The Revenue Adequacy of Site Value Taxation in a Ricardian System of Economic Growth

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ABSTRACT. The *federal administration* has sought to reduce the growth of *federal expenditures* by shifting some *government costs* to *state and local governments.* An increased expenditure burden for the latter governments would require increased *tax rates* for existing types of *taxes* that have adverse impacts on economic incentives. *Land taxes* are considered as a source of *revenue* because of their efficiency aspects. Unfortunately this idea is all too often dismissed because of alleged revenue inadequacy. Thus an analysis is called for of the revenue adequacy of site value taxation in a *Ricardian model* of *economic growth.* The model allows analysis of revenue adequacy over time in an economic growth context that is suited for the long range *tax-expenditure planning* horizon with which local governments are faced. When revenue needs are primarily dependent upon the *population size,* and the *fisc* is initially operating at a deficit, for a land tax to permit attainment of balance, per capita *rents* must be increasing over time. Also when the economy's *public service demand* is primarily dependent upon *income,* deficits will not occur if rental share exceeds the share of income devoted to public output. Not all income goes to fiscal output, so rent eventually exceeds expenditures.

I

Introduction

IN THIS PAPER we analyze the revenue adequacy of a site value tax in a Ricardian model of economic growth. We believe that the issue of land taxation deserves further attention because of its potential to aid in the resolution of some of the most pressing fiscal problems of the 1980s and beyond. The Reagan Administration's attack on the growth of federal outlays has been multi-pronged, in part because of fears that efforts to finance escalating federal deficits will exert upward pressures on interest rates and

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reduce private investment. This of course would retard recovery from the recession which was one of the prime causes of the decline in tax revenues in the first place.

One facet of this battle against mounting deficits has been a call for a 'New Federalism,' in which large portions of the federal expenditures burden would be shifted to state and local governments. Higher tax revenues will be necessary if state and local governments are to shoulder increased expenditure burdens. This might be possible via higher marginal rates for existing taxes, but only if state and local governments are willing to bear the adverse consequences for supply incentives—*e.g.,* substitutions of leisure for labor, or of current consumption for investment—that would be associated with higher marginal tax rates for existing taxes.

The desire to avoid inefficient overtaxation of existing tax bases should stimulate interest in alternative sources of revenues. Land taxes have several characteristics that make them attractive alternatives to heavier levies on improvements to property, higher sales taxes, or higher taxes on personal or corporate incomes[1]. For economists, the most important feature of land taxes is that they are allocatively neutral, and may be uniquely so. Indeed, the use of land as a tax base is widely recognized as desirable on efficiency grounds, but all too often is dismissed as naive because of alleged revenue inadequacy[2].

This paper uses a Ricardian growth model to cast in new light the question of whether adequate revenues can be raised with land-based taxation[3]. Most existing analyses have attempted to answer the question as to whether or not site value taxation is capable of generating the same revenues as are presently received from general property taxes[4]. To us, the more relevant question is whether substantial revenues might be generated by site taxes over the time horizons considered by state and local governmental decision-makers. Our model allows analysis of revenue adequacy over time by integrating revenue and expenditure functions into a Ricardian system of economic growth.

II

The Basic Ricardian Growth Model

In the Ricardian system, economic growth emerges primarily from the activities of capitalists, but ultimately subsides into a steady state. The steady state is achieved when the process of transforming profits into capital comes to a halt. The process of capital accumulation evaporates when profits are eroded. That is, the marginal returns from new capital diminish rapidly as ever more (fixed coefficient) doses of labor and capital are applied first to the best land available and then to less and less productive land. Consequently, the pressures generated as land rents increase over time (until the economy reaches its steady state) tend to squeeze wages and depress the rate of profit[5].

In the Ricardian system we consider, output is a function of three factors—land, labor, and capital. The total supply of land is fixed, and so can be subsumed in technology and excluded from the explicit production function. Thus, output is a function of labor and capital alone. The essential results of this analysis of land taxes are not lost and we avoid the redundancy of separately deriving symmetric results for capital and labor by assuming that they are applied to land in fixed-coefficient doses. Let Y denote output (income) and N be the number of doses of capital-and-labor[6]. Thus,

$$Y = f(N) \quad [1]$$

with the properties:

$$f'(N) > 0 \quad [1a]$$

$$f''(N) < 0 \quad [1b]$$

$$f'''(N) \leqq 0 \quad [1c]$$

The average product curve in Figure 1 reflects the fact that labor and capital are increased in a given ratio; for every unit of labor applied to the land, x units of capital are applied. Lowering the K/L ratio shifts average product to the left (or to the right for increases in K/L). This presumption of constant proportions of these two variable inputs predictably restricts the generality of our model, but only trivially so for the major purposes of this inquiry.

Output is assumed homogeneous and inflation can be ignored here, so real and monetary values are identical[7]. Marginal product is positive, and marginal returns diminish at constant or increasing rates (inequalities [1a], [1b] and [1c])[8].

The total wage bill (W), total rent (R), and total profits (π), are defined as follows:

$$W = Nw \quad [2]$$

$$R = f(N) - Nf'(N) \quad [3]$$

$$\pi = N(f'(N) - w), \quad [4]$$

where w is the real wage rate. The magnitude of rent depends solely on the gap between average product and marginal product. Total profits consist of a residual equal to total product minus rent, minus the wage bill.

Capital is considered to be circulating capital, and therefore consists entirely of the wage bill[9]. Symbolically,

$$K = w. \qquad [5]$$

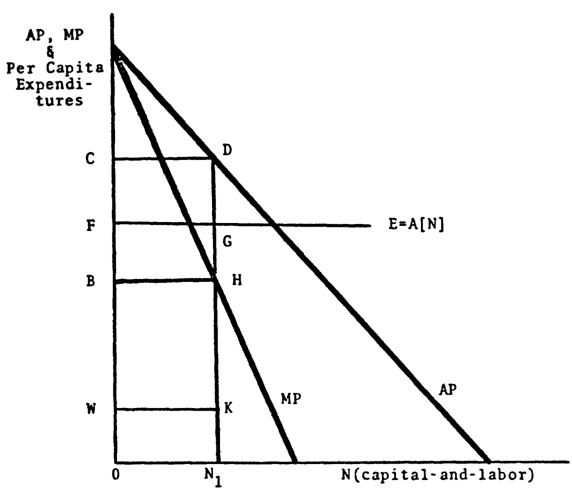
There are five equations thus far, but seven variables have appeared: Y, X, W, R, π, K, and w. Two additional equations are needed to make the system determinate. In the equilibrium that Ricardo considered natural, the following two parameters would prevail:

$$w - \bar{w} > 0 \qquad [6]$$

and

$$K = \bar{K}, \qquad [7]$$

Figure 1



Rents, Profits, Wages, and
Expenditures (ψ=0, ϕ=1) in
The Ricardian System

where $\bar{K}$ equals the stock of capital given at the beginning of the year[10], and $\bar{w}$ is the natural wage rate[11]. The system is now determinate. The solution to Equations (1)–(7) is the natural equilibrium of this Ricardian system.

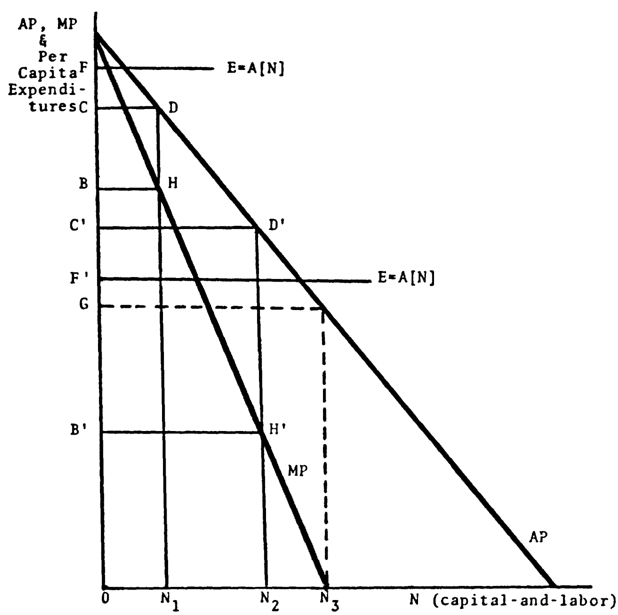
The linear system is diagrammed at population N_1 in Figure 1. Area ON_1DC is total product, area BHDC is total rent on land, and BC is the per capita rent on land. The supply curve of labor is assumed to be infinitely elastic at the subsistence wage rate Ow, and profits are defined as the total product minus rent minus wages, and they are equal to area wKHB. In all graphs after Figure 1, subsistence wages will be considered to be the X axis such that point W in Figure 1 represents point 0 in subsequent figures (this simplifies graphing considerably).

III

Expenditures as a Function of Population Alone

LET ψ = THE INCOME ELASTICITY of demand for public expenditures and ϕ equal the population elasticity of demand for public expenditures. In a sense,

Figure 2



System in which both (1) rents are sufficient to eventually finance the public sector and, (2) expenture deficits are inevitable

ϕ reflects economies of scale in the provision of public goods (for $\phi < 1$) or diseconomies (to the extent that $\phi > 1$). For the moment, we assume that expenditures are related solely to population, ($\psi = 0$), or

$$E = AN^{\phi}. \quad [8]$$

Initially, assume that $\phi = 1$. Total expenditures are a linear function of population and per capita expenditures are at a constant level A. At any point in time, tax revenues will cover or exceed expenditures if

$$AN \leqq gR, \quad [9]$$

$$A \leqq gR/N. \quad [10]$$

If the tax rate $g = 1$, then the community can cover expenditures or run a surplus if per capita rent is greater than or equal to per capita expenditures demands. This is shown in Figure 1.

For exposition purposes, the origin for expenditures has been raised to point B. Per capita expenditures A = BF and total expenditures E = $(ON_1)(BF)$. This facilitates comparisons of aggregate rent BHDC and aggregate expenditures BHGF, and of per capita comparisons BC and BF as well. Thus, if at any point in time BC ≥ BF, then the budget can be balanced by setting $g = BF/BC < 1$, generating just enough revenue to cover expenditures.

Now consider the case where $A > R/N$, (BF > BC); per capita expenditures exceed per capita rents. The result is clear in the situation depicted in Figure 2. With community size originally N_1, per capita rent is BC, per capita expenditures are BF, and exceed per capita rent by CF. As the community grows, aggregate rent and rentshare expand so that at population N_2, per capita rent is B′C′, exceeding per capita expenditures B′F′ (=BF) by F′C′.

However, consider the case depicted in Figure 2, when per capita expenditures equal OF′. Total expenditures exceed total rents, even when profits are driven to their minimum. When the community expands as far as it can (population + ON_3), per capita expenditures (OF′) still exceed per capita rents (OG). The following section will set out the conditions required for aggregate rent to finance aggregate public expenditures within the Ricardian framework.

We continue to assume that $\phi = 1$. With total expenditures linearly related to population, and total revenue equal to some fraction, g, of aggregate rent, the net public deficit can be stated as

$$D = AN - gR. \quad [11]$$

Initially, if the public sector operates at a deficit ($D > 0$), then a necessary condition for restoring a balanced budget is

$$\frac{dD}{dn} < 0, \quad [12a]$$

which is

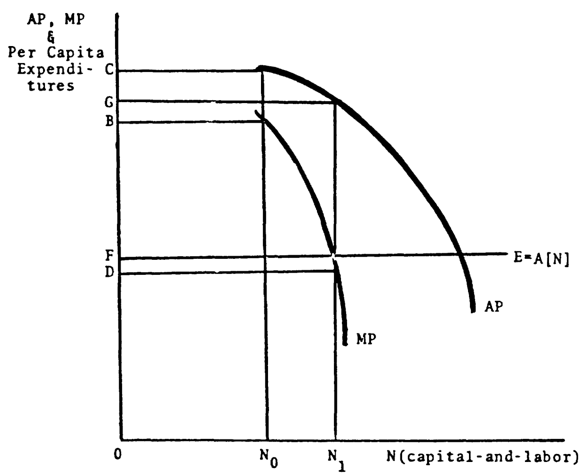
$$\frac{dD}{dN} = A + gf''(N)N < 0, \qquad [12b]$$

which reduces to

$$A < -gf''(N)N. \qquad [13]$$

Per capita expenditures, A, are constant. Therefore, with a given tax rate (g), the budget will be more easily balanced when f″(N) is smaller. That is, the more rapidly returns to the variable factor decline, the more likely a tax on aggregate rent will provide sufficient revenue.

Figure 3



Expenditures and rents when returns to the variable factor decline at an increasing rate

Figure 3 incorporates the same expenditure relationship as Figure 2, but the production function is characterized by returns to the variable factor decreasing at an increasing rate. At the initial population N_0, per capita expenditures OF exceed per capita rents BC. As population grows toward N_1, per capita rents increase and eventually exceed per capita spending (DG > OF). After population reaches N_1, a tax rate of less than unity (OF/DG) is adequate to balance the budget.

Thus far, it has been assumed that $\phi = 1$. Next, consider the problem when $\phi \lessgtr 1$. In this event, Equation [13] becomes

$$\phi A N^{\phi-1} = gf''(N)N < 0, \qquad [14]$$

which reduces to

$$A < \frac{-gf''(N)^{(2-\phi)}}{\phi} \qquad [15]$$

If $\phi < 1$, then the right hand side of Equation [15] is smaller than the right hand side of Equation [13]. Consequently, Equation [15] is harder to satisfy in that a greater degree of diminishing returns to the variable factor is required. The result is that the expenditure line curves up and to the right, thus narrowing the population range over which a balanced budget or a surplus will be achieved. Alternatively, if $\phi < 1$, the opposite occurs because the right hand side of Equation [15] is always larger than the right hand side of equation [13]. As the community grows, per capita expenditures decline and the budget is more easily balanced.

III

Expenditures as a Function of Per Capita Income

THIS SECTION CONSIDERS expenditures solely related to per capita income, ($\phi = 0$), or

$$E = A\left(\frac{Y}{N}\right)^{\psi}. \qquad [16]$$

For this section of the analysis, we will assume that $\psi = 1$, so that expenditures are linearly related to per capita income. Revenues will equal or exceed expenditures whenever

$$gR \geqq A\frac{Y}{N}. \qquad [17]$$

Dividing Equation [17] and Equation [16] by Y and assuming $g = 1$ yields

$$\frac{R}{Y} \geqq \frac{A}{N} = \frac{E}{Y}. \qquad [18]$$

Thus, whenever the share of income going to landowners exceeds the share devoted to public output, government can finance its services with a tax on rent. The net public deficit can be written as

$$D = A\left(\frac{Y}{N}\right) - gR. \qquad [19]$$

If the public sector initially operates at a deficit ($D > 0$), a necessary condition for the budget to eventually be balanced is

$$\frac{dD}{dN} < 0, \qquad [20]$$

or

$$\frac{dD}{dN} = A\left(\frac{Nf'(N) - f(N)}{N^2}\right) + gf''(N)N < 0. \qquad [21]$$

As the community grows ($dN > 0$), the deficit will be smaller when

$$A\left(\frac{Nf'(N) - f(N)}{N^2}\right) < -gf''(N)N. \qquad [22]$$

Rewriting Equation [22] results in

$$\frac{A}{N^2}\left(\frac{Nf'(N)}{f(N)} - 1\right) < \frac{-gf''(N)N}{f(N)} \qquad [23]$$

The bracketed term on the left side of Equation [23] is always negative, because labor's income share is always less than one, while the right hand side is always positive because $f''(N) < 0$ by assumption.

As the economy expands (population increases) per capita income declines due to diminishing marginal returns to labor and the fixed land resource. Total expenditures, E, also decline because A is a fixed parameter. At the same time, aggregate rent, R, increases, because

$$\frac{dR}{dN} = -f''(N)N > 0. \qquad [24]$$

Consequently, the aggregate deficit will fall.

Up to this point, we have assumed that $\psi = 1$. Consider briefly the model when $\psi \gtrless 1$. Again suppose that the public sector is operating at a deficit. Consider the necessary conditions for the budget to eventually be balanced. When $\psi <> 1$, Equation [23] becomes

$$\left\{U\left(\frac{f(N)^{\psi-1}}{N}\right)\right\}\frac{A}{N^2}\left(\frac{Nf'(N)}{f(N)} - 1\right) < \frac{-gf''(N)N}{f(N)}. \qquad [25]$$

Equation [25] replicates Equation [23], except for the term in the brackets, { }, which we will label as Z. When $\psi > 1$, the bracketed term, Z, >1. Therefore, for any population size, the larger is ψ, the lower will be the deficit as the community grows. Alternatively, if $\psi < 1$, the bracketed term is less than one and the opposite result occurs. Again, this is the result of falling per capita income when population rises.

The fact that a larger per capita income elasticity is beneficial to revenue adequacy may seem perverse. This is due to two factors. First, capital is only permitted to grow as rapidly as does population (capital-and-labor are applied to land in fixed proportions). Because of a fixed land resource, per capita income falls as population rises. However, if capital were permitted to grow more rapidly than labor, per capita income could rise, and a larger per capita income elasticity would hinder the attainment of adequacy. Second, we have not introduced technical change into this model. Technical change would tend to increase per capita income as the economy grew, and therefore a larger per capita income elasticity would work against the attainment of a balanced budget.

Fixed capital-and-labor doses and the absence of technical progress do limit the generality of this model. Therefore, our conclusions as to the effect of different per capita income elasticities on revenue adequacy require some caveats. We assert that allowing technological progress and appropriate variations in capital-to-labor ratios yields the more intuitively plausible result that a larger per capita income elasticity hinders attainment of revenue adequacy.

IV

Expenditures: A Function of Both Population and Income

In this section, assume that expenditures are related to both per capita income and population ($\phi > 0$ and $\psi > 0$). We also assume that at a given point in time, some fraction of the budget can be financed by a tax on rent or land value. For this rent levy to continually support this proportion of expenditures, the rate of growth of rents must equal or exceed the rate of growth of expenditures. The rate of growth of rents, r, is

$$r = \frac{1}{R}\frac{dR}{dt} = \frac{f'(N)\dfrac{dN}{dt} - (Nf''(N) = f(N))\dfrac{dN}{dt}}{f(N) - Nf'(N)} \qquad [26]$$

or

$$r = \left(\frac{-Nf''(N)}{\dfrac{f(N)}{N} - f'(N)} \right)^{n} \qquad [27]$$

where

$$n = \frac{1}{N}\frac{dN}{dt}.$$

The resource expenditure function for the community is specified as[11],

$$E = AN^{\phi}\left(\frac{Y}{N}\right)^{\psi} \qquad [28]$$

From these, the rate of growth of expenditures, e, is

$$e = \frac{1}{E}\frac{dE}{dt} = (\phi - \psi)n + \psi y, \qquad [29]$$

where y is the rate of growth of aggregate income:

$$y = \frac{1}{Y}\frac{dY}{dt} = \left(\frac{Nf'(N)}{f(N)}\right)^{n}. \qquad [30]$$

Adequacy requires that

$$r \geqq e. \qquad [31]$$

Substituting Equations [27], [29], and [30] into equation [31] yields

$$\left(\frac{-Nf''(N)}{\frac{f(N)}{N} - f'(N)}\right)^{n} \geq (\phi - \psi)n - \psi\left\{\frac{Nf'(N)}{f(N)}\right\}^{n}. \qquad [32]$$

Dividing both sides by n and rewriting results in

$$\frac{-Nf''(N)}{\frac{f(N)}{N}\left(1 - \frac{Nf'(N)}{f(N)}\right)} \geq \phi - \psi\left(1 - \frac{Nf'(N)}{f(N)}\right). \qquad [33]$$

The results of this section indicate, as expected, that deficits will be smaller over time, *ceteris paribus:* (1) the faster returns to the variable factor decline, (2) the smaller is the population expenditure elasticity, ϕ, and (3), the larger is the per capita income elasticity, ψ.

V

Concluding Comments

INTEGRATION OF REVENUE and expenditure functions for a land value tax (as Henry George proposed) into a Ricardian system of economic growth has shown that when revenue needs are primarily dependent upon the population and the fisc initially is operating at a deficit, for a tax on site rent to permit attainment of balance, per capita rents must be increasing over time, and at faster rates than per capita governmental expenditures. The extent of this difference will determine the length of time or growth of population required for revenues to equal expenditure requirements. In addition, unless the public sector is characterized by powerful economies of scale, the private production function must be subject to decreasing returns at a constant or increasing rate if the fisc is to eventually balance.

If the public sector is characterized by diseconomies of scale, adequacy conditions are most difficult to achieve. The greater the share of public output devoted to pure public goods, the more easily the budget can be balanced. As the community grows, the total cost of public services is spread over more individuals.

When the economy's public service demand is primarily dependent upon income, deficits will not occur if rental share exceeds the share of income devoted to public output. Since not all income is allocated to fiscal output, total rent must eventually exceed local expenditures if returns to variable factors decline at constant or increasing rates. How large the community must grow before rents are sufficiently large depends on the proportion of total output diverted to the public sector and how rapidly returns to the variable factors decline.

The possibility that the enormous deficits forecast for the federal government may cause shifts in expenditure burdens to state and local governments cannot be dismissed. This paper has explored the conditions under which Georgian 'site value' taxes might help alleviate the shocks to local fiscal authorities if this shift occurs. We believe that the shortcomings of raising marginal rates on existing taxes are powerful arguments that alternative taxes deserve exploration, and that land taxes may at least partially resolve these budget problems.

Notes and References

1. Although questions of equity are outside the province of this paper, we believe that many interested in these issues would agree with the following sentiments expressed by Adam Smith: "As soon as the land of any country has all become private property, the landlords, like all men, love to reap where they never sowed, and demand a rent even for its natural produce." (*An Inquiry into the Nature and Causes of the Wealth of Nations.* Cannan edition, Methuen, London 1961. Book 1, ch. XI, p. 276, and ch. VI, p. 61.) Similar attitudes impelled Henry George to spearhead a movement to impose a 'single tax' on this 'unearned surplus'. See, *passim,* George's *Progress and Poverty,* 1879 (Reprint: Robert Schalkemback Foundation, New York, 1955).

2. See Dick Netzer, *Economics of the Property Tax,* Studies of Government Finance (Washington, D.C.: The Brookings Institution, 1966), and James Heiburn, *Real Estate Taxes and Urban Housing* (Columbia Univ. Press, 1966).

3. See the rudiments of Ricardian growth theory in Volume 2, David Ricardo, *The Works and Correspondence of David Ricardo,* (Sraffa edition, 11 volumes), Cambridge, UK: Cambridge

Univ. Press, 1957–73. Mark Blaug provides an excellent overview of Ricardian growth theory in Ch. 4 of his *Economic Theory in Retrospect,* rev. ed. (Homewood, Ill.: Richard D. Irwin, Inc., 1968). A simple Ricardian growth model is provided in *An Introduction to Modern Economics,* by Joan Robinson and John Eatwell (London: McGraw-Hill, 1973), Bk. Ch. 1., *passim.*

4. This question has been addressed in a dynamic context using a neoclassical approach by G. W. Stone, "Public Spending, Land Taxes and Economic Growth", *American Journal of Economics and Sociology,* Vol. 34, No. 2 (April, 1975), pp. 113–26. Most other analyses of this question are static.

5. L. L. Pasinetti, "A Mathematical Formulation of the Ricardian System," *Review of Economic Studies,* Vol. 27 (1980), p. 81.

6. To avoid excessive notation, we also use "N" to represent population. In this case, labor is synonymous with the population. Consequently, population and the units of "capital-and-labor" are numerically the same. That is, for every dose of labor (person), some constant multiple of capital is applied, leaving capital-and-labor doses and population numerically equal. Pertinent distinctions between population and K/L doses are noted in the text.

7. By assuming one homogeneous output, we exclude valuation considerations. Our approach is similar to that of N. Kaldor, in "Alternative Theories of Distribution," *Review of Economic Studies, 1955–1956,* pp. 83–104, and H. Barkie, "Ricardo on Factor Prices and Income Distribution in a Growing Economy", *Economics,* August 1959, pp. 240–50. Pasinetti, *op. cit.,* presents a Ricardian model with two commodities, in which he considers various valuation questions. For our purposes, value neither introduces any important problems, nor does it answer any relevant questions, and is therefore excluded from the analysis.

8. The assumption of marginal returns diminishing at an increasing rate characterizes typical production functions used throughout microeconomic theory. In his examples, Ricardo assumed that returns diminished at a constant rate.

9. See Pasinetti, *op. cit.,* p. 125.

10. See Pasinetti, *op. cit.,* p. 127. The production process requires exactly one year to complete, and capital (all circulating) takes one year to be re-integrated.

11. The natural real wage rate is defined as that wage rate which keeps population constant. Paul Samuelson, in "The Canonical Classical Model of Political Economy," *Journal of Economic Literature,* Vol. 16, No. 4 (December, 1978), pp. 1420–22, has developed a dynamic Ricardian system, in which w can exceed $\bar{w}$ until labor supply (population) grows to equilibrate $w = \bar{w}$. When adjustment is instantaneous, the results are equivalent to the static Ricardian model.

12. For the complete derivation of this function, see G. W. Stone, "Revenue Adequacy of Land Value Taxation," *Southern Economic Journal,* Vol. 41, No. 3 (January, 1975), p. 444.

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