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Federal Income Tax and Its Effects On Inter- and Intracity Resource Allocation

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Abstract

This article discusses the distortive effect of the federal income tax on the efficiency of resource allocation within and between cities. This distortion shifts production to the smaller and less productive cities from the larger and more productive cities. To eliminate these distortive effects, a city-size deduction should be applied. The underlying assumption is that cities differ from one another in labor productivity. Consequently, in equilibrium, the size, the nominal income, and the price of housing vary across cities. When a uniform income tax rate is used for financing federal expenditure, the shadow price of housing exceeds the market price in the larger cities, indicating that the stock of housing is too small and the per-capita housing consumption is too large. The opposite is true in small cities, where also, if housing and the LPG (local public good) are net substitutes, the provision of the LPG is excessive. The article also discusses the effects of federal corporate profit taxes, which are shown to discourage the supply of the LPG, and shows that a net land rent tax is not always a feasible tax instrument capable of raising the predetermined tax revenue.

FEDERAL INCOME TAX AND ITS EFFECTS ON INTER- AND INTRACITY RESOURCE ALLOCATION

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1. INTRODUCTION

The distortive effects of the personal income tax on the allocation of time between work and leisure, on intertemporal resource allocation (i.e., saving), and on risk taking (i.e., the allocation of investment between high-risk and low-risk ventures) are well known. These effects are extensively discussed in the public economics literature (see, e.g., Hausman 1985; Sandmo 1985; Stiglitz 1985). One impor-

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tant distortive effect of income tax is absent in the present discussion—its effect on intercity (interregional) population distribution and the provision of local public goods (LPG).

Intercity population distribution and the provision of local goods (public and private) are subjects of interest in the local public economics literature. This literature, however, has been concerned with the effect of local finance and has totally ignored the relevant effects of central government taxation (see, e.g., Wildasin 1986; Hoyt 1991).

In this article, we explore the impact of central government income taxation on the intercity population distribution and the provision of local goods. Thus our article adds valuable knowledge about a significant distortive effect of current federal income tax practice not reported before. We show that a federal income tax adversely affects intercity population distribution and provision of the LPG. We also offer a practical alternative procedure that will, if adopted, eliminate the inefficiency discussed in this article.

A nationwide poll tax (a personal lump sum tax), including a tax on land rent, is a first-best instrument for financing pure public goods, including pure LPG. A local head tax is a first-best instrument for internalizing the external effects of a congested LPG and partially financing its provision. These observations are extensively discussed in the local public goods literature and lucidly documented in Wildasin (1986, 1987). It is shown, for example, how using residence-based taxation for financing a pure LPG or using source-based taxation for financing a congested LPG adversely affects intercity population distribution and provision of the LPG.[1]

The present article is concerned with financing a predetermined central government expenditure (G), in addition to the LPG. As in the case of LPG, the first best tax instruments for financing G must be neutral with respect to residential location incentives. We show that a federal poll tax still fulfills this requirement, but a federal tax on land rent is efficient only if the local land rent tax is deductible. Otherwise, the federal land rent tax becomes equivalent to a poll tax coupled with a tax on the LPG, resulting in its underprovision.

A uniform head tax is an efficient but inequitable tax instrument when the population is heterogeneous. To be equitable, the tax rates should increase with the inherent ability of the taxpayer to pay.

However, in practice, identifying the true ability to pay is infeasible, and, instead, nominal income is used as a proxy for ability. Thus personal income tax is calculated as an increasing rate of nominal income. The source of the distortion resulting from such a tax is that under locational equilibrium, the nominal wage rate of individuals with identical ability may vary across cities; only the attainable welfare is equalized. Relating the tax to nominal income rather than to real income affects the migration incentives in favor of low nominal-income cities. As a result, a large-scale distortion in the production process of the economy as a whole occurs, so that production is shifted from the larger and more productive cities to the smaller and less productive ones.

Our article goes beyond examining the distortion associated with income tax rates by suggesting how to solve this problem. Our main finding is that, under the prevailing personal income tax, efficiency can be enhanced, at the margin, if production of housing increases in the larger (more productive) cities and production of housing decreases and per capita consumption of housing increases in the smaller (less productive) cities. We also show that if housing and LPG are net substitutes, the supply of the LPG is excessive in the smaller, less productive cities. (We cannot show, however, that the opposite is true in the more productive cities.)

A tax scheme is suggested, according to which each member of any given socioeconomic group bears the same real burden of income tax, regardless of the household's city of residence. According to this tax scheme, no distortion due to differences in city size prevails. We also examine the effect of taxing land rent (pure profits) for financing G, showing that this tax policy distorts the provision of the LPG.

In section 2 we present a simple illustration of the distortive effect of income taxation on intercity population distribution. In section 3 we present a more elaborate model on which our main discussion focuses, and we characterize efficient resource allocations. In section 4 we present the competitive market realization of the efficient allocation discussed in section 3 when the government, being equipped with a full tax menu, finances its expenditures appropriately. The distortion of intercity population distribution and LPG provision, resulting from imposing a uniform income tax rate on personal earned and nonearned income when the full tax menu is not available, are the subjects of section 5. In section 6 we discuss practical implications, applications, and extensions. Concluding comments and summation are provided in section 7. In the appendix we formally derive our main results.

2. A SIMPLE ILLUSTRATION OF THE DISTORTIVE EFFECT OF INCOME TAX[2]

In this section, we use a simple model to illustrate the intercommunity population distribution distortion generated by income taxation, leaving the more elaborate model and its extensions and ramifications to subsequent sections.

Consider an economy with two fully spatially detached communities, denoted by 1 and 2, accommodating jointly N identical households, each contributing a single working unit to the local labor force. The productivity, in terms of a composite good, of a household residing in community i is $w_i (i = 1, 2)$. Each household derives utility from consuming a composite good, Z, and requires one unit of housing bundle, which includes not only shelter but also transportation services to the centers of activity. The cost, in terms of the composite good, of accommodating the N_i households in a given community i, each with one unit of housing, is $c(N_i)$, exhibiting $c'(\bullet)$, $c''(\bullet)$ >) 0. These properties of $c(\bullet)$ reflect the increase in housing density, average distance traveled, and congestion with community size. Finally, the central government requires G units of the composite good for public expenditure.

The issue explored here is how to optimally finance the central government expenditure, G. To define optimality, we assume that the social planner requires either equal utility across communities or is constrained by such an equality due to free migration between communities. Optimal resource allocation is then represented by the solution of the following problem:

$$\max_{Z, N_l} Z$$

so that

$$[NZ + c(N_1) + c(N - N_1) + G] - [N_1 w_1 + (N - N_1) w_2] = 0, \tag{1}$$

where N is the total population size.

The first bracket of equation (1) represents the resource cost associated with providing the representative household with Z units of the composite good, given the predetermined levels of housing and transportation. The second bracket represents the resources available to the economy as a function of the intercommunity population distribution.

The first-order condition with respect to N_1 is

$$w_1 - c'(N_1) = w_2 - c'(N - N_1), \tag{2}$$

which also implies

$$[Z + c'(N_1)] - w_1 = [Z + c'(N - N_1)] - w_2. \tag{3}$$

Thus the marginal net social benefit of accommodating a household is equated across communities. (The marginal gross social benefit is the marginal productivity, w_i, and the marginal social cost is the value of the consumption bundle, where housing is priced at marginal cost.)

With a few manipulations equations (1) and (3) can be reduced to

$$Z + c'(N_i) = w_i + (ALR - G)/N; \; i = 1, 2, \tag{4}$$

where

$$ALR \equiv [N_1 c'(N_1) - c(N_1)] + [(N - N_1) c'(N - N_1) - c(N - N_1)]. \tag{5}$$

The aggregate land rent, ALR, is the sum across communities of profits derived from housing production, that is, where the profit in each community is the quantity of housing supplied in each community times its respective marginal cost minus the cost of housing construction.

We now consider a decentralization of the optimum where the aggregate land rent is equally distributed to every household independently of residential location, the wages are equal to the (value of) marginal product of labor, and housing is priced at marginal cost.

The assumption of equal ownership of land requires elaboration in the present context. Our specification of the optimal allocation requires that, with the exception of the central government, only households residing in the two communities have claims on the output produced in the economy, as in equation 1, and that everyone is treated equally (because everyone is provided with one unit of housing and Z units of the composite good). A decentralization of such an allocation implies that corresponding to the first requirement, the net (of local and central government taxes) rent is redistributed to the population of the two communities so that no net rent revenue leaks to absentee landlords. The second requirement implies that the net rent revenue of each community is equally distributed to every household, independently of its residential location; otherwise, it cannot be guaranteed a priori that all the households have identical initial endowments and correspondingly have a posteriori identical welfare.

With such decentralization, equation (4) implies that minimizing the burden of G requires that it be financed by a poll tax of G/N, or, if ALR exceeds G, by taxing ALR, so that only the balance of $ALR - G$ is distributed to the households.[3]

Suppose instead that an equal-rate income tax at rate t is imposed on both communities to finance G. Then consumption in community i becomes

$$Z_i + c'(N_i) = (w_i + ALR/N)\,(1 - t) \text{ for } i = 1, 2, \tag{6}$$

and free migration implies

$$Z_1 = Z_2. \tag{7}$$

Combining equations (6) and (7), it follows that

$$(1 - t)w_1 - c'(N_1) = (1 - t)w_2 - c'(N - N_1), \tag{8}$$

which is inconsistent with the efficiency condition (2).

The above distortion is illustrated diagrammatically in Figure 1. The intersection of the $w_i - c'(N_i)$ curves (efficient curves) determines

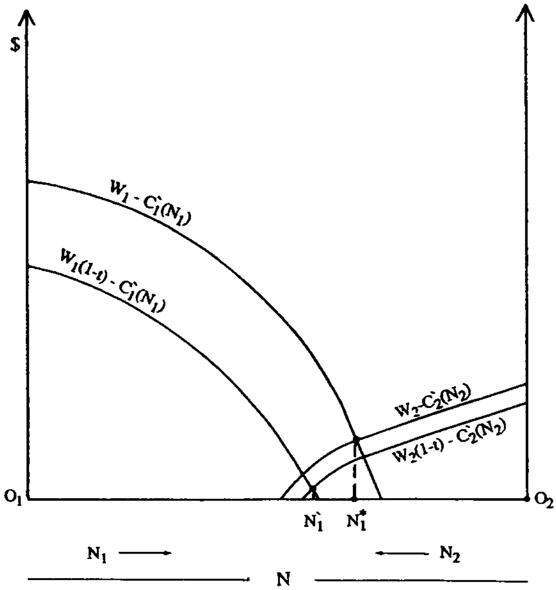

Figure 1

the efficient allocation; the intersection of the $w_i(1-t)-c'(N_i)$ curves (inefficient curves) determines the inefficient uniform income tax rate allocation. The introduction of t causes a larger gap between the efficient and inefficient curves of the more productive community than does the gap between the curves of the less productive community, resulting in a reduction of the optimal community-size disparity.

We conclude that the result regarding the inefficiency generated by the income tax is robust; it prevails even when we extend the model to more than only two communities, allowing substitution between housing and other commodities and provision of LPG by local governments, extensions often assumed in the local public goods literature. However, some of the results derived by using our simplified specification are not robust enough to prevail under these extensions. In particular, the equivalence of poll and land taxation disappears and a uniform-rate land tax imposed by the central government to finance its expenditure, G, turns out to be inefficient. Furthermore, the effect of the income tax on community-size distribution, illustrated in Figure 1, may even reverse itself. Therefore, we now extend the model by relaxing some of its restrictive assumptions.

3. OPTIMAL ALLOCATION WITH LPG AND G

THE EXTENDED SETUP

We extend the model to an economy with I detached communities,[4] introducing LPG, and some other structure that underlies the increasing marginal cost of accommodating households in a given community. We still assume a homogeneous population. Although in a homogeneous population a uniform poll tax is practical, contrary to that of a heterogeneous one, the nature of the distortions caused by uniform and increasing income tax rates (as well as the rest of the taxes discussed here) are the same in both populations. Thus there is no loss of generality in the assumption of a homogeneous population.

As in the preceding section, one unit of labor can produce w_i units of a composite good in community i. However, in this extended version, the composite good is used for direct private consumption, for the production of two local goods, one private housing, the other a pure LPG, and for central government consumption G. Housing in community i is produced by land, L_i, and composite good, X_i, according to a decreasing returns to scale production function, $F(L_i, X_i)$, with positive first-order and negative second-order derivatives. $F(L_i, X_i)$ exhibit decreasing returns to scale due to increasing average cost of transportation, housing construction, and congestion when city size increases. Assume that L_i in each city is fixed and equal to 1 and has no alternative cost, then $F(L_i, X_i) = f(X_i)$ where $f(\bullet)$ exhibits decreasing marginal product of X. The LPG in each community is produced by a fixed proportion technology and, without loss of generality, one unit of the composite good produces one unit of the LPG. Accordingly, the material balance of the composite good is

$$\Sigma_i(N_iZ_i + X_i + G_i) + G = \Sigma_iN_iw_i, \tag{9}$$

where N_i, Z_i, and G_i are the number of households, per household consumption of the composite good, and the provision of the LPG in community i, respectively, and G is the federal expenditure on the composite good.

Each household in community i consumes H_i units of housing. The material balance of housing, therefore, is

$$N_i H_i = f(X_i). \tag{10}$$

The material balance of labor is

$$N = \Sigma_i N_i. \tag{11}$$

where N is the given population size in the economy.

A **feasible allocation** is a set N_i, X_i, Z_i, H_i, G_i, for $i = 1, \ldots, I$, and G, which satisfies equations (9) through (11).

The household's utility in community i depends on the consumption of a composite good, Z_i, housing, H_i, and LPG, G_i, supplied in i, according to a strictly concave utility function, $u(Z_i, H_i, G_i)$.

An **optimal allocation** is a feasible allocation that maximizes a common utility level, U, satisfying

$$U = u(Z_i, H_i, G_i). \tag{12}$$

The necessary conditions for such an allocation are

$$u^i_H / u^i_Z = 1/f'(X_i), \tag{13}$$

$$N_i(u^i_G / u^i_Z) = 1, \tag{14}$$

and

$$Z_i + H_i\, u^i_H/u^i_Z = w_i + \{\Sigma_i[f(\bullet)\, u^i_H/u^i_Z - X_i - G_i] - G\}/N = w_i + (ALR - G)/N, \tag{15}$$

where $ALR \equiv \Sigma_i[f(\bullet)(u^i_H/u^i_Z) - X_i - G_i]$, and $u^i_j = \partial u(Z_i, H_i, G_i)/\partial j$; $j = Z_i$, H_i, G_i.

Equation (13) says that the marginal rate of substituting the composite good for housing and the marginal rate of transforming the composite good to housing are equal. Equation (14) is the Samuelson rule for provision of a public good.

The left-hand side of equation (15) represents the cost of the consumption bundle allocated to each household in community *i*, where housing is evaluated at marginal cost. Thus it can be interpreted as the marginal resource cost of accommodating a household in that community. Using equations (10) and (12) through (14) to eliminate Z_i, H_i, X_i, and G_i, the left-hand side of equation (15) collapses to a marginal cost function of labor (households), N_i, in community *i*, given the utility level *U*. The right-hand side of equation (15) represents the marginal benefit of a household to community *i*, in terms of the additional resources available to the community, given the fixed economywide parameters *N*, *G*, and *ALR*. This benefit comprises the labor productivity, w_i, and the share of the households in the distributed profits that it is entitled to $(ALR - G)/N$. The optimal population size is the one that equates the marginal cost to the marginal benefit.

The marginal benefit and cost functions are depicted in Figure 2. Being independent of N_i, the marginal benefit function, $w_i + (ALR - G)/N$, is horizontal. The marginal cost function has a U shape, resulting from the opposing effects of scale economies associated with LPG cost sharing, on the one hand, and the scale diseconomies associated with land scarcity and the resulting increase in housing marginal cost, on the other hand. For a small population size, the scale economies are dominant; for a large population size, the scale diseconomies more than offset the scale economies. (The marginal effect of cost sharing decreases with population size and the housing marginal cost is assumed to increase at an increasing rate with population size.) It is assumed that the population marginal cost is increasing at a nondecreasing rate, as depicted in Figure 2, thus guaranteeing intersection of the population marginal cost and benefit loci at a finite population size in which the marginal cost curve is upward sloping, thus satisfying second-order conditions.

Because in our specification, the communities differ from one another only by productivity, w_i, it follows that the marginal cost function is identical across communities and that they differ from one another only by the level of their marginal benefit function. These considerations allow us to deduce that under our specification the community size increases with productivity (see Figure 3).[5]

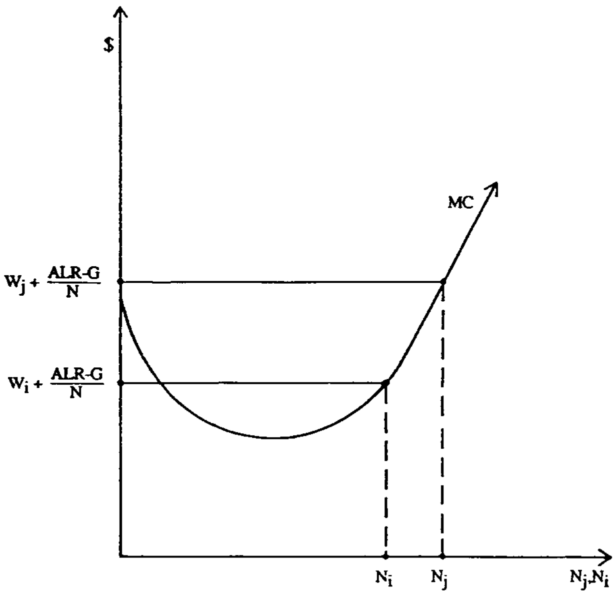

Figure 2

4. PRICE-TAKING EQUILIBRIA WITH A FULL TAX MENU

PRICE-TAKING EQUILIBRIA

Five agents are defined in a price-taking equilibrium setup: households, producers of the composite good, producers of housing, local governments, and a federal government. The behavior of each one is described below.

Households

Given the supply of the LPG, G_i, the price of housing, P_i, in community i, and its income, every household chooses a utility-maximizing consumption bundle. Mobility between communities is assumed to be costless, and therefore the resulting maximized utility, U, is equalized across communities. It follows that for any inhabited

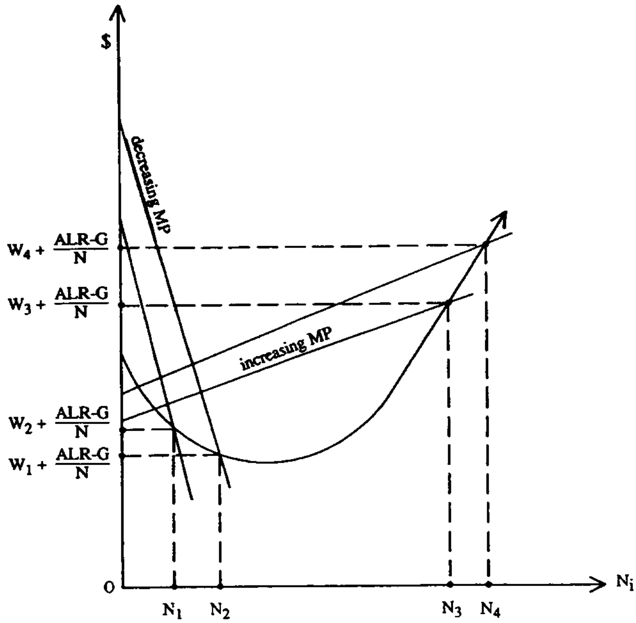

Figure 3

community, we can define the compensated demands for Z_i and H_i, respectively as

$$Z_i = z(P_i, G_i, U) \tag{16}$$

and

$$H_i = h(P_i, G_i, U). \tag{17}$$

As in the preceding section, we assume that all households have the same initial endowment; in particular, each household owns the same share of land in every community and is, therefore, entitled to the same share in profits, Π. Being paid a wage W_i, the gross income earned by a household living in i is $W_i + \Pi$. Paying a personal income tax rate of t_i and a poll tax of T_i, the budget constraint of the representative household is

$$e_i(P_i, G_i, U) \equiv z(P_i, G_i, U) + P_i h(P_i, G_i, U) = (W_i + \Pi)(1 - t_i) - T_i. \tag{18}$$

Composite Good-Producing Firms

The composite good, the numeraire, is produced in each community by price and wage-taking firms, implying, therefore, that the wage is equal to the marginal (and average) product of labor, w_i.

$$W_i = w_i. \tag{19}$$

Of course, no profits are derived in the composite good production.

Housing-Producing Firms

Price-taking firms choose composite good inputs, X_i, to maximize their profits, which is the difference between the value of housing output and the cost of inputs. With a fixed amount of land, the return on land, R_i, is given by

$$R_i = r(P_i) = \underset{X_i}{\text{Max}} \, [f(X_i)P_i - X_i]. \tag{20}$$

Maximizing profit by choosing X_i, when P_i is given, requires

$$f'(X_i)P_i = 1, \tag{21}$$

of which the inverse is the aggregate demand of housing producers in community i for the composite good input. This demand is represented by

$$X_i = x(P_i). \tag{22}$$

Local Governments

We assume that in supplying the LPG, local governments behave as profit-maximizing developers. More specifically, a developer, on behalf of the landlords (the total population) rents the land to the housing producers, finances the LPG from the rent revenue, pays taxes, and redistributes the balance to the landlords. This assumption is often used in the literature to fill the gap in Tiebout's specification regarding the objective function of local governments.

Following Pines's (1991) specification, local governments take as given the effect of G_i on land rent, R_i, implied by equations (18) and (20), which yields

$$R_i = r[p(G_i)] \tag{23}$$

for given U, T_i, t_i, W_i, and Π, where $p(G_i)$ solves equation (18) for the same parameters.

Given equation (23), the local governments choose that amount of the LPG, G_i, which maximizes the net return on land, $\pi(G_i)$, where

$$\pi(G_i) = [[r(p(G_i))\,(1 - \tau_i) - W_i] - G_i](1 - \gamma_i), \tag{24}$$

for given U, W_i, T_i, t_i, π, τ_i and γ_i, where τ_i is a federal tax rate on gross land rent (i.e., a tax rate on land rent from which local taxes are not deducted), and γ_i is a federal tax rate on net land rent (i.e., a tax rate on rent from which local taxes are deductible).

This maximization requires

$$\pi'(\bullet) = r'(\bullet)p'(\bullet)(1 - \tau_i) - 1 = 0. \tag{25}$$

We evaluate equation (25) by calculating $r'(\bullet)p'(\bullet)$. First, we apply the envelope theorem on the maximization in equation (20) to obtain

$$r'_i(\bullet) = f(X_i). \tag{26}$$

Then, we differentiate equation (18) with respect to G_i and P_i to obtain

$$p'(G_i) = -e^i_G/e^i_p = -e^i_G/H_i = (u^i_G/u^i_Z)/H_i, \tag{27}$$

where use is made of the derivative property of the expenditure function and the third equation follows from applying the envelope theorem to the definition of the expenditure function.

Finally, substituting equations (26) and (27) into equation (25), it reduces to a more familiar relationship:

$$-[f(X_i)/H_i]\, e^i_G = [f(X_i)/H_i]u^i_G/u^i_Z = 1/(1 - \tau_i), \tag{28}$$

which, for $\tau_i = 0$, becomes the Samuelson rule for the provision of the public good.

Federal Government

The federal government spends G (which, by assumption, has no direct effect on utility) and finances the cost by the taxes specified above. Accordingly, the budget of the government is represented by

$$G = \Sigma_i[N_i[T_i + (\Pi + W_i)t_i] + [f(X_i)P_i - X_i]\tau_i + [[f(X_i)P_i - X_i](1 - \tau_i) - G_i]\gamma_i. \quad (29)$$

Market Clearing Conditions and Equilibrium

Using equations (16), (19), and (22), the clearing of the composite good market can be reduced to

$$\Sigma_i[N_i z(P_i, G_i, U) + x(P_i) + G_i - N_i W_i] + G = 0. \quad (30)$$

Likewise, using equations (17) and (22), in clearing the housing market, equation (10) becomes

$$N_i h(P_i, G_i, U) - f(x(P_i)) = 0. \quad (31)$$

Equations (18) and (19) yield the representative household's budget constraint:

$$e_i(P_i, G_i, U) - (W_i + \Pi)(1 - t_i) + T_i = 0. \quad (32)$$

Equations (17), (22), (28), and (31) imply

$$-N_i e^i_G = 1/(1 - \tau_i). \quad (33)$$

Finally, equations (19), (22), and (29) yield

$$G - \Sigma_i[N_i[T_i + (\Pi + W_i)t_i] + [f(x(P_i))P_i - x(P_i)](\tau_i + (1 - \tau_i)\gamma_i) - G_i\gamma_i = 0. \quad (34)$$

Given the full set of tax instruments $\{T_i, t_i, \tau_i; \gamma_i; i = 1, \ldots, I\}$, a price-taking equilibrium can be defined as a set $\{U, \Pi, N_i, P_i, G_i; i =$

$1, \ldots, I\}$ satisfying equations (11) and (30 through 34). This system constitutes $3I + 3$ equations and $3I + 2$ variables. It turns out that not all the tax rates may be discretionary; one rate must be determined endogenously. Given the endogenous tax rate, we assume that there exists a unique solution to these $3I + 3$ equations and $3I + 3$ variables.

OPTIMAL TAXATION

In section 2, we showed that it is optimal to finance the public expenditure of the central government by a nationwide poll tax of G/N. We have also shown that under common ownership, a land rent tax is equivalent to a poll tax, so that all or part of G can optimally be financed by taxing land rent. The superiority of poll taxation carries over to the present extended framework. However, because in the present analysis we are concerned also with financing the LPG, we have to distinguish between net and gross land rent taxation. Our former result regarding the equivalence of taxation of land rent to poll tax at W_i carries over to net land taxation only, not to gross land taxation. We can see this by observing that given any equilibrium allocation with the land rent tax system $\{\gamma_i\}$ we can substitute a poll tax of magnitude T, calculated according to

$$T = \Sigma_i[f(x(P_i))P_i - x(P_i) - G_i]\gamma_i)/N_i, \tag{35}$$

for the land tax without violating any of the equations (11) and (30) through (34).

Note that, as in section 2, the opposite is not necessarily true because even when $\gamma_i = 1$ for all i, the total tax revenue, NT, which follows from equation (35), may not be sufficient to finance the federal public consumption, G, and therefore cannot be a substitute for a straight poll tax. Only when the federal public expenditure, G, is smaller than the total surplus, can a tax on the surplus be used as a perfect substitute for the poll tax. There is, therefore, a difference between the LPG and G. In the case of the LPG, if equilibrium exists at all, the land rent of any given community is always sufficient for financing G_i. Otherwise, the community is abandoned by the profit-maximizing developer.

5. THE DISTORTIONS ASSOCIATED WITH FINANCING G BY INCOME TAXES

In this section, we investigate the case where G is financed by a gross land rent tax and personal income tax. The reason why we are interested in the effect of these taxes is that in the real world a differentiated poll tax system is based on equity considerations (a different head tax on individuals from different population groups) is not feasible. This is sc because implementation requires unobserved information about the taxpayer's characteristics. Indeed, this drawback is relevant only in the case of a heterogeneous population, which is not the case illustrated here. We can still continue using the simplified specification of homogeneous population for investigating the distortive effects of these taxes, although their very use is explained by the infeasibility of a poll tax when the population is heterogeneous.[6]

In view of our preceding discussion, one may wonder whether a lump-sum tax can be implemented through net land rent taxation, at least in a case when it exceeds G. Even in the case where this rent is sufficient to finance G, not only is its mere assessment complicated but it is not necessarily better, equitywise, than even a uniform head tax. To be certain of its desirability, we would have to consider all the sources of an individual's income, including those from net land rents. But in this case, the net land rent tax would become part of the individual's income tax.

We therefore assume from here on that optimal taxation, whether through a poll tax or a tax on net land rent, is infeasible and, instead, concentrate on the implications of using second-best tax instruments, in particular the distortive effects of taxing income from land and labor.

GROSS LAND RENT TAX OR CORPORATE PROFIT TAX, τ_i

In general, in the long run, where land is the only nonmobile factor, and in particular in our model, federal gross land rent and corporate profit taxes are identical and distortive. To illuminate this issue, let $T_i = t_i = \gamma_i = 0$ for all i and $\tau_i > 0$ for at least some i. It is clear that in this case, equation (28) is inconsistent with equation (14), which is the Samuelson rule for efficient provision of a pure public good.

The distortion may be surprising because the tax is imposed on a factor with fixed supply. However, the puzzle is solved when we realize that the quality of land is not infinitely inelastic but instead responds to changes in the supply of the LPG. This change in quality is reflected in its net return, $\pi(G_i)$. As a matter of fact, imposing a tax of τ_i on the gross rent by the central government is equivalent to imposing the same tax rate on net land rent (i.e., $\gamma_i = \tau_i$) and, in addition, a tax rate of τ_i on the provision of the LPG, G_i.

This can be summarized by

Proposition 1: Financing G by land rent tax where local taxes are not deductible result in underprovision[7] of the LPG.

PERSONAL INCOME TAX, t_i

Now we assume that $T_i = \tau_i = \gamma_i = 0$ for all i and $t_i > 0$ for at least some i. It is clear that if the federal government possesses the required information and can discriminate among communities (cities), the optimal uniform poll tax rate would be achieved. More specifically, this result can be obtained by letting t_i satisfy

$$t_i = G/\{Nw_i + \sum_j [P_j^* f(x_j(P_j^*)) - x_j(P_j^*) - G_i^*]\}, \tag{36}$$

where P_i fulfills equation (21) and an asterisk denotes the optimal value of the respective variable. It follows from equation (36) that the tax rate should decrease with w_i.

Of course, equation (36) is practical only when the population is homogeneous. When the population is heterogeneous, community specific tax rates cannot by themselves guarantee equalization of the tax burden across communities for a given household type. In this case, the tax rate should vary, not only with communities but also with household types. However, this involves precisely the same monitoring problems that make the poll tax and land rent tax impractical.

According to equation (36), the tax rate declines with w_i. In practice, it is common to apply the same (distortive) tax rate to all communities, which, within the framework of our simple model, is reflected in $t_i = t$.[8] To verify the effect of this second-best tax structure on the resource allocation, we return once again to the diagrammatic exposition of marginal cost and benefit associated with population size.

Consider Figure 4. The supply of labor (housing units) curve S depends on the utility level of the population. The higher the utility level, the higher is S for any given population size (i.e., it costs more to accommodate the same number of households at a higher level of utility). Thus curve S^* denotes the supply curve in the optimum, as in Figure 2, and S_i $\grave{i} = 1.2$ (two alternatives, only one at a time possible) denotes the supply curve in the second-best case (SBC). Let ALR^* and $ALR^\grave{}$ be the aggregate land rents in the optimum and the SBC, respectively. The demand for labor in city i in the optimum is given by the horizontal line

$$w_i + \frac{ARL* - G}{N}.$$

In the SBC this demand is represented by

$$(w_i + \frac{ALR^\grave{}}{N})(1 - t).$$

Define a small city to be a city in which the following inequality holds:

$$w_i + \frac{ARL* - G}{N} < (w_i + \frac{ALR^\grave{}}{N})(1 - t).$$

Thus a small city is defined in this case to be a city in which the demand for labor in the SBC is larger than in the optimum. Define a large city as one that is not small. It is easy to see that a large city has a higher wage rate and more population than any of the small cities, and if there are $i \neq j$ such that $w_i \neq w_j$, then small and large cities exist (otherwise the total population will not be equal in the first and second best). In Figure 4, demands of a typical small city ($i = s$) and of a typical large city ($i = b$) are depicted. It is clear from Figure 4 that the small cities are larger in the case of the second best than in the optimum. The large cities are not necessarily smaller in the SBC than in the optimum, as seen in Figure 4. However, at least some of the large cities must be smaller in the SBC than they are in the optimum to account for the increase in the size of the population in the small cities.

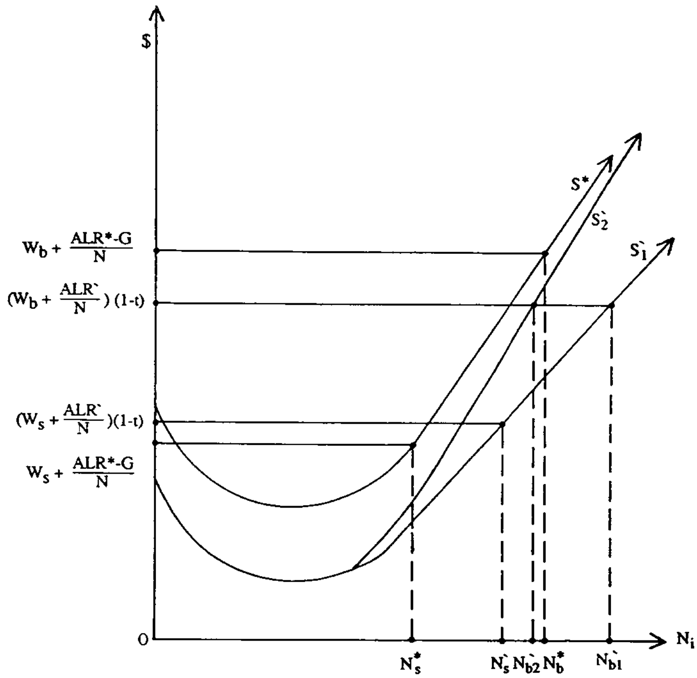

Figure 4
NOTE: $S_1^`$ and $S_2^`$ are two alternative supply curves and $N_{b1}^`$ and $N_{b2}^`$ are two possible alternative outcomes to the SBC of city *b*.

In the small communities, the marginal benefit of city size is negative at the second-best point and it will increase efficiency to reduce their size. In the large communities, we do not know whether the city population is too small or too large because the reduction in nominal income and the consequent reduction in utility have opposite effects on population size. However, we do know that the amount of housing is too low (for a rigorous proof, see the appendix) and that an additional unit of housing in the SBC has positive net marginal benefits. In the appendix, we also show that if housing and LPG are net substitutes, then the supply of the LPG in small communities is excessive in the SBC, in the sense that utility can be increased by reducing the supply of the LPG. These results are summarized in the following proposition.[9]

Proposition 2 (the proof appears in the appendix): There is a threshold of city wage rate such that all cities with higher wage rate are considered large cities and all cities with lower or equal wage rate are considered small.

a. In equilibrium with a uniform income tax rate, given the level of the LPG, the common utility can be increased if the production of housing increases in the large communities and decreases in the small communities.
b. Given the level of the LPG, the common utility can be increased if the per household consumption of housing decreases in the large communities and increases in the small ones.
c. If housing and LPG are net substitutes, then the net social benefit of the LPG is negative, indicating that too many resources are devoted to LPG.

Points a and b imply, of course, that the common utility can be increased if the population of small communities decreases, as illustrated in Figure 4.

GROSS LAND RENT TAX AS A SECOND BEST

So far we have discussed the specific distortive effects of gross land rent tax and personal income tax, assuming in each case that the other tax rate is zero. It is interesting, however, to reexamine whether this should, indeed, be the case in the relevant second-best context, where both taxes can be collected simultaneously. Specifically, we examine whether introducing a gross land rent tax is distortive, once a uniform proportional personal income tax is collected. This question can be resolved by substituting $T_i = \gamma_i = 0$, $t_i = t$, and $\tau_i = \tau$, and differentiating equations (30), (31), (32), and (34) with respect to t, τ, P_i, and Π, bearing in mind that equation (33) defines G_i as a function of τ. The necessary conditions can be shown to imply that both t and τ should be used in such a second-best problem, although we are unable to characterize the solution similarly to the case of personal income tax alone.

6. PRACTICAL CONSIDERATIONS

The misallocation discussed in this article arises because a uniform tax across both communities and socioeconomic groups, although being efficient, is regressive and may therefore yield an undesirable income distribution.

The tax structure that is both efficient and equitable, from the planner viewpoint, requires an application of different poll tax on each socioeconomic group that does not vary with community (of employment), where a socioeconomic group is distinguished by, among other attributes, skill. The implementation of such a structure calls for identifying the group to which each household belongs and, therefore, the household's unobservable skill.

The common practice is to use wage as the proxy for skill. This leads to distortions, some of which are extensively studied in the literature, such as the distortion associated with the allocation of time between work and leisure. The present article focuses, instead, on the intercommunity misallocation, resulting from using nominal income as the proxy for skill. Because the same skill can earn different nominal wages and different skills can earn the same wage in different communities, the present practice combines households of different skills into one taxable group and classifies households with identical skills in different groups.

Indeed, one can argue that allowing deduction of imputed rent realized by owner-occupiers from their taxable income adjusts the tax rates in the right direction because the imputed rent increases with community size and is, therefore, positively correlated with wages. However, this deduction is very crude and its intracommunity variation may exceed its intercommunity variation. We shall, therefore, disregard this deduction in the following discussion.

As a matter of fact it is practically possible to identify identical skill groups across communities, thus allowing the implementation of equal treatment of households possessing the same skill. To that end we have to define a set of occupations such that (1) each occupation requires the same skill everywhere (occupations such as porters, mailmen, bank branch managers, certain clerical workers, etc. are able to fulfill this requirement); (2) these occupations have to exist in all communities; and (3) these occupations have to be chosen so that they represent the whole range of incomes in each of the communities.

Because these occupations exist everywhere, we can identify the set of wages paid to the same occupation in different communities as being equivalent to each other in real terms. As these wages represent the full range of possible wages, we can establish groups of wages equivalent to each other in different communities. Each equivalence group (each a set of equivalent wages in all the different communities) represents, therefore, the same skill level and can be used to identify the household's skill in each community. Once all the population groups are identified, the desired identical tax can be imposed on all group members in the different communities and thus the desired income distribution can be obtained efficiently.

7. CONCLUDING COMMENTS

When the population is homogeneous, having the same preferences, skills, and initial endowment, efficiency (with equal treatment of equals) can be achieved by a uniform poll tax across communities. When the population is heterogeneous, being composed of types different from one another by preferences, skills, or initial endowment, the implementation of the social optimum by a poll tax requires its variability according to type. This complication can be accommodated if nominal income is an unequivocal identifier of the type. We know that, in general, this is not the case, particularly in the context of population distribution among communities where the nominal income varies according to community and not just according to type. The current practice of uniform personal income tax rates that does not account for intercommunity variability is, therefore, distortive.

Taxes on net land rent cannot in practice become a perfect substitute for the poll tax for three main reasons. First, the tax base may be too narrow for financing the federal consumption. Second, in the case of the heterogeneous population, the tax rate should vary according to ownership. This would make the land rent tax a personal income tax with its typical limitations. Third, the information on the rent itself is hard to obtain, especially by a federal assessor. This is a kind of tax that should be left for financing LPG by local governments.

The main result derived in this article, namely, that the equilibrium nominal income can vary across communities—real income being the same, and, therefore, uniform personal income tax rates on nominal income is distortive—is not confined to the specification of community structure adopted in this paper. Rather, it equally applies to other specifications when communities are a priori identical and a posteriori different, as in Hochman (1981, 1990) and Wilson (1987), because of increasing returns to scale and specialization. Similarly, our conclusions regarding the limitation of the net land rent tax, the distortive effect of corporate tax, and the potential usefulness of the latter in the context of the second best can also be extended to these specifications. However, the more specific results regarding the characteristics of the distorted resource allocation need not apply. For example, in Wilson's case, bigness is not associated with higher productivity and, therefore, with a higher wage rate as in our case.

APPENDIX
Proof of Proposition 2

To verify the effect of the tax structure on the resource allocation, we evaluate the shadow prices associated with this distorted allocation. To this end, we assume that G_i is exogenously given and derive necessary conditions for maximizing U subject to the $2I + 2$ constraints: equations (11), (31), and (32) through (34). This is a degenerate maximization problem, because the feasible set fully determines the solution of the $2I + 2$ variables: N_i, P_i, U, Π, and t. This procedure, however, is useful for obtaining shadow prices and, in particular, the shadow price of housing. We see this technique in Arnott (1979a, 1979b) and Pines and Sadka (1985).

Accordingly, the relevant Lagrangian is

$$L = U - \lambda\{\Sigma_i[N_i z + x_i + G_i - N_i w_i] + G\} - \Sigma_i \rho_i\{N_i h - f\} - \mu(\Sigma_i N_i - N) - \Sigma_i \delta_i[e - (w_i + \Pi)(1 - t)] - \psi[G - \Sigma_i N_i(w_i + \Pi)t]. \quad \text{(A1)}$$

The necessary condition for maximizing L with respect to P_i is

$$-\lambda[N_i z_{P_i} + x' - \rho_i\{N_i h_{P_i} - f']x'\} - \delta_i e_{P_i} = 0. \quad \text{(A2)}$$

(continued)

APPENDIX: Continued

Dividing equation (A1) across by λ, substituting equation (21) and the well-known relation $z_{P_i} = -P_i h_{P_i}$ into the result yield

$$\Delta_i(N_i h_P^i - x_i'/P_i) = h^i(\delta_i/\lambda), \tag{A3}$$

where Δ_i denotes the difference between the market and the shadow prices of housing in community i, that is,

$$\Delta_i \equiv P_i - \rho_i\lambda. \tag{A4}$$

The necessary condition for maximizing U with respect to Π is

$$\psi\Sigma_i N_i t - \Sigma_i\delta_i(1-t) = 0. \tag{A5}$$

Dividing across by λ and using equation (11), yields

$$\Sigma_i(\delta_i/\lambda)(1-t) + Nt(\psi/\lambda) = 0. \tag{A6}$$

The necessary condition for maximizing U with respect to t is

$$\psi\Sigma_i N_i(w_i + \Pi) - \Sigma_i\delta_i(w_i + \Pi) = 0. \tag{A7}$$

Dividing across by λ, and substituting equations (32) and (A4) into the result, yields

$$\Sigma_i N_i(w_i + \Pi)(\psi/\lambda) - \Sigma_i(w_i + \Pi)(\delta_i/\lambda) = 0. \tag{A8}$$

The necessary condition for maximizing U with respect to N_i is

$$-\lambda[z_i - w_i] - \rho_i h_i - \mu + \psi(w_i + \Pi)t = 0. \tag{A9}$$

Dividing across by λ, and substituting equations (32) and (A4) into the result yields

$$h^i\Delta_i = \{[1 - t(1 + \psi/\lambda)]\Pi + \mu/\lambda\} - [t(1 + \psi/\lambda)]w_i. \tag{A10}$$

Now, because by the envelope theorem, $dU/dG = -\psi$, and because the maximized U increases with the composite good and declines with G, we can conclude that ψ/λ is positive. However, if, on the one hand, δ_i/λ is positive for all i, the left-hand side of equation (A6) must be positive, which is impossible; if, on the other hand, δ_i/λ is negative for all i, the left-hand side of equation (A8) is positive, which again is impossible. We can therefore conclude that for some i, δ_i/λ is positive and for others, it is negative.[10]

We can now determine the sign of Δ_i, that is, the relationship between the market and the shadow prices. We do this in two steps: First, because the coefficient of Δ_i in

APPENDIX: Continued

equation (A3) is negative, the sign of Δ_i is the opposite of the sign of δ_i/λ. Hence there must exist some i where Δ_i is positive and some other i where it is negative. Also, due to continuity, there exists some i, with productivity denoted by w^o, where Δ_i vanishes. Second, equation (A10) can be rewritten as

$$\Delta_i = A - Bw_i, \tag{A11}$$

where A is constant and B is a positive constant. The right-hand side of equation (A11) is a strictly decreasing function of w_i, which, by the conclusion of step (i) vanishes for $w_i = w^o$. Therefore, it must be the case that Δ_i is positive for communities where productivity is lower than w^o and negative where it is higher.

It follows from the definition of Δ_i, equation (A4), and the conclusion from the second step above that there always exists some i for which $w_i = w^o$ such that

$$\rho_i \gtreqless p_i \text{ as } w_i \gtreqless w^o. \tag{A12}$$

In other words, the shadow price exceeds (is exceeded by) the market price in communities with productivity higher (lower) than w^o. A difference between the shadow and the market prices indicates the direction of change in resource allocation at the distoral allocation that can enhance utility. More specifically, if agents take as given the shadow price rather than the market price, utility is increased. Because a higher price of housing is associated with higher production and lower consumption, the first and the second steps of proposition 2 follow.

We turn now to the third part of proposition 2. Applying the envelope theorem, the marginal social benefit of the given level of LPG in community i can be determined by differentiating the Lagrangian of the above (degenerate) maximization problem with respect to G_i. This procedure yields

$$(dU/dG_i)/\lambda = (-N_i e^i_G - 1) - (\psi/\lambda + N_i e^i_G\, \delta_i/\lambda - N_i h^i_G\, \Delta_i). \tag{A13}$$

The left-hand side of equation (A13) is the marginal social benefit in terms of the composite good of providing the LPG by the local government of i. The first parenthesis on the right-hand side is the net benefit of the LPG as perceived by the local government of i under equilibrium with a uniform income tax. To determine whether this perceived net benefit overstates or understates the social benefit, we have to evaluate the sign of the second parenthesis. The first term, ψ/λ, is always positive, as argued previously. By nonsatiation of the LPG, e^i_G is always negative, and, for the less productive communities, δ_i/λ is negative as shown above. Hence, for the less productive communities, the second term in the second parenthesis is also positive.

(continued)

APPENDIX: Continued

We have shown that for the less productive communities, Δ_i is positive. The sign of h_G^i is negative (positive) if housing and the *LPG* are net substitutes (complements). Hence, if they are net substitutes, for the less productive communities, the third term, being preceded by a negative sign, is also positive. This proves the third part of proposition 2.

NOTES

1. These distortions are sometimes discussed in the context of "fiscal externalities" (see Buchanan and Goetz 1972; Flatters, Henderson, and Mieszkowski 1974) or in the context of "interregional tax competition" (see Wilson 1986; Zodrow and Mieszkowski 1986).

2. This simplified exposition was suggested to us by an insightful referee.

3. Whether *ALR* is sufficiently large to finance *G* or not depends on whether globally the economy exhibits scale diseconomies or scale economies. Specifically, applying the envelope theorem to the maximization problem, we have

$$ALR \overset{>}{\underset{<}{=}} G \text{ as } dZ/dN \overset{<}{\underset{>}{=}} 0.$$

dZ/dN is the effect of the total population on welfare which reflects the outcome of two opposing forces. The first is the increase in housing marginal cost, which generates scale diseconomies; the second is the cost sharing of *G*, which generates scale economies. As a matter of fact, the above relationship is a generalized version of the Henry George rule applied under our specification to the expenditure of the central government. (In the existing literature, the rule is discussed only in the context of LPG. See discussion of the generalized version of the rule in Berglas and Pines 1981.)

4. One can conceive of a system of communities, each located on a separate island, as in Stiglitz (1977), where transporting the composite good among the islands and migration are both costless, whereas interisland commuting is prohibitively costly.

5. The relationship between marginal productivity and size is not that robust after all and may be different under other specifications. In particular, if the marginal productivity of the composite good were decreasing with population size, as in Stiglitz (1977), rather than being constant, w_i, as in our specification, then the marginal benefit curve in Figure 2 would have been downward sloping. In this case, the marginal productivity in the larger city may be lower than in the smaller city, as depicted in Figure 3 in the curves associated with w_1 and w_2. For nondecreasing marginal product of labor, however, as in our case, as well as in the case of increasing returns to scale in the basic industry, which is the case in the large metropolitan cities (see Hochman 1990), the result that higher wages imply larger cities holds throughout, as is shown in Figure 3 by the curves associated with w_3 and w_4.

6. This approach is often used in the literature on the distortive effect of property tax. For example, see Zodrow and Mieszkowski (1986).

7. Here and elsewhere, "underprovision" is used locally; that is, a small increase at the distorted optimum ceteris paribus would increase the value of the objective function.

8. In this case, the set of $3I + 3$ equations, equations (11) and (30) through (34), completely determines the set $\{t, U, \Pi, N_i, P_i, G_i; i = 1, \ldots, I\}$.

9. The result in the proposition below appear somewhat stronger than the results derived from the diagrammatic analysis carried out above. Three reasons may have caused these differences. First, the results of the diagrammatical exposition are based on comparisons between the second- and first-best solutions, whereas the results of the proposition below are based on marginal deviations from the second-best case; obviously some of the seemingly stronger ceteris paribus results may not carry over to the comparison between the two final solutions. Second, the threshold between small and large cities in the two cases does not necessarily coincide. Third, it is possible that we failed to prove diagrammatically some of the results that we proved analytically.

10. Noticing that the coefficient of Δ_i in equation (A3) is always negative, we conclude that δ_i/λ cannot be zero for all i. Otherwise, it follows from equations (A3) and (A6) that $\Delta = \psi/\lambda = 0$, implying that the allocation is efficient in the first-best sense. This, however, is impossible because w_i varies across cities and the tax rate does not, thus violating equation (36).

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