will *not* be neutral, at least in certain circumstances, in that it will provide an incentive to convert land to higher uses sooner than in the absence of the tax."

Ellson and Roberts [8, p. 477], citing Bentick and Shoup, say, "Value-based taxation favors near-term projects relative to far term."

Pillai [21, p. 45], citing Bentick, says, "It is true that a tax on the value of land . . . may be non-neutral if, for example, (1) the time profiles of future income streams from various parcels of land differ from each other."

Turnbull [30, p. 557], citing Bentick, says, "[B]ecause land-value tax does not synchronize tax payments with rental receipts over time, it distorts the relative present values of mutually exclusive land uses . . . and alters development decisions."

Bourassa [4, p. 110] says, "Bentick shows mathematically that the effect of a land tax may be to give the stream of land rents from the immediately developable project the higher present value."

If any of these writers realize that they are discussing the properties of a tax on PVPNI rather than a tax on the value that land would have if it were unimproved, they do not make it clear. Wildasin [31, p. 105] does make the source of the non-neutrality conclusion clear. He says:

[I]f one defines some *use independent . . . standard value*, a tax on this standard value will be equivalent to a use-independent per unit tax, and thus neutral. This does not contradict the Bentick-Mills conclusions because these authors consider taxes on the *current market value* of land and because, . . . physically homogeneous units of land will in general have values that differ over time depending on use.

While Wildasin's description of what must be done to achieve neutrality is correct, his description of the Bentick-Mills tax base as "the current market value of land" is not accurate. Their tax base is the present value of planned net income. To describe this as "the current market value of land" is to suppose that there is a market in which it is possible to observe the net returns from the planned use of land. But no such observation is possible. What can be observed is the current market value of the combination of land and improvements. Any attribution of value to land alone, other than what the land would be worth if it were unimproved, is arbitrary.

Wildasin [31, p. 107] also mentions that a tax on the current rental income of land is non-neutral if tax rates change from year to year, because investors will tend to choose income streams that are heavy in years when taxes are light. While this is true, a tax on the rental *value* of land as defined by (1) or (2) is neutral even if rates change from year to year, be-

cause this definition is independent of how land is actually used. A tax on the rental income from land, even if rates are constant, is likely to be non-neutral in practice, because of the difficulty of separating the realized return to land from the returns to capital and entrepreneurship.

The effects of any real tax on land, of course, depend not on theoretical calculations, but on the behavior of tax administrators and on the expectations of citizens about their future behavior. What economic theory shows is that there is a set of instructions for tax administrators that, if anticipated and followed in a world of perfect markets, would motivate owners of land to use it in the same way that they would use it if there were no tax. The next section shows that, in a world of imperfect markets, taxing land can offset some of those imperfections and produce more efficient land use than is attained in the absence of the tax.

IV. How Land Taxes Do Affect the Timing of Development

Henry George [13, p. 436] argued that a tax on land would curb land speculation, that is, that a tax on land would affect the timing of land development. He regarded this impact of taxing land on the timing of development as socially beneficial. From the theory presented in the previous section, one might conclude that George was mistaken in his economics and needlessly concerned about the possibility that holding land unused would be inefficient. From the theory of maximizing behavior, one would say that the owner of any asset employs it in such a way as to maximize the present discounted value of future returns. If the owner of a parcel of land leaves it unused, this should be regarded as part of a plan by the owner for profit-maximizing use of the land through time. Efficient use of developed land requires durable immobile structures. It would be wasteful to build these before they can be used, so it should be expected that land will be undeveloped for some span of time before it is used intensively. On this basis, Ely [9] argued that the incomes of land speculators come from undertaking successfully the socially valuable activity of determining the best time for land to be developed.

Ely's argument raises the question of whether land speculators are properly compensated for the service they perform, or overcompensated or undercompensated. But before addressing that question, it is useful to understand how a tax on land affects the quantity of land speculation, that is, how a tax on land can affect the timing of development.

The way that a tax on land can reduce the amount of land speculation was explained by Brown [5], who pointed out that the participants in a market can have different beliefs about the future, and that taxation can affect the relative value of land to persons with different beliefs. In particular, land taxation takes some of the gain that would otherwise accrue to those who leave land undeveloped because they foresee rises in rent that others do not foresee. Thus a tax on land generates greater reductions in offer prices for those who foresee rises in rent of land than for those who do not, thereby making some land more valuable to persons who wish to develop it immediately than to the land speculators who would otherwise be the highest bidders for it.

This point can be clarified by using a more modern model than the one Brown used. Suppose that there is a site near a mine, which would be a good place to put a restaurant for the

miners. But it is not certain how much ore is in the mine, and therefore what the demand for restaurant services will be. Whatever the amount of ore, the mine will be worked for just two periods; the site will have no value after the second period. If the ore that has already been discovered is all that will be discovered, then there will be 100 workers in period one and 100 in period two. The best use of the site is then "Plan A," building a small cafe, which will generate a net return to the site of 100 in each period. It is possible that at the end of the first period, a second seam will be discovered, leading to the use of 200 workers in the second period. If it were certain that that would occur, the best use of the site would be "Plan B," operating out of trailers for the first period and building a large restaurant for the second period. This would lead to a net return to the site of 50 for the first period and 180 for the second. If Plan A is undertaken and the second seam is discovered, then the return in the second period is 110, because the cafe can adjust by accommodating more customers and raising prices. If Plan B is undertaken and the second seam is not discovered, then the best use of the site in the second period will be to continue to use the trailers and achieve a return of 50 in the second period. The possibilities can be considered a two-by-two game against nature, as shown in figure 1.

Assume that money in the second period is discounted by 10% to convert it to present value. Then if there is no discovery, Plan A with a present value of 190 will maximize profits, and if the discovery occurs, Plan B with a present value of 212 will maximize profits.

If some people believe that the discovery will occur and others that it will not, then the land will be most valuable to those who believe that the discovery will occur, and Plan B will be implemented.

Now suppose there is an ad valorem tax at a rate of 25 percent. What effect, if any, will this have on how the site is used? The analysis begins with the second period and works back. If there is no discovery, then the value of the site in the second period, if it is unimproved and is subject to a 25 percent ad valorem tax, will be 40, so that the tax of 10 plus the value will be 50. If there is a discovery, then its value in the second period will be 144, so that the tax of 36 plus the value will be 180. Subtracting the present value of the second-period tax from the first-period value of the site in the absence of a tax yields 181 as the value before first-period taxes for a proponent of Plan A who does not expect the discovery, and 179.6 as the value for a proponent of plan B who does expect a discovery. Since the expected value prior to first-period taxes is higher for the proponent of Plan A, this is the plan that will prevail. An ad valorem tax had changed the profit-maximizing use of the land.

This tax-induced change in the use of the land occurs independently of what is actually most efficient, that is, whether the discovery will actually occur. Thus, in a world with non-uniform beliefs, a tax on rent can either improve or worsen the allocation of land.

This rather surprising result is a consequence of a lack of complete markets. The proponents of Plan A and Plan B have different beliefs about the rent of the site in the second period. In a world with complete markets, these disparate beliefs would be arbitrated through the determination of a market-clearing probability of the discovery, and hence a market-clearing expected rent in the second period. If the probability of the discovery is p , then the present value of the expected return from Plan A (in the absence of land taxes) is $100 + 99p + 90(1 - p)$. The present value of the expected return from Plan B is $50 + 162p + 45(1 - p)$. These two quantities are

equal if $p = 95/108$. If p is greater than $95/108$, then plan B has the greater expected return. If p is less than $95/108$, then Plan A has the greater expected return.

The present value of the expected rent of the site for the second period is $162p + 45(1 - p) = 45 + 117p$. With complete markets, a person who was considering implementing Plan A could purchase for this price an insurance policy that would pay the rent in the second period. The rent that such a person would be willing to pay for the first period, believing that the probability of discovery is p , would be $100 + 99p + 90(1 - p) - 45 - 117p = 145 - 108p$. For a person who planned to buy an insurance policy to pay the rent in the second period and implement Plan B, the first period bid would be $50 + 162p + 45(1 - p) - 45 - 117p = 50$. The first-period bids of those who contemplate Plan A and those who contemplate Plan B are equal if and only if $p = 95/108$.

Thus with complete markets, the market for insurance policies to pay the second year's rent yields a price that informs people in the first period whether Plan A or Plan B is better (in terms of the market-clearing probability that the discovery will be made). Without a futures market in land rent, those who believe the probability of rise in the value of land is high trade on that knowledge by buying land. The concern of Brown [5] was that this concentrates land in the hands of those who have the most extreme beliefs about future rises in land values.

The idea that it is socially costly to concentrate land in the hands of those who believe that future land rents will be highest is a variation on the theme of the winner's curse (Milgrom and Weber [16]). This is the phenomenon that, when people have disparate beliefs about the value of a thing, the highest bid is made by the person who makes the most extreme upward error in valuation, and this person loses by succeeding in acquiring the thing. The less land is taxed, the greater will be the weight of extreme beliefs about high future land rents in determining bids for land, and the greater will be the artificial scarcity of land for current use that will be created by land speculation. The winner's curse will be shifted to society.

Turn now to the question of whether land speculators are properly compensated for the service of identifying the profit-maximizing time of land development. Ely [9] is correct in saying that identifying this time is a socially valuable service. But it does not follow that institutions that award all of the rent of land to private owners provide the proper incentive for the performance of that service. The social value of withholding land that would otherwise be developed is measured by the increase in total return that results from postponing development. In the example above, if the discovery is going to be made, then, from figure 1, the social present value of using Plan B rather than Plan A is $212 - 199 = 13$. However, the private present value (with respect to this one site) of knowing that the discovery will be made, if everyone else believes that it will not be made, is the return to Plan B under discovery minus the return to Plan A with no discovery, or $212 - 190 = 22$. Awarding all of the increase in value to the person who makes the decision to withhold land from development would equate private and social returns only if early development would eliminate *all* of the gains that the currently unforeseen possibility would allow. The excess of the private return over the social return will not only concentrate land in the hands of those who have the most extreme beliefs about future possibilities, but it will also induce an inefficient flow of resources to the activity of trying to be the first one to perceive future opportunities.

This excessive return to those who discover new opportunities has been discussed previously by Paul Samuelson [23, p.209] who wrote:

Suppose my reactions are not better than those of other speculators but rather just one second quicker. (This may be because of the flying pigeons I own or quickness of my neurones.) In a world of uncertainty I note the consequences of each changing event one second faster than any one else. I make my fortune—not once, but every day that important events happen. Would anyone be foolish enough to argue that in my absence the equilibrium pattern would fail to be reestablished? By hypothesis, my sole contribution is to have it established one second sooner than otherwise.

Similarly, discussing the returns to invention, Jack Hirshleifer wrote [14, p. 572]:

Do we have reason to believe that the potential speculative profits to the inventor, from the pecuniary effects that will follow release of the information at his unique disposal, will be so great that society need take no care to reserve for him any portion of the technological benefit of his innovation? The answer here is indeterminate. There is no logically necessary tie between the size of the technological benefit on the one hand, and the amplitude of the price shifts that create speculative opportunities on the other.

A tax on rent reduces the gain from being the first one to perceive future opportunities. Therefore such a tax will sometimes make it unprofitable for those who foresee future opportunities to bid land away from premature development. As with other situations in the economics of discovery, it is difficult to devise a set of institutions that provides the right incentives. But rewarding speculators with the opportunity to pocket some or all of the increases in the present value of futures rents is a relatively unpromising way of motivating them to invest optimally in discovering future opportunities. Rises in future rents are what will occur with or without their activity. What is saved by forestalling premature development is the loss in the value of immobile and durable capital that is inefficiently placed where future opportunities will make it prematurely obsolete. To avoid these losses, it makes more sense to promote markets in which those with a skill for identifying future opportunities can sell insurance to those who want to use land now, against the possibility that future increases in rent will reduce the value of their capital. If the value of identifying future opportunities can be efficiently motivated through an insurance market in future land rent, then there will be no efficiency losses to offset the efficiency gains that taxing land provides through reduction in the excessive application of resources to identifying future opportunities and reduction in the artificial scarcity of land for current use that arises when the winner's curse is shifted to society.

Another way in which land taxes improve resource allocation has been identified by Gaffney [11, 12]. He points out that land taxes improve the efficiency of land development decisions by mitigating the effects of friction in the lending market. Land, he suggests, is an investment that commends itself to investors with low discount rates and high opportunity costs of their time. It requires little attention; unlike investments in on-going enterprises, land is unlikely to fall greatly in value as a consequence of neglect. Potential users of land, on the other hand, are likely to be people who have above-average discount rates. Because

of the combination of differing capacities of borrowers to offer collateral and the difficulties in identifying borrowers who will be good risks, an equilibrium can persist in which competing bidders for land have quite divergent discount rates. In such circumstances, the taxation of land ameliorates the variation in discount rates. The taxes are capitalized into lower purchase prices, so the tax has the effect of substituting a recurring annual charge for a one-time charge. This makes land relatively more attractive to people with high discount rates and relatively less attractive to people with low discount rates. When evaluated at a common discount rate, the projects of those who have high discount rates and become highest bidders when land is taxed have greater present values than the projects of those who have low discount rates and are displaced by land taxes. Thus a tax on land improves economic efficiency as it mitigates capital market imperfections. If Gaffney's characterization of persons with high and low discount rates is correct, the mitigation of capital market imperfections also shifts land out of the hands of people who will leave it idle and into the hands of people who will develop it.

V. Conclusion

Taxes on land seem almost too good to be true. Not only do they have no excess burden, unlike almost all other sources of public revenue, but they actually improve allocation. The idea that taxes on land could induce inefficient decisions in the timing of development might have made them seem no better than any other tax. But the allegation is unsupported. It depends on the tax base being the present value of planned net income rather than the value of land in an unimproved condition.

The mathematics of land taxes is tricky. It is important not to confuse the value of land with the present value of planned net income. To have a definition of the rent of land that does not become negative when investments are needed, rent must be defined as the opportunity cost of leaving unimproved land unused, rather than as the net return after payments to other factors.

The allocative improvements from taxing land arise because land taxes mitigate market imperfections. In a world with incomplete futures markets for land, the distribution of land among persons with different beliefs about whether it is efficient to develop land now or hold it idle varies with the level of taxes on land. Not taxing land creates a "social winner's curse," in which an artificial scarcity of land arises from the fact that land is worth the most to those who have the most extreme beliefs about future speculative gains from land.

In a world with imperfect capital markets, a tax on land makes land relatively less attractive to those with low discount rates and relatively more attractive to those with high discount rates. This improves efficiency and accelerates development.

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**Figure 1: Returns in First and Second Periods
As a Function of State of Nature and Action Taken**

	No Discovery	Discovery
Plan A	100, 100	100, 110
Plan B	50, 50	50, 180