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Decentralized Tax and Public Service Policies with Differential Mobility of Residents

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Abstract

A central focus of an extensive literature on fiscal competition has been on how the decentralization of tax and service policy affects efficiency, generally whether public services are inefficiently under- or overprovided. This question has traditionally been addressed in a framework in which the tax base regions compete for mobile capital.

Here I am also interested in the impact of fiscal decentralization on both public service provision and tax policy but in a framework with both labor and capital mobility. Rather than limiting the competing regions to taxing only capital or only labor, I consider the endogenous choice of the two tax instruments in the context of two related models. In the first model, while labor is mobile it is also homogeneous. In this model I show that regions will choose to only tax income and not capital when public service costs are proportionate to the population and, by doing so, will provide the efficient level of public services. However, if there are public service costs not proportionate to the population, "fixed costs," if given the option, regions will tax or subsidize capital as well as tax income. As a result of capital taxation, the public service is underprovided.

I extend the model along the lines of Wildasin (AER, 2000) to consider two groups of workers who differ in both mobility and, in my case, human capital (skill). Unlike Wildasin, the difference in income is exogenous and not the result of investment decisions. In this model, I first consider the policies chosen by these regions when they can only tax income. I find that the public service can be either over or underprovided, depending on the relative impact of changes in public services and taxes on the mobility of the two groups. Next, I consider whether, in the absence of fixed costs, regions will want to tax or subsidize capital and find that in general they will with the magnitude and sign of a tax (subsidy) on capital depending on how capital taxation affects the relative mobility of the two groups of workers.

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In what has become an extensive literature, most research in the field of fiscal competition has focused, explicitly or implicitly, on competition between jurisdictions for physical or, perhaps, financial capital. Most of these studies assume a very general notion of capital probably most consistent with the phenomenon of business owners deciding in which jurisdiction they should locate a plant or operation. Given the focus on the location of plants and physical capital, the literature on fiscal competition has primarily focused on how this competition influences the decisions of governments on taxes imposed on businesses, particularly taxes on physical capital such as property taxes, and government services that are used as inputs in production. That labor is typically assumed immobile in these studies of fiscal competition, is more evidence of the focus of this research on physical capital.

While there is certainly evidence, both anecdotal and from rigorous empirical studies, that local, regional, and frequently even national governments compete for physical capital and investment using both tax and service instruments, here we intend to consider competition for another form of capital, human capital. In contrast to the traditional framework (for example, Zodrow and Mieszkowski (1986) and Wilson (1986)), we assume both labor and capital are mobile among regions. While Bucovetsky and Wilson (1991), Keen and Marchand (1997), and Huber (1999) consider the models in which labor supply is explicitly modeled and taxed, these models assume labor is immobile with only capital being mobile. In contrast to our model, however, in these models labor supply (for an individual) is elastic.

While studies including Hoyt (1991, 1992a 1992b), Wilson (1995), and Brueckner (1999) have mobile labor, our framework differs from those found in these papers in several respects. Though labor is mobile in the papers by Hoyt and Wilson, all individuals are identical and the focus is still on the tax on capital, that is, a property tax. While Brueckner (1999) has heterogeneity, again the focus is on capital taxation.

With the exception of the few studies noted above, most studies of decentralized taxation of human or physical capital assume an exogenously determined tax base. Here, however, I consider the endogenous determination of both tax rates and tax bases when both capital and labor are mobile. While in the United States, the primary source of tax revenue for local governments is the property tax, a tax primarily on capital; this is not the case for state governments. As can be seen in *Table 1*, in 2007 local governments collected 76.2 percent of their revenues from the property tax, another 1.3 percent from the corporate net income tax and only 3.9 percent from individual income taxes. In contrast, state governments collected 35.8 percent of their taxes from the individual income tax and only 1.6 percent and 6.8 percent from the property and corporate net income taxes.

Table 1: State and Local Tax Revenues, U.S. Total 2007[a]

	State and Local		Local		State	
Total	1,270,640	%	511,429	%	759,211	%
Individual Income	291,405	22.9	19,985	3.9	271,420	35.8
Corporate Net Income	58,351	4.6	6,844	1.3	51,507	6.8
Property	401,896	31.6	389,573	76.2	12,323	1.6
General Sales	305,009	24.0	64,317	12.6	240,692	31.7
Select Sales	60,586	4.8	1,684	0.3	58,902	7.8
Motor Vehicle	23,231	1.8	1,412	0.3	21,819	2.9
All Other	130,162	10.2	27,614	5.4	102,548	13.5

Amounts are in $1,000,000. Source: Quarterly Summary of State and Local Government Tax Revenue (http://www.census.gov/govs/www/qtax.html)

I examine this mix of taxation on human capital (income taxation) and physical capital (property taxation) using two distinct frameworks. First, I consider a model with homogeneous, but imperfectly mobile, labor. I model imperfect or costly mobility using the concept of attachment to home following the approach used by Myers (1990) in which there is a distribution of this attachment to home among the population. Using this framework, I consider the mix and level of taxation and public service chosen by a welfare-maximizing regional government when public service costs are strictly proportionate to the population. I then examine the region's policy choices when services exhibit a "fixed" cost, thereby making costs no longer proportionate to the population.

With this simple framework, I find that when public service costs are strictly proportionate to the population, regions will independently choose to only tax income and will provide an efficient level of public services. However, when costs are not strictly proportionate to the population, if allowed, regions will choose to tax or, subsidize, capital as well as tax labor. Whether and how much capital is taxed or subsidized depends on whether capital and labor are substitutes or complements in production and the extent of interregional mobility of labor. As a consequence of this capital taxation, regions will underprovide public services regardless of whether capital is taxed or subsidized. If regions do not have the option to tax capital and can only tax income, the public service is efficiently provided -- even with the existence of fixed costs.

Next I allow for the possibility of heterogeneous workers, specifically two groups of workers, skilled and unskilled, that differ in earnings (wages), tastes for the public service, and interregional mobility. Unlike Wildasin (2000) the distinction between skilled and unskilled is not endogenous, that is, a choice of workers but instead it is exogenously determined. The analysis is done for arbitrary degrees of mobility for the two groups, with the possibility that skilled workers are more or less mobile than unskilled workers. However, evidence on the relationship between educational achievement or skill and geographical mobility suggests that in the U.S. households with higher levels of education tend to be more mobile. In the case of mobile skilled workers, the focus of policy might be the impacts of taxation on the residential location of the highly-skilled; in the case of mobile unskilled workers, redistributive policies that may influence the location of lower skilled workers are the policy focus. Here, I first examine income tax policies when regions are faced with heterogeneous workers with differing degrees of mobility. My focus is on how this differential mobility of workers, along with different tastes for the public service, and different taxable earnings influences the level of the public service the welfare-maximizing regions will provide. When restricted to the income tax, I find that regional governments may either underprovide or overprovide public services. With an income tax, skilled workers generate a "fiscal surplus," that is the revenue collected from them exceeds the cost of providing public services to them while unskilled workers generate a "fiscal deficit." Because of the fiscal surpluses and deficits associated with the two types of workers, regional governments have incentives to attract skilled workers to their region and deter the entry of unskilled workers. Then whether public services are below or above the efficient level of provision depends on the relatively mobility of the two groups of workers and, more importantly, on the relative influence of changes in income tax rates and public services on the mobility of both groups.

Given that the policies of these regional governments will not, in general, result in the efficient provision of public services, I then consider whether, if given the option, regions will choose to tax or, possibly, subsidize capital. I find that, in general, this will be the case with one of two conditions necessary for a region to choose to employ a nonzero tax (subsidy) on capital: the marginal cost of public funds not equaling one when the region only employs the income tax or the two groups of workers respond differently to a tax on capital. Whether regions will tax or subsidize capital depends on the relationships between capital and the two types of labor, specifically whether and how strong a substitute or complement with capital each may be. The other determinant of the level and sign of a tax on capital is the relative impact of a tax increase on the number of workers in each group in the region.

While it may be argued that the findings of models of fiscal competition for physical capital apply to the case of mobile human capital as well, there are some important and obvious distinctions between the two cases. First, while there are obviously reasons to think that physical capital (i.e. different business and industrial activities) may differ in its mobility, the policy implications of differential mobility in the case of physical capital are probably of much less interest than they are in the case of human capital. Differences in human capital imply differences in income, making competition for human capital relevant for both efficiency and equity reasons. Perhaps the most significant difference between the models of capital tax competition and my models of labor tax competition is that in traditional models of tax competition flows of capital only affected tax revenues and not public service costs. Here income taxation induces flows of labor and both revenues and costs in a region are affected. When individuals are identical and public services have constant costs (with respect to the population) and only labor was taxed, migration has no budgetary impacts – revenues collected from an individual would equal to the cost of providing services to him or her. Here, either because of fixed costs of the public service or because there are two groups of workers with different incomes, labor migration has budgetary impacts when only labor is taxed. It is for this reason, that regions have an incentive to tax or subsidize capital as well as labor.

In the next section, I examine the policies chosen by regional governments when workers are homogenous and mobile. My primary interest is in considering the choice of taxing capital and labor with the objective of determining under what conditions, will regions choose to tax capital as well as labor. As mentioned, as the structure of public service costs are critical to a region's choice of whether or not to tax capital, I consider both the case of public service costs being strictly proportionate to the population and the case in which public services have a cost independent of the population. To offer some illustration of the nature and possible magnitude of capital taxation in this model, I discuss the results of a simple numerical parameterization of the model.

In *Section 3*, I extend the model to incorporate two types of labor potentially differing in wages, interregional mobility, and taste for the public service. I first outline and discuss the equilibrium regional policies when they can only tax income. In addition to summarizing the theoretical results obtain with this model, I again provide a simple numerical parameterization of it that offers additional insights. Next, I consider whether and when, in this model, the regional governments will choose to tax or subsidize capital. Again, I provide and discuss a simple numerical parameterization of the model. Finally, section 4 concludes.

2. *Policies with Homogeneous Workers*

In this section, I focus on the choice of income and capital taxation when regional governments are faced with a mobile but homogeneous labor force. As discussed earlier, I first consider the choice of tax and public service policies when public service costs are proportionate to the population and then consider policy choices when public services might exhibit "fixed" costs.

The policies of a single region are assumed to be determined independently of and simultaneously with the policies of the other regions in the economy. The regional government chooses its policies to maximize social welfare subject to its budget constraint. Unlike the central government, the regional government's policies influence wages, population, and profits.

This extensive endogeneity complicates the analysis. This being the case I suppress intermediate steps in the derivation of the results and focus on characterizing the policy choices of the region in a way that allows for interpretation. Technical proofs are relegated to the *Appendix*.

2.1 *The Framework*

I consider a framework in which there are J regions. None of these identical regions are large enough to influence the prices of traded commodities or the utility level received by residents of other regions. As this is the case we focus on the policy choices of a single region and suppress any references to regions and to equilibrium conditions for the entire economy.

Workers and capital are used to produce an intermediate good *(x)* that can be consumed directly or be used to produce one unit of the public service *(g)* per individual. As x is traded its price is set to unity and suppressed. Then the production process in the region is described by the strictly concave function $f(N,K)$ where $f_j = \frac{\partial f}{\partial j} > 0,\ j = N, K$ and $f_{jj} = \frac{\partial^2 f}{\partial j^2} < 0$, with N denoting the number of workers and K denoting the amount of capital in the region. As both the labor and capital markets are assumed to be perfectly competitive, the wage is simply $w = f_N$ with the rate of return on capital denoted by *r*. Profits, or the returns to the local factor of production, are

$$\pi = f(N,K) - Nf_N - Kf_K = f(N,K) - Nw - (r + \tau_k)K \tag{2.1}$$

where τ_k is the (ad-valorem) tax on capital. Rather than closing the model by distributing profits to the workers, I assume they are received by a second group, "landowners" who receives the rent on their endowment of capital, $\frac{1}{J}\overline{K}$, as well.

I examine the use of both the income tax (τ) and capital tax (τ_k) to finance the government good (g). Then the government budget constraint is

$$S(\tau, \tau_k, g) = N(\tau w - g) + \tau_k K = N\left(\tau w - g - \frac{F - \tau_k K}{N}\right) = 0 . \tag{2.2}$$

where F is a fixed cost independent of the number of workers in the region. While this fixed cost is independent of both the population and the level of public service, most of the results I obtain generalize to a cost function of the form c(n,g) = F(g) + c(n)g with F'>0 and c' > 0. I choose the simpler cost function for expositional purposes.

Utility for the workers is defined by $U = x + u(g)$. I assume that individual labor supply is exogenously given. Finally, there are differences among individual workers in the utility they receive by residing in this region rather than another region. If individuals are ordered by mobility then we can think of utility of individual N as given by

$$U(N) = \phi(N) + w(1-\tau) + u(g), \tag{2.3}$$

where $\phi' \equiv \frac{\partial \phi}{\partial N} < 0$. Then as the number of the group of workers increases, the "attachment to home" for the marginal worker diminishes. Note that if we differentiate *(2.3)* with respect to the wage rate *(w)* and the number of workers *(N)* we obtain

$$\frac{dN}{d[w(1-\tau)]} = -\frac{1}{\phi'} > 0 \text{ and } \gamma \equiv \frac{dN}{d[w(1-\tau)]}\frac{w(1-\tau)}{N} = -\frac{1}{\phi'}\frac{w(1-\tau)}{N} . \tag{2.4}$$

The term γ is simply expressing the mobility of the workers in response to changes in their gross wages rates as an elasticity.

2.2 Social Welfare

There are two distinct agents in the model to be considered in the social welfare function: the "landlords" who receive the residual profits in the region as well as the return to capital and the two groups of workers. Here I focus on the "Utilitarian" social welfare function given by

$$W(\tau,\tau_k,g)=\pi(\tau,\tau_k,g)+NU(\tau,\tau_k,g)+\frac{1}{J}r\overline{K} \qquad (2.5)$$

As consumption of the private good enters into the utility function in a linear fashion, utility can essentially be measured in dollars. In essence, this welfare function is simply measuring total income or the income equivalent of all goods in the region.

2.2 Equilibrium Conditions and Comparative Statics

The equilibrium conditions within the region require that the labor markets for both skilled and unskilled workers clear, or

$$w=f_N(N,K) \qquad (2.6a)$$

and

$$r+\tau_k=f_K(N,K). \qquad (2.6b)$$

In addition, it must be the case that the utility of the marginal worker in the region is equal to the utility she could obtain elsewhere. This requires that

$$\phi(N)+w(1-\tau)+u(g)=\overline{U} \qquad (2.7)$$

where $\overline{U}$ represents the utility obtainable for workers in the other regions.

To understand the choice of tax and service policies made by the regional government, I first determine how these policies affect migration and wage rates. To do this, the equilibrium conditions are totally differentiated with respect to the relevant government policy. Doing this gives

$$\hat{w}_\tau=\frac{1}{(1-\tau)}\left(\frac{\gamma}{\gamma-\eta_{ll}}\right)>0,\ \hat{w}_g=-\left(\frac{\gamma}{\gamma-\eta_{ll}}\right)\frac{MRS}{w(1-\tau)}<0,\text{ and }\hat{w}_{\tau_k}=\left(\frac{\eta_{lk}}{\gamma-\eta_{ll}}\right)\frac{1}{(1+\tau_k)} \qquad (2.8)$$

where $\hat{x}=\frac{dx}{x}$, the percentage change in variable x and $MRS=\frac{\partial U}{\partial g}$. In *(2.8)* η_{ij} is the price elasticity of input *i* with respect to the price of input *j*. Using these changes in the wage rates, the impacts of the three policies on the number of workers can be obtained. These are

$$\hat{N}_\tau = \left(\frac{\gamma\eta_{ll}}{\gamma-\eta_{ll}}\right)\frac{1}{(1-\tau)} > 0,\ \hat{N}_g = -\left(\frac{\gamma\eta_{ll}}{\gamma-\eta_{ll}}\right)\frac{MRS}{w(1-\tau)} < 0, \text{ and } \hat{N}_{\tau_k} = \left(\frac{\eta_{lk}\gamma}{\gamma-\eta_{ll}}\right)\frac{1}{(1+\tau_k)} \qquad (2.9)$$

Finally, the stock of capital in a region is affected by changes in both wages and the gross price of capital. Then we have

$$\hat{K}_\tau = \frac{\eta_{kl}}{(1-\tau)}\left(\frac{\gamma}{\gamma-\eta_{ll}}\right) > 0,\ \hat{K}_g = -\eta_{kl}\left(\frac{\gamma}{\gamma-\eta_{ll}}\right)\frac{MRS}{w(1-\tau)} < 0, \text{ and } \hat{K}_{\tau_k} = \left(\eta_{kk} + \frac{\eta_{kl}\eta_{lk}}{(\gamma-\eta_{ll})}\right)\frac{1}{(1+\tau_k)} < 0. \qquad (2.10)$$

2.3 Regional Policies

2.3.1 Policies with No Fixed Costs

The regional government is assumed to choose its policies to maximize social welfare *(2.5)* subject to the government budget constraint *(2.2)*. While the objective is the same as the central government, unlike the policies of a central government, policy choices of the regional government will influence the region's wage rate, population, and capital stock as described by (2.8) – (2.10). This being the case, the first order condition with respect to the income tax rate can be expressed as

$$(\lambda-1)Nw(1+\tau\hat{w}_\tau) = -\lambda\tau_k K(\hat{K}_\tau - \hat{N}_\tau) \qquad (2.11a)$$

with the first order condition with respect to the tax on capital given by

$$(\lambda-1)(K + \tau Nw\hat{w}_{\tau_s}) = -\lambda\tau_k K(\hat{K}_{\tau_s} - \hat{N}_{\tau_s}). \qquad (2.11b)$$

Finally, the first order condition for the public service can be expressed as

$$N(MRS-1) = (\lambda-1)N(1-\tau w\hat{w}_g) - \lambda\tau_k K(\hat{K}_g - \hat{N}_g) \qquad (2.11c)$$

where all three first order conditions were simplified by applying the balanced budget condition.

I first consider whether the region will use a tax on capital before considering what the optimal rate on it might be. If the region does not tax on capital, then the first order condition for the income tax, *(2.11a),* requires λ = 1. With λ = 1 and $\tau_k = 0$, the first order condition for the tax on capital, *(2.11b)* will be satisfied as well. Finally, in this case the first order condition for the public service, *(2.11c),* reduces to $N(MRS - 1) = 0$ and the public service is efficiently provided. These results are summarized in a simple proposition:

Proposition 1: When the costs associated with providing a public service to a single group of workers are proportionate to the number of workers, the use of an income tax on these workers to finance the public service will result in the efficient level of public service regardless of the mobility of the group. Further, the optimal tax rate on capital is zero.

Given that the region had an efficient level of the public service in the absence of capital taxation, it is not surprising to that it does not tax capital. With public service costs strictly proportional to the population, the income tax serves two purposes. First, it raises the revenue needed to finance the public service. Second, it ensures that the cost of providing the public service to another worker is exactly offset by the revenue obtained from the worker. This feature of the income tax distinguishes it from the tax on capital. Since the cost of the public service is assumed to be unrelated to the capital stock in the region, while flows of capital into or out of the region will change tax revenue they do not change public service costs.

2.3.2 Policies with Fixed Costs of Public Services

I now consider the case in which there is a fixed cost of providing the public service. With fixed costs, the first order condition with respect to the income tax rate is

$$(\lambda - 1)Nw(1 + \tau\hat{w}_\tau) = \lambda\left((\tau_k K - F)\hat{N}_\tau - \tau_k K\hat{K}_\tau\right) \tag{2.12a}$$

and with respect to the capital tax rate,

$$(\lambda - 1)(K + \tau Nw\hat{w}_{\tau_k}) = \lambda\left((\tau_k K - F)\hat{N}_{\tau_k} - \tau_k K\hat{K}_{\tau_k}\right). \tag{2.12b}$$

Finally the first order condition with respect to the public service is

$$N(MRS - 1) = (\lambda - 1)\left(N(1 - \tau w\hat{w}_g)\right) + \lambda\left((\tau_k K - F)\hat{N}_g - \tau_k K\hat{K}_g\right). \tag{2.12c}$$

where I again simplify the first order conditions by applying the balanced budget condition.

Again, I first consider the case when the regional government only uses income taxation making $\tau_k = 0$ in *(2.12a)* and *(2.12c)* with *(2.12b)* not applying. With $\tau_k = 0$, the right side of *(2.12a)* is positive. Then for *(2.12a)* to be satisfied $\lambda > 1$. From *(2.8),* $\hat{w}_g = -\frac{MRS}{w}\hat{w}_\tau$. This being the case, then any income tax rate and (balanced-budget) level of public service that satisfies *(2.12a)* also ensures that the right side of *(2.12c)* equals zero, meaning that for *(2.12c)* to be satisfied, $MRS = 1$. Thus even with the existence of a fixed cost, the public service is efficiently provided if regions only use the income tax.

Will the region choose to employ any tax on capital? To consider this question, evaluate *(2.12b)* when $\tau_k = 0$,

$$\left.\frac{\partial \tilde{W}}{\partial \tau_k}\right|_{\tau_k=0} = (\lambda - 1)\left(K + \tau N w \hat{w}_{\tau_k}\right) + \lambda F \hat{N}_{\tau_k} \qquad (2.13)$$

where $\tilde{W}$ refers to the value of the welfare function with optimally chosen income tax and public service policies. Recall that $\lambda > 1$ when $\tau_k = 0$ and *(2.12a)* and *(2.12c)* are satisfied. Then if capital and labor are substitutes $(\eta_{lk} > 0)$ the region will impose at least some tax on capital as the tax will increase the wage rate and the population. Since $\lambda > 1$ even if increases in τ_k have no impact on the labor market $\left(\eta_{lk} = 0,\ \hat{w}_{\tau_k} = 0,\ \hat{N}_{\tau_k} = 0\right)$ the region will again impose a tax on capital as the benefits of the increased revenue, λK, exceed the loss in profits, $-K$. This leaves the case of when capital and labor are complements $(\eta_{lk} < 0)$. Using *(2.12a)* I can substitute for the value of λ when $\tau_k = 0$ in *(2.13)*. Making this substitution and substituting for $\hat{w}_{\tau_k}$ and $\hat{N}_{\tau_k}$ in *(2.13)* using *(2.8)* and *(2.9)* gives

$$\left(\frac{\gamma}{\gamma - \eta_{ll}}\right)\left(-\eta_{ll} K + \left((1-\tau)(\eta_{ll} + \eta_{lk}) + \tau\eta_{lk}\right) N w\right) > (<)\ 0 \Rightarrow \left.\frac{\partial \tilde{W}}{\partial \tau_k}\right|_{\tau_k=0} > (<)\ 0. \qquad (2.13')$$

As *(2.13')* indicates, if the capital and labor are not too strong of complements, labor is relatively mobile, and capital is a relatively significant share of the potential tax base, we expect $\left.\frac{\partial \tilde{W}}{\partial \tau_k}\right|_{\tau_k=0}$ to be positive. Though as *(2.13')* also indicates, $\left.\frac{\partial \tilde{W}}{\partial \tau_k}\right|_{\tau_k=0}$ may not be positive if the two factors of production are strong complements, labor is relatively immobile, and wages in the region *(Nw)* are much greater than capital costs *(K)*.

If *(2.13')* is positive, the region will tax capital. It does so in this case and not in the absence of fixed costs because the marginal cost of public funds *(MCPF)* exceeds unity when regions only use the income tax. The *MCPF* exceeds unity because an additional cost of the income tax is the reduction in population it causes. The region now has an incentive to increase the population to "spread" these fixed costs. Then a tax on capital can, by reducing the income tax rate, increase the population. If labor and capital are substitutes, a tax on capital increases the population even more by increasing the demand for labor.

What will the equilibrium tax on capital be? If labor and capital are neither substitutes nor complements ($\eta_{lk} = 0$), *(2.12)* becomes much simpler. With $\eta_{lk} = 0$ we have $\hat{w}_{\tau_k} = \hat{N}_{\tau_k} = \hat{K}_{\tau} = \hat{K}_g = 0$. In this case, an obvious choice for τ_k is to set it so that revenue from tax on capital equals the fixed cost of the public service, $\tau_k = \dfrac{F}{K}$. This rate allows the income tax to be set so that revenue per worker equals marginal cost per worker, $\tau w = g$. While an intuitively appealing solution, we can see that in *(2.12b)* $\tau_k K \hat{K}_{\tau_k} < 0$ -- the tax on capital is too high. Then with $\eta_{lk} = 0$ in equilibrium the region will set its policies so that $\tau_k K < F$, $\tau w > g$, and $g < g^{*}$. These results, specifically the under-provision of public services, are consistent with the general findings of the tax competition literature. Here, because to the region the taxation of capital is distorting, the optimal policy is to reduce this distortion by adding a distortion in the income tax, specifically setting it so that the revenue per worker exceeds the marginal cost of providing the public service to each worker.

The general case with $\eta_{lk} \neq 0$ is more difficult to evaluate. Using the first order conditions for the income and capital tax rates, *(2.12a)* and *(2.12b)* we obtain the following expression for τ_k,

$$\tau_k = \frac{\gamma\left(\frac{Nw}{K}\frac{\eta_{kl}}{(1-\tau)} - \eta_{ll}\right)}{\left(\gamma\left(\frac{Nw}{(1-\tau)K}\eta_{kl} - \eta_{ll}\right) - \left(\eta_{kk}\frac{Nw}{K}\left(\frac{\gamma}{(1-\tau)} - \eta_{ll}\right) + \eta_{kl}\left(\frac{Nw}{K}\eta_{lk} - \gamma\right)\right)\right)}\frac{F}{K} \qquad (2.14)$$

In *(2.14)* the numerator and the first term of the denominator are identical. Further, by the second order conditions we have denominator being positive. Then from *(2.14)* if $\eta_{lk} > 0$, $\tau_k > 0$ and if, as seems reasonable, $-\left(\eta_{kk}\frac{Nw}{K}\left(\frac{\gamma}{(1-\tau)} - \eta_{ll}\right) + \eta_{kl}\left(\frac{Nw}{K}\eta_{lk} - \gamma\right)\right)>0$, then it must be the case that $\tau_k K < F$, the tax on capital does not cover the fixed costs. Finally, if the numerator, $\left(\frac{Nw}{K}\frac{\eta_{kl}}{(1-\tau)} - \eta_{ll}\right)$, is negative the tax on capital is also negative. This, of course, requires that $\eta_{lk} < 0$. I summarize these results in the following proposition:

Proposition 2: Assume that the there exists some fixed cost in the production of public services (F). Then:

a) *In the absence of capital taxation, an income tax on workers, regardless of their mobility, will lead to an efficient provision of the public service.*

b) *If the elasticity of substitution between labor and capital is greater than zero ($\eta_{lk} > 0$) then:*

i) *It will be optimal to impose some positive tax on capital ($\tau_k > 0$)*

ii) *The level of the tax on capital will be such that the revenues from the capital tax will be less than the fixed costs of are less than the fixed cost ($\tau_k K < F$), income taxes per worker exceed the cost of providing the public service to the worker ($\tau w < g$), and the level of public service will be less than the efficient level ($g < g^{*}$).*

c) *If the elasticity of substitution between labor and capital is less than zero the tax on capital is positive if* $\frac{Nw}{K}\frac{\eta_{kl}}{(1-\tau)} - \eta_{ll} > 0$.

d) *Let the cost function for the public service be of the form c(n,g) = F(g) +c(n)g where F'>0 and F"<0. Then in the absence of capital taxation, an income tax on workers, regardless of their mobility, will lead to an efficient provision of the public service.*

Proof of parts *a)* and *d)* of the proposition are found in the *Appendix*. Part *d)* is simply a generalization of part *a)* to a broader set of public service cost functions, specifically cost functions where the cost of the public service is not strictly proportionate to the population. As an extreme case if the cost function were simply c(n,g) = F(g) and the cost of the public service is independent of the number of workers, the result is still obtained.[1]

[1]While the optimal regional size with respect to the public service would encompass the entire economy because of diminishing returns to labor in the production function, workers will be distributed throughout the regions.

To provide additional intuition and some concrete examples of how the extent of capital taxation depends on the mobility of labor among regions as well as the elasticities of capital and labor in production I provide a few parameterizations of *(2.14)* in *Table 2*. In the table I report capital tax revenue as a fraction of fixed costs, $\left(\frac{\tau_k K}{F}\right)$ for a variety of values for the elasticity of population with respect to the wage (γ), the price elasticity of labor and capital $(\eta_{ll} \text{ and } \eta_{kk})$, and the cross price elasticities of labor and capital, $(\eta_{kl} = \eta_{lk})$, which, for the purposes of this example, I assume are identical. I assume that wages are seventy percent of production costs *(Nw = .7)*, capital costs are thirty percent *(K = .3)* and fixed *(F)* and total marginal costs *(Ng)* are equal. The income tax rate *(τ)* endogenously determined to ensure a balanced budget.

The results of this numerical exercise generally accord with what we might intuitively expect. For example, looking at row (1) we see that as labor mobility *(γ)* decreases, the fraction of fixed costs covered by capital taxation decreases. With $\frac{\tau_k K}{F}$ =.258 as in row (1), column (a) then $\frac{N(\tau w - g))}{F}$ = .742, that is, capital is bearing 25.8 percent of the fixed costs with labor bearing 74.8 percent in addition to the marginal costs associated with the public service. As can be seen when comparing row (2) where the cross price elasticity between capital and labor, η_{kl}, is equal to 0.5 and row (3) where η_{kl} = -0.5 to row (1) where η_{kl} = 0, the share borne by capital increases when capital and labor are substitutes and decreases when they are complements with the tax on capital actually being negative when η_{kl} = -0.5. Again, as we would expect, from inspection of rows (1) and (4), for example, we see that as labor becomes relatively more elastic ($\frac{\eta_{ll}}{\eta_{kk}}$ increases) the tax burden on capital increases. Note that only when $\eta_{ll} = -1.5, \eta_{kk} = -0.5$, and $\eta_{kl} = 0.5$ and labor is extremely mobile *(γ=100)* (row (8), column (4)) is it the case that the tax revenue collected from capital is close to equaling the fixed costs ($\frac{\tau_k K}{F}$ = .966).

My results, while consist with those generally found in the tax competition literature, suggest that inefficiencies are not inherent to decentralized tax policy formation. Here, as I show, the problem is related to the choice of instruments the regions used. If constrained to income taxation, the regions will choose tax policies to provide public services efficiently. However, if allowed to use tax capital, these regions use the tax and, as a result, underprovide public services.

3. Income and Capital Taxation with Heterogeneous Workers

I now consider regional policies when there are two groups of workers, potentially earning different wages, having different tastes for the public service, and having different rates of mobility, that is, responding differently to changes in regional tax and public service policies. It is how these differences in rates of mobility, combined with differences in earnings and tastes for the public service affect regional policies that is the focus of the analysis in this section. Because many of the results in the case of fixed costs with homogeneous workers apply here, I only briefly discuss this case with heterogeneous workers.

The framework is essentially the same as with homogeneous workers with production now being characterized by $f(N^s,N^u,K)$ where the superscripts s and u denote skilled and unskilled workers. I assume that in equilibrium $w^s \geq w^u$. Profits, then, are given by

$$\pi = f(N^s,N^u,K) - N^s f_s - N^u f_u - Kf_k = f(N^s,N^u,K) - N^s w^s - N^u w^u - (1+\tau_k)K \qquad (3.1)$$

where $f_j = \dfrac{\partial f}{\partial N^j}$, $j = s,u$. The budget constraint can now be expressed as

$$S(\tau,\tau_k,g) = N^s(\tau w^s - g) + N^u(\tau w^u - g) + \tau_k K = 0. \qquad (3.2)$$

The utility function is the same as with homogeneous worker except that I allow for differences in tastes between the two types of workers with the utility function for a worker of type k given by $U^k = x + u^k(g) + \phi^k(N^k)$ where $\phi^k(N^k)$ is the attachment to home for a worker in group k. The elasticity of mobility for a worker in group k, γ_k, is also defined as before. As with homogeneous workers, regional policies are chosen to maximize social welfare where the social welfare function includes the utility of both groups of workers (skilled and unskilled) and profits,

$$W(\tau,\tau_k,g)=\pi+N^sU^s+N^uU^u. \qquad (3.3)$$

3.1 Equilibrium Conditions and Comparative Statics

As before, equilibrium requires that labor and capital markets clear in each of the regions,

$$w^j = f_j\left(N^s,N^u,K\right),\ j=s,u \qquad (3.4a)$$

and

$$r+\tau_k = f_K\left(N^s,N^u,K\right). \qquad (3.4b)$$

The marginal worker in each group must receive the same utility as she can obtain elsewhere,

$$w^j(1-\tau)+u^j(g)+\phi^j\left(N^j\right)=\overline{U}^j,\ j=s,u. \qquad (3.5)$$

Not surprisingly, the comparative statics are more complicated than for the case of homogeneous workers, primarily because of the possibility that the marginal product for one type of worker is dependent on the number of the other type of worker $\left(f_{ji}\right)\neq 0, i, j=s,u$. Differentiating the equilibrium conditions, *(3.4)* and *(3.5)*, gives

$$\hat{w}_\tau^j=\left[\gamma^j\left(\gamma^i-\eta_{ii}\right)+\gamma^i\eta_{ji}\right]\frac{\tilde{A}^{-1}}{(1-\tau)},\ \hat{w}_g^j=\left[\gamma^j\left(\gamma^i-\eta_{ii}\right)\frac{MRS^j}{w^j}+\gamma^i\eta_{ji}\frac{MRS^i}{w^i}\right]\tilde{A}^{-1}, \text{ and}$$

$$\hat{w}_{\tau_k}^j=\left[\left(\gamma^i-\eta_{ii}\right)\eta_{jk}-\eta_{ji}\eta_{ik}\right]\frac{d\tau_k}{\left(r\left(1+\tau_k\right)\right)}\tilde{A}^{-1},\ j,i=s,u; j\neq i \qquad (3.6)$$

where η_{ji} is the elasticity of demand for workers of type *j* with respect to the wages of workers of type *i* and $\tilde{A}=(\eta_{ss}\eta_{uu}-\eta_{su}\eta_{us})-\eta_{ss}\nu_u-\eta_{uu}\gamma_s+\gamma_u\gamma_s>0$.

3.2 Regional Income Tax Policies in the Absence of Capital Taxation

I begin by considering the income tax policies chosen by the regions when they cannot tax capital. I then consider whether the regions do, in fact, have the incentive to tax capital. When the regions can only tax income, the first order condition with respect to the income tax rate can be expressed as

$$\left(\lambda-1\right)\left(N^{s}w^{s}\left(1+\tau\hat{w}_{\tau}^{s}\right)+N^{u}w^{u}\left(1+\tau\hat{w}_{\tau}^{u}\right)\right)=-\lambda N^{s}\left(\tau w^{s}-g\right)\left(\hat{N}_{\tau}^{s}-\hat{N}_{\tau}^{u}\right) \qquad (3.7a)$$

and the first order condition for the public service expressed as

$$\underbrace{N^{s}MRS^{s}+N^{u}MRS^{u}-\left(N^{s}+N^{u}\right)}_{(a)}=\left(\lambda-1\right)\left(N^{s}\left(1-\underbrace{\tau w^{s}\hat{w}_{g}^{s}}_{(b)}\right)+N^{u}\left(1-\tau w^{u}\hat{w}_{g}^{u}\right)\right)-\underbrace{\lambda N^{s}\left(\tau w^{s}-g\right)}_{(c)}\left(\hat{N}_{g}^{s}-\hat{N}_{g}^{u}\right). \qquad (3.7b)$$

I obtain *(3.7)* by using the budget constraint, *(3.2')*, to substitute $-N^{s}\left(\tau w^{s}-g\right)$ for $N^{u}\left(\tau w^{u}-g\right)$. Equation *(3.7a)* is expressed in a way to highlight the impact of fiscal deficits or surpluses associated with the two groups of workers on the marginal cost of public funds *(λ)*. In *(3.7b)* the first order condition is expressed to contrast it with the condition obtained with a centralized government. Term (a), the left side of the equation, is the first order condition for the centralized government. Term (b) represents differences due to capitalization and term (c) represents differences due to fiscal surpluses or deficits. With equal weights on profits and utility, changes in the gross wage do not affect welfare as any increase in utility is offset by a decrease in profits. However, changes in wages that are taxed do affect welfare if the marginal cost of public funds (λ) and marginal social welfare *(1)* are not equal.

We gain some insights into the factors that influence the policies set by regions by considering the case when wages, but not mobility, are equal in the two sectors. In this case neither group generates a fiscal surplus or deficit so that $\tau w^{s}-g=0$ in *(3.8)* . Therefore the right side of *(3.7a)* is zero and $\lambda = 1$ to ensure the left side also equals zero. With $\lambda = 1$ and $\tau w^{s}-g=0$ the right side of *(3.7b)* is zero. Then the left side must also equal zero requiring $MRS - 1 = 0$.

Given that the mobility of a single group of workers had no impact on the provision of the public service, it is not surprising that when the wages of the two groups are equal that neither the relative nor the absolute mobility of these two groups has any impact on the level of public services. While the assumption of equal wages is not, in itself, either realistic and or particularly interesting, it suggests why public services set by regional governments may diverge from the levels set by centralized governments. When the income tax is used and wages are equal neither group generates a fiscal surplus or deficit, that is, the revenues obtained from the group of workers equals the costs of providing the public services to them. In the absence of any surplus or deficit, the government has no incentive to alter taxes or public services to either attract surplus-generating workers or deter deficit-generating workers.

More interesting is the case when wages for the two groups are not equal. An increase in skilled workers increases in net revenue $(\tau w^s - g > 0)$ while an increase in unskilled workers decreases net revenue $(\tau w^u - g < 0)$. Because of the unequal impact on net revenues, the relative mobility of the two groups of workers will matter. As inspection of *(3.7a)* shows, whether the marginal cost of public funds is more or less than one $(\lambda >(<) 1)$ depends on whether the percentage loss in skilled workers from a tax increase is more or less than the loss in unskilled workers $\left(\hat{N}_\tau^s < (>) \hat{N}_\tau^u\right)$. The relative mobility of these two groups depends on underlying labor demand and supply conditions, the elasticity of the labor supply with respect to income (γ_s, γ_u) and the elasticities and cross-price elasticities of labor demand $(\eta_{uu}, \eta_{su}, \eta_{us}, \eta_{su})$.[2] As extreme cases, if either the supply of unskilled workers in the region is inelastic $(\gamma_u = 0)$ or their demand is inelastic $(\eta_{uu} = \eta_{us} = \eta_{su} = 0)$ then a larger percentage reduction in skilled workers when taxes increase $\left(\hat{N}_\tau^s - \hat{N}_\tau^u < 0\right)$ is obtained. We may believe, a priori, that skilled workers are more mobile than unskilled workers, $\gamma_s > \gamma_u$, in response to changes in their gross wages. However, how wages change in response to tax rates depends on both the elasticity and cross-price least elasticities of demand for the respective groups making it difficult to surmise anything about the relative values of $\hat{N}_\tau^s$ and $\hat{N}_\tau^u$ based simply on the relative values of γ_s and γ_u.

The mobility of the two groups with respect to the public service also affects the choice of

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[2]The relationship between $\hat{N}_\tau^s$ and $\hat{N}_\tau^u$ is given by

$$\hat{N}_\tau^s - \hat{N}_\tau^u = \frac{\tilde{A}^{-1}}{(1-\tau)}\left(\gamma_u \gamma_s \left((\eta_{ss} + \eta_{su}) - (\eta_{uu} + \eta_{us})\right) - (\gamma_s - \gamma_u)(\eta_{ss}\eta_{uu} - \eta_{su}\eta_{us})\right) \text{ where } \tilde{A}^{-1} > 0.$$

policies. Again the relative change in the populations of the two groups depends on complicated interactions of the elasticities of labor supply and demand for the two groups. In addition, it depends on the valuation of the public service of the two groups relative to their wages $\left(\frac{MRS}{w}\right)$. Mobility depends on $\frac{MRS}{w}$ rather than simply the valuation or marginal rate of substitution *(MRS)* because the tax cost of an additional unit of the public service to each group $\left(w^i \frac{d\tau}{dg},\ i = u, s\right)$ is proportional to its wage rate. Given this discussion of the relative mobility of the two groups, we summarize some results in the following proposition:

Proposition 3. Let g^c *denote the public service level at which* $N^s MRS^s + N^u MRS^u = N^s + N^u$ *and* g^* *denote the equilibrium level chosen by the region satisfying (3.7).*

a) *If* $w^s = w^u$, *then* $\lambda^* = 1$ *and* $g^* = g^c$.

b) *If* $\hat{N}_\tau^s = \hat{N}_\tau^u < 0$ *then* $\lambda^* = 1$. *Then if at* g^c, $\frac{MRS^s}{w^s} > (=) < \frac{MRS^u}{w^u}$ *or equivalently,* $\hat{N}_g^s > (=) < \hat{N}_g^u$ *then* $g^* > (=) < g^c$.

c) *If* $\hat{N}_\tau^s < \hat{N}_\tau^u < 0$ *then* $\lambda^* > 1$. *Then if at* g^c, $\frac{MRS^s}{w^s} > (=) < \frac{MRS^u}{w^u}$ *or, equivalently,* $\hat{N}_g^s > (=) < \hat{N}_g^u$ *then* $g^* ?(<) < g^c$.

d) *If* $0 > \hat{N}_\tau^s > \hat{N}_\tau^u$ *then* $\lambda^* < 1$. *Then if at* g^c, $\frac{MRS^s}{w^s} > (=) < \frac{MRS^u}{w^u}$ *or, equivalently,* $\hat{N}_g^s > (=) < \hat{N}_g^u$ *then* $g^* > (>) ? g^c$.

The notation "?" in *Proposition 3* refers to an ambiguous sign. Proof of *Proposition 3* is found in the *Appendix*. When the skilled and unskilled workers react the same to a change in the tax rate, that is, $\hat{N}_\tau^s = \hat{N}_\tau^u$, the government cannot use the tax rate as a means of changing the mix of skilled and unskilled workers. Instead, differences in tastes for the public service must be used to change the relative population of the two groups. At g^c if $\frac{MRS^s}{w^s} > \frac{MRS^u}{w^u}$ then skilled workers place a higher value on the public service relative to its tax cost to them than unskilled workers do. This being the case, balanced-budget increases in the public service will lead to increases in the number of skilled workers relative to unskilled workers $\left(\hat{N}_g^s > \hat{N}_g^u \text{ at } g^c\right)$. If $\frac{MRS^s}{w^s} = \frac{MRS^u}{w^u}$ at g^c the efficient level of the public service will be provided because $\hat{N}_g^s = \hat{N}_g^u$ and balanced budget changes in the public service will not alter the mix of workers. Finally, if $\frac{MRS^s}{w^s} < \frac{MRS^u}{w^u}$ at g^c the public service will be underprovided since increasing it above g^c will result in more, not fewer, deficit-generating unskilled workers.

If skilled workers are more responsive to a tax increase than low-workers $\left(\hat{N}_\tau^s < \hat{N}_\tau^u\right)$ increases in the tax rate will increase the number of low-skilled workers relative high-skilled workers. For this reason the marginal cost of funds exceeds unity *($\lambda^*>1$).* If, at the efficient level of public service, the public service is relatively or equally valued by the low-skilled workers $\left(\frac{MRS^s}{w^s} \leq \frac{MRS^u}{w^u}\right)$ the public service will be underprovided, thereby reducing the number of unskilled workers. If the public service is valued relatively more by skilled workers, the equilibrium level of the public service is ambiguous as increases in the public service increase the relative mix of skilled workers but the balanced-budget increase in the tax rate reduces the mix. Analogously, if the unskilled workers respond more to a tax than the skilled workers $\left(\hat{N}_\tau^s > \hat{N}_\tau^u\right)$ then increases in the tax rate reduce the relative number of skilled workers. In this case, if the public service is valued more by skilled workers it is unambiguously over-provided. If the public service is relatively valued less by the skilled workers, its provision relative to the efficient level is ambiguous since the impacts of the increases in both the tax rate and public service level have different impacts on the relative mix of skilled and unskilled workers.

Alternatively, we can add *(3.7a)* to *(3.7b)* to obtain the condition,

$$\begin{aligned} N^s MRS^s + N^u MRS^u - \left(N^s + N^u\right) = &\underbrace{(\lambda - 1)\left(N^s\left(1 + w^s(1 + \tau(\hat{w}_\tau^s - \hat{w}_g^s))\right) + N^u\left(1 + w^u(1 + \tau(\hat{w}_\tau^u - \hat{w}_g^u))\right)\right)}_{(a)} \\ &- \underbrace{\lambda N^s\left(\tau w^s - g\right)\left(\left(\hat{N}_\tau^s - \hat{N}_g^s\right) - \left(\hat{N}_\tau^u - \hat{N}_g^u\right)\right)}_{(b)} \end{aligned} \qquad (3.7b')$$

As can be seen in *(3.7b'),* whether left side is negative or positive and the public service is underprovided or overprovided depends on the two terms on the right side. The sign of the first term, term (a), depends on whether λ is greater or less than one. If λ > 1, the term is positive; if λ < 1 it is negative. Then from *(3.7a)*, this, in turn, depends on whether high skilled workers are relatively more responsive to changes in taxes than unskilled workers, that is, whether $\hat{N}_\tau^s \geq \hat{N}_\tau^u$. The sign of the second term depends on the relative magnitude of the net impact, $\hat{N}_\tau - \hat{N}_g$, of a balanced-budget tax increase on the population of the two groups of workers in the region. If the net impact on skilled workers is less than it is on unskilled workers, $\left(\hat{N}_\tau^s - \hat{N}_g^s\right) - \left(\hat{N}_\tau^u - \hat{N}_g^u\right) < 0$, the term is positive; if $\left(\hat{N}_\tau^s - \hat{N}_g^s\right) - \left(\hat{N}_\tau^u - \hat{N}_g^u\right) > 0$, the term is negative. The first term reflects the impact the marginal cost of funds *(λ)* has on the level of the public service the regions will offer. The higher the marginal cost of funds, the higher $N^s MRS^s + N^u MRS^u$ and the lower the level of the public service. The second term reflects how net changes in the relative populations of the two groups of workers will influence the provision of the public service. When increases in both the tax and public service lead to greater (percentage) losses of skilled workers $\left(\left(\hat{N}_\tau^s - \hat{N}_g^s\right) - \left(\hat{N}_\tau^u - \hat{N}_g^u\right) < 0\right)$ the level of the public service is reduced.

In *Table 3*, I report the results of a simple numerical parameterization of the general equilibrium outcome with decentralized policy determination when regions can only tax income and have heterogeneous workers. This model is only intended to be illustrative as I did not make any attempts at finding empirically-based values for the parameters. In this simple model, utility for a worker in group i, $i = s, u$ is $U^i = w^i(1-\tau) + a^i ln(g) + \phi^i(N^i)$ where I vary the values for a^i and γ^i, the elasticity of mobility. The parameters were chosen so that for all specifications, the efficient outcome has an income tax rate of $\tau = .1333$ and public service level of $g = .2$. In equilibrium, the wage of the high skilled workers is *2* and that of the low skilled workers is *1* with the equilibrium rate of return on capital of one as well. As well, in equilibrium there are equal numbers of high skilled and low skilled workers $(N^s = N^u = .5)$ and the equilibrium amount of capital is one in each region.

In column (a) the taste for the public service is equal for both groups. However as $w^s > w^u$, we have $\frac{MRS^s}{w^s} < \frac{MRS}{w^u}$. Then when mobility is equal for the two groups ($\gamma^s = \gamma^u = 3$, column a.1), the relative impact of a tax increase on the number of workers is equal $\left(\frac{\hat{N}^s_\tau}{\hat{N}^u_\tau} = 1\right)$ but the impact of a reduction of the public service is greater for the unskilled workers $\left(\frac{\hat{N}^s_g}{\hat{N}^u_g} = .5\right)$. This being the case, the public service is underprovided (g = .1972). When the skilled workers are relatively more mobile than the unskilled workers ($\gamma_s = 5.5$ and $\gamma_u = 0.5$, column a.2) while they are both more responsive to increases in tax and public services than the unskilled workers $\left(\frac{\hat{N}^s_\tau}{\hat{N}^u_\tau} = 2.38\right)$ and $\left(\frac{\hat{N}^s_g}{\hat{N}^u_g} = 1.27\right)$, the difference is greater for taxes making it optimal for regions to underprovide the public service. When unskilled workers are relatively more mobile (column a.3), the impact of the taxes is still relatively greater for the skilled workers, making it again optimal to underprovide the public service. Note that regardless of the specification of tastes and mobility, as expected, the decentralized outcome results in higher utility for skilled workers and lower utility for unskilled workers than the centralized outcome though the differences in total social welfare are extremely small. As suggested by our discussion of expression *(3.7b')*, it is interesting to note that in these numerical examples that if skilled workers are more responsive to both tax and public service changes than unskilled workers $\left(\frac{\hat{N}^s_\tau}{\hat{N}^u_\tau} > 1 \; and \; \frac{\hat{N}^s_g}{\hat{N}^u_g} > 1\right)$ or are less responsive to both $\left(\frac{\hat{N}^s_\tau}{\hat{N}^u_\tau} < 1 \; and \; \frac{\hat{N}^s_g}{\hat{N}^u_g} < 1\right)$, whether they are relatively more or less responsive to taxes or public services will determine whether the public service is underprovided or overprovided. If $\frac{\hat{N}^s_\tau}{\hat{N}^u_\tau} \Big/ \frac{\hat{N}^s_g}{\hat{N}^u_g} > 1$ then the relative responsiveness of skilled workers to taxes exceeds their relative responsiveness to public services and a balanced-budget decrease in taxes reduces the ratio of unskilled to skilled workers making it optimal for the region to underprovide the public service. Analogously, if $\frac{\hat{N}^s_\tau}{\hat{N}^u_\tau} \Big/ \frac{\hat{N}^s_g}{\hat{N}^u_g} < 1$ then a balanced-budget increase in taxes reduces the ratio of unskilled to skilled workers making it optimal for the region to overprovide the public service.

3.3 Regional Policies with Capital Income Taxation

With homogeneous labor and no fixed costs for the public service, the optimal tax on capital was zero. I now examine whether this is the case with heterogeneous workers and no fixed costs. With the addition of the tax on capital, the government budget constraint can now be expressed as

$$S(\tau,\tau_k,g) = N^s\left(\tau w^s - g + \frac{1}{2}\frac{\tau_k K}{N^s}\right) + N^u\left(\tau w^u - g + \frac{1}{2}\frac{\tau_k K}{N^u}\right) = 0 \qquad (3.8)$$

The first order conditions when the region can tax capital are given by *(3.9)* with *(3.9b)* being the first order condition for the tax on capital. These conditions are

$$(\lambda-1)\left(N^s w^s\left(1+\tau\hat{w}^s_\tau\right)+N^u w^u\left(1+\tau\hat{w}^u_\tau\right)\right) = -\lambda\left[N^s\left(\tau w^s - g\right)\hat{N}^s_\tau + N^u\left(\tau w^u - g\right)\hat{N}^u_\tau + \tau_k K\hat{K}_\tau\right] \qquad (3.9a)$$

with the first order condition with respect to the tax on capital given by

$$(\lambda-1)\left(\tau\left(N^s w^s\hat{w}^s_{\tau_k} + N^u w^u\hat{w}^u_{\tau_k}\right)+K\right) = -\lambda\left[N^s\left(\tau w^s - g\right)\hat{N}^s_{\tau_k} + N^u\left(\tau w^u - g\right)\hat{N}^u_{\tau_k} + \tau_k K\hat{K}_{\tau_k}\right] \qquad (3.9b)$$

Finally, the first order condition for the public service can be expressed as

$$\underbrace{N^s MRS^s + N^u MRS^u - \left(N^s+N^u\right)}_{(a)} = \underbrace{(\lambda-1)\begin{pmatrix} N^s\left(1-\tau w^s\hat{w}^s_g\right) \\ +N^u\left(1-\tau w^u\hat{w}^u_g\right)\end{pmatrix}}_{(b)} - \underbrace{\lambda\begin{bmatrix} N^s\left(\tau w^s - g\right)\hat{N}^s_g + N^u\left(\tau w^u - g\right)\hat{N}^u_g \\ +\tau_k K\hat{K}_g \end{bmatrix}}_{(c)}. \qquad (3.9c)$$

Before trying to characterize the optimal policy, I first consider whether and when a tax on capital would be used. To do this I evaluate the impact of a tax on capital on social welfare when $\tau_k = 0$ and the income tax rate and level of public service are at the socially optimal levels in the absence of a tax on capital (τ^*, g^*). This gives

$$W_{\tau_k}\Big|_{\tau_k=0} = \underbrace{\left(\lambda^*-1\right)\left[\tau^*\left(N^s w^s\hat{w}^s_{\tau_k} + N^u w^u\hat{w}^u_{\tau_k}\right)+K\right]}_{(a)} + \underbrace{\lambda^*\left[N^s\left(\tau^* w^s - g\right)\left(\hat{N}^s_{\tau_k} - \hat{N}^u_{\tau_k}\right)\right]}_{(b)} \qquad (3.10)$$

where I assume that $\tau^*\left(N^s w^s\hat{w}^s_{\tau_k} + N^u w^u\hat{w}^u_{\tau_k}\right)+K > 0$ – at the optimal income tax rate (τ^*) the imposition of a tax on capital will increase tax revenue. Recall that if $\hat{N}^s_\tau = \hat{N}^u_\tau$ we have $\lambda^* = 1$ making term (a) equal to zero. Sufficient conditions for $\hat{N}^s_\tau = \hat{N}^u_\tau$ to equal zero are or $\eta_{ss} = \eta_{uu}$, $\eta_{su} = \eta_{us}$, and $\gamma_s = \gamma_u$. For $\hat{N}^s_{\tau_k} = \hat{N}^u_{\tau_k}$ we need the additional condition that $\eta_{uk} = \eta_{sk}$. If this is satisfied, term (b) and *(3.10)* equals zero -- there is no gain to the region taxing capital. If, however, $\lambda^{*}= 1$ but $\eta_{uk} \neq \eta_{sk}$, then a zero tax rate on capital is not optimal.[3] With $\eta_{sk} > \eta_{uk}$, $\hat{N}^{s}_{\tau_k} > \hat{N}^{u}_{\tau_k}$ and, with $\lambda^{*}= 1$, *(3.10)* will be positive. With skilled labor a stronger substitute for capital, it will be optimal to tax capital to encourage greater inflows of skilled labor. If $\eta_{sk} < \eta_{uk}$ then $\hat{N}^{s}_{\tau_k} < \hat{N}^{u}_{\tau_k}$ and with $\lambda^{*} = 1$, capital should be subsidized as skilled labor is a relative complement with it.

If $\lambda^{*} > 1$ $\left(\hat{N}^{s}_{\tau} < \hat{N}^{u}_{\tau} < 0\right)$, term (a) is positive. Then if $\hat{N}^{s}_{\tau_k} > \hat{N}^{u}_{\tau_k}$, *(3.10)* is positive and it will be optimal to tax capital as high-skilled workers are a stronger substitute for capital than unskilled workers. Alternatively, if $\lambda^{*} < 1$ $\left(0 > \hat{N}^{s}_{\tau} > \hat{N}^{u}_{\tau}\right)$ and $\hat{N}^{u}_{\tau_k} > \hat{N}^{s}_{\tau_k}$ then it will be optimal to subsidize capital as the skilled workers are relatively stronger complements with capital. Summarizing:

Proposition 4: Let λ^{*} denote the value for λ that satisfies (3.7), the first order conditions in the absence of capital taxation. Then with capital taxation we have:

a) *If* $\lambda^{*} = 1\left(\hat{N}^{s}_{\tau} = \hat{N}^{u}_{\tau} < 0\right)$ *then if* $\eta_{uk} > (=) < \eta_{sk}$, $\tau_k > (=) < 0$.

b) *If* $\lambda^{*} > 1\left(\hat{N}^{s}_{\tau} < \hat{N}^{u}_{\tau} < 0\right)$ *then if* $\hat{N}^{s}_{\tau_k} > \hat{N}^{u}_{\tau_k}$, $\tau_k > 0$.

c) *If* $\lambda^{*} < 1\left(\hat{N}^{u}_{\tau} < \hat{N}^{s}_{\tau} < 0\right)$ *then if* $\hat{N}^{u}_{\tau_k} > \hat{N}^{s}_{\tau_k}$, $\tau_k < 0$.

While we would expect the income tax rate to be higher or lower than the rate when there is no capital taxation depending on whether the tax on capital is positive or negatives, intuitive statements about the level of public service, relative to the efficient level or the level in the absence of income taxation, are difficult. For this reason, statements about the level of welfare are also difficult to make. To provide some indication of how the opportunity to tax capital affects public service provision, utility of the two groups, and overall welfare, I modify the general equilibrium simulations reported in *Table 3* to allow regions to tax capital as well as income.

In *Tables 4a – 4c,* the results of these simulations with capital taxation are presented. The

[3]Recall that land is a fourth factor of production meaning that $\eta_{ss} = \eta_{uu}$, $\eta_{su} = \eta_{us}$ does not necessarily imply that $\eta_{uk} = \eta_{sk}$.

parameterization is identical to the earlier simulations reported in *Table 3* except now the cross price elasticities between labor and capital are non-zero. I consider four alternative sets of values for these cross-price elasticities (η_{sk}=.5, η_{uk}=0; η_{sk}=-.5, η_{uk}=0; η_{sk}=0,η_{uk}=.5; η_{sk}=0, η_{uk}=-.5). The three tables differ in the taste parameters for the public service with *Table 4a* having equal valuations of the public service for the two groups (a^s=a^u =.2), *Table 4b* reports the results for when only the skilled workers value the public service (a^s=.4; a^u =0) and *Table 4c* reports when only unskilled workers value the public service (a^s=0; a^u =.4). In addition to varying the taste parameters and the elasticity of substitution between the two types of labor and capital, I also ran simulations with different degrees of mobility for the two groups as I did in the simulations with no capital taxation.

Perhaps the most interesting results from these simulations is the sign and magnitude of the tax on capital. Capital is positively taxed when skilled labor and capital are substitutes (column (a) of *Tables 4a- 4c)* except when unskilled labor is much more mobile than skilled labor (γ_s = 0.5; γ_u = 0) in which case it subsidized. When unskilled labor is a complement with capital (column (d)) it is always taxed regardless of the relative mobility of the two types of labor. As expected, capital is subsidized whenever skilled labor is a complement with capital (column (b)) and when unskilled labor is a complement with it, though not when skilled labor is relatively more mobile (column (c)).

Public service provision with capital taxation exceeds that when only the income tax is used when the tax on capital is positive though it is not necessarily the case that it exceeds the efficient level of the public service (g = .20). When the tax on capital is negative, the level of public service is below the level provided in the absence of capital taxation.

Relative total welfare is quite close to that found with only the income tax in all cases. However, utility for both skilled and unskilled workers is higher with capital taxation when the tax on capital is positive and lower when the tax is negative. That welfare can be quite similar in both cases and utility quite different in some cases is explained by the impact of capital taxation on the return to capital owners. If the tax on capital is positive, the return is lower; a negative tax increases the return to capital owners.

The results of these simulations confirm that the sign and magnitude of any tax on capital imposed by regions depends on the elasticity of substitution between the two types of labor and capital and, to a less extent, the relative mobility of the two types of labor. The tax on capital appears to have little effect on overall welfare, though the impact on the level of public service, the welfare of the workers, and the returns to capital owners are directly related to whether capital is taxed or subsidized which, as mentioned, depends on the relationships of the two types of labor with capital.

4. Conclusion

There has been extensive literature addressing the issue of tax competition, with the focus on competition for mobile capital, physical or financial. Most, though not all, studies have assumed immobile labor. Because labor is immobile, the cost of public services provided to residents is not influenced by changes in capital, the tax base. Those studies that do assume mobile labor such as Brueckner (1999) or Wilson (1991) or Hoyt (1991, 1992) generally either have identical labor or capital taxation, a source of taxation not directly linked to the population. Typically these studies have public service costs proportionate to the population as well. In these cases, population movements do not have direct budgetary impacts in the sense that changes in population will either not directly affect revenues or affect revenues and costs equally. An exception is Hoyt (1993) in which the use of land taxation will lead to population (and associated housing capital) movements to generate fiscal deficits. Here we obtain distinctly different results from traditional tax competition results because we assume movements in the tax base affect the cost of providing public services. Then given limited tax instruments and different wage rates, movements by one group affect net revenue differently than another group. In fact, the results of traditional models of tax competition such as those introduced by Wilson (1986), Zodrow and Mieszkowski (1986), can be reinterpreted in the context of our model. With capital mobile but generating no costs and labor immobile and consuming the public service, our model would predict underprovision of the service to the input that generates a fiscal deficit, labor. Our results on the overprovision of public services to the skilled workers is consistent with the result in Keen and Marchand (1997) that there is an inefficiently high mix of public inputs in production relative to public services consumed by residents. In the context of our model capital generates a fiscal surplus as the cost of providing the public input is independent of the amount of capital. Therefore, our model would offer the same prediction.

Somewhat in contrast to Keen and Marchand (1997) and Huber (1999), complementariness or substitutability in production, in our case between the two types of labor and in their models between capital and labor, has a second order influence on policies. Distortions in public services are only obtained in our model when there are fiscal imbalances between the two groups and differences in the tastes for the public services. If there are no fiscal imbalances, regional provision is efficient – the distortions arising from the income tax with inelastic labor are due to labor mobility. In contrast, in both Keen and Marchand (1997) and Huber (1999), labor is elastically supplied. Then even with centralized government provision, the efficacy of taxing labor and by how much relative capital will depend on the relationship between them.

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Appendix

A.1 Proof of Proposition 2

To prove part (a) of the proposition rewrite *(2.14a)* when $\tau_k = 0$ as

$$(\lambda-1)Nw\left(1+\tau\hat{w}_\tau\right)=-\lambda F\hat{N}_\tau \qquad (A.1.1a)$$

and *(2.14b)* as

$$N(MRS-1)-(\lambda-1)\left(N\left(1-\tau w\hat{w}_g\right)\right)=-\lambda F\hat{N}_g \qquad (A.1.1b)$$

Then substituting $-\frac{MRS}{w}\hat{w}_\tau$ for $\hat{w}_g$ and $-\frac{MRS}{w}\hat{N}_\tau$ for $\hat{N}_g$ gives

$$N(MRS-1)-(\lambda-1)\left(N\left(1+\tau MRS\hat{w}_\tau\right)\right)-\lambda\frac{MRS}{w}F\hat{N}_\tau=0 \qquad (A.1.2)$$

which can be expressed as

$$N(MRS-1)-\frac{1}{w}\left[(\lambda-1)\left(Nw\left(1+\tau(MRS-1)\hat{w}_\tau\right)\right)+\lambda(MRS-1)F\hat{N}_\tau\right]=\frac{1}{w}\left[(\lambda-1)\left(Nw\left(1+\tau\hat{w}_\tau\right)\right)+\lambda F\hat{N}_\tau\right]=0 \qquad (A.1.2')$$

Then as the term on the right side must equal zero for *(2.12a)* to be satisfied when $\tau_k = 0$, the left must also equal zero. This will occur when $MRS = 1$.

A.2 Proof of Proposition 3

Part a) of the proposition follows immediately and need not be discussed further. In part b) if, as is assumed, $\lambda^* = 1$, then *(3.7b)* reduces to

$$\underbrace{N^s MRS^s + N^u MRS^u - \left(N^s + N^u\right)}_{(a)} = \underbrace{-\lambda N^s\left(\tau w^s - g\right)}_{(c)}\left(\hat{N}_g^s - \hat{N}_g^u\right) \qquad (A.2.1)$$

If $\hat{N}_\tau^s = \hat{N}_\tau^u < 0$ then it follows that

$$\hat{N}_\tau^s - \hat{N}_\tau^u = \left(\eta_{ss} - \eta_{us}\right)\hat{w}_\tau^s - \left(\eta_{uu} - \eta_{su}\right)\hat{w}_\tau^u = 0 \qquad (A.2.2)$$

where

$$\hat{w}_\tau^s = \left(\gamma_s\left(\gamma_u - \eta_{uu}\right) + \gamma_u \eta_{su}\right)\frac{\tilde{A}^{-1}}{(1-\tau)} \text{ and} \qquad (A.2.3a)$$

$$\hat{w}_\tau^u = \left(\gamma_u\left(\gamma_s - \eta_{ss}\right) + \gamma_s \eta_{us}\right)\frac{\tilde{A}^{-1}}{(1-\tau)} \qquad (A.2.3b)$$

and

$$\hat{w}_g^s = -\left(\gamma_s\left(\gamma_u - \eta_{uu}\right)\frac{MRS^s}{w^s} + \gamma_u \eta_{su}\frac{MRS^u}{w^u}\right)\frac{\tilde{A}^{-1}}{(1-\tau)} \text{ and} \qquad (A.2.4a)$$

$$\hat{w}_g^u = -\left(\gamma_u\left(\gamma_s - \eta_{ss}\right)\frac{MRS^u}{w^u} + \gamma_s \eta_{us}\frac{MRS^s}{w^s}\right)\frac{\tilde{A}^{-1}}{(1-\tau)} \qquad (A.2.4b)$$

Then substituting *(A.2.3)* for the gradients into *(A.2.4)* gives

$$\hat{N}_\tau^s - \hat{N}_\tau^u = \begin{bmatrix} \underbrace{\left[\left(\eta_{ss}-\eta_{us}\right)\gamma_s\left(\gamma_u-\eta_{uu}\right)-\left(\eta_{uu}-\eta_{su}\right)\gamma_s\eta_{us}\right]}_{(a)}+ \\ \underbrace{\left[\left(\eta_{ss}-\eta_{us}\right)\gamma_u\eta_{su}-\left(\eta_{uu}-\eta_{su}\right)\gamma_u\left(\gamma_s-\eta_{ss}\right)\right]}_{(b)} \end{bmatrix}\frac{\tilde{A}^{-1}}{(1-\tau)} = 0 \qquad (A.2.5)$$

From inspection it is apparent that for *(A.2.5)* to be equal to zero, term (a) must be negative and term (b) must be positive. Then the public service we have

$$\hat{N}_g^s - \hat{N}_g^u = \left(\eta_{ss} - \eta_{us}\right)\hat{w}_g^s - \left(\eta_{uu} - \eta_{su}\right)\hat{w}_g^u \qquad (A.2.6)$$

and substituting for the wage gradients with respect to the public service *(A.2.4)* into *(A.2.6)* gives

$$\hat{N}_g^s - \hat{N}_g^u = -\begin{bmatrix} \underbrace{\left[\left(\eta_{ss}-\eta_{us}\right)\gamma_s\left(\gamma_u-\eta_{uu}\right)-\left(\eta_{uu}-\eta_{su}\right)\gamma_s\eta_{us}\right]}_{(a)}\dfrac{MRS^s}{w^s}+ \\ \underbrace{\left[\left(\eta_{ss}-\eta_{us}\right)\gamma_u\eta_{su}-\left(\eta_{uu}-\eta_{su}\right)\gamma_u\left(\gamma_s-\eta_{ss}\right)\right]}_{(b)}\dfrac{MRS^u}{w^u} \end{bmatrix}\frac{\tilde{A}^{-1}}{(1-\tau)} \qquad (A.2.7)$$

Then given that term (a) and term (b) in *(A.2.7)* are of equal magnitude but opposite signs, $\hat{N}_g^s - \hat{N}_g^u = 0$ if $\frac{MRS^s}{w^s} = \frac{MRS^u}{w^u}$ making the right side of *(A.2.1)* equal to 0 so $N^s MRS^s + N^u MRS^u - \left(N^s + N^u\right) = 0$. Then $\hat{N}_g^s - \hat{N}_g^u > (<)\ 0$ if $\frac{MRS^s}{w^s} > (<)\ \frac{MRS^u}{w^u}$ making $N^s MRS^s + N^u MRS^u - \left(N^s + N^u\right) < (>)\ 0$ as $sign\left\{N^s MRS^s + N^u MRS^u - \left(N^s + N^u\right)\right\} = -\,sign\left\{\hat{N}_g^s - \hat{N}_g^u\right\}$.

In part (c), $\hat{N}_\tau^s < \hat{N}_\tau^u < 0$. Then from *(3.7.a)* $\lambda^* > 1$. With $\lambda^* > 1$in *(3.7.b)* the term $(\lambda - 1)\left(N^s\left(1 - \tau w^s \hat{w}_g^s\right) + N^u\left(1 - \tau w^u \hat{w}_g^u\right)\right)$ is positive. Then an unambiguous sign for the right side of *(3.7b)* is only obtained when $\hat{N}_g^s - \hat{N}_g^u < 0$ or $\frac{MRS^s}{w^s} < \frac{MRS^u}{w^u}$ as in this case term (b) of *(3.7b)* will also be positive. An analogous argument applies for part (d) of the proposition.

Table 2: Capital Taxes as a Share of Fixed Costs, Alternative Parameterizations

		(a)	(b)	(c)	(d)	(e)	(f)
	γ	100	5	0.5	100	5	0.5
		$\eta_{ll}=-1, \eta_{kk}=-1$					
(1)	η_{kl}	0					
	$\tau_k K/F$	0.258	0.231	0.160			
(2)	η_{kl}	0.5					
	$\tau_k K/F$	0.516	0.458	0.315			
(3)	η_{kl}	-0.5					
	$\tau_k K/F$	-0.204	-0.169	-0.098			
		$\eta_{ll}=-0.5, \eta_{kk}=-1.5$			$\eta_{ll}=-1.5, \eta_{kk}=-0.5$		
(4)	η_{kl}	0			0		
	$\tau_k K/F$	.100	.094	.074	.529	.470	.323
(5)	η_{kl}	0.5			0.5		
	$\tau_k K/F$	.339	.313	.240	.784	.692	.472
(6)	η_{kl}	-0.5			-0.5		
	$\tau_k K/F$	-.267	-.244	-.171	-.027	-.021	-.011
		$\eta_{ll}=-0.25, \eta_{kk}=-1.75$			$\eta_{ll}=-1.75, \eta_{kk}=-0.25$		
(7)	η_{kl}	0			0		
	$\tau_k K/F$	.045	.043	.038	.734	.676	.510
(8)	η_{kl}	0.5			0.5		
	$\tau_k K/F$	.271	.258	.216	.966	.875	.635
(9)	η_{kl}	-0.5			-0.5		
	$\tau_k K/F$	-.289	-.272	-.217	.194	.153	.080

Table 3: Income Taxation with Heterogeneous Workers

Tastes for Public Service															
	(a)			**(b)**			**(c)**			**(d)**			**(e)**		
a^s, a^u	0.2, 0.2			0.4, 0			0, 0.4			0.3, 0.1			0.25, 0.15		
Mobility															
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
γ^s	3	5.5	0.5	3	5.5	0.5	3	5.5	0.5	3	5.5	0.5	3	5.5	0.5
γ^u	3	0.5	5.5	3	0.5	5.5	3	0.5	5.5	3	0.5	5.5	3	0.5	5.5
Decentralized Policies															
τ	0.1314	0.1321	0.1316	0.1373	0.1359	0.1369	0.1261	0.1285	0.1269	0.1343	0.1340	0.1342	0.1329	0.1330	0.1329
g	0.1972	0.1981	0.1975	0.2060	0.2039	0.2053	0.1892	0.1927	0.1903	0.2015	0.2010	0.2013	0.1993	0.1995	0.1994
λ	1	1.0119	0.9881	1.0000	1.0123	0.9876	1.0000	1.0116	0.9886	1.0000	1.0121	0.9879	1.0000	1.0120	0.9880
Decentralized Polices relative to Centralized Policies															
Relative Utility, Skilled $\left(\frac{U^{s^*}}{U^{s^c}}\right)$	1.0007	1.0004	1.0006	1.0035	1.0023	1.0031	1.0083	1.0056	1.0075	1.0002	1.0001	1.0002	1.00004	1.00003	1.00004
Relative Utility, Skilled $\left(\frac{U^{u^*}}{U^{u^c}}\right)$	0.9982	0.9988	0.9984	0.9954	0.9970	0.9959	0.9325	0.9550	0.9398	0.9997	0.9998	0.9997	0.99990	0.99994	0.99991
Relative Welfare, $\left(\frac{W^*}{W^c}\right)$	1.0000	1.0000	1.0000	0.9999	1.0000	0.9999	0.9998	0.9999	0.9998	1.0000	1.0000	1.0000	1.00000	1.00000	1.00000
Gradients															
$\hat{N}_\tau^s / \hat{N}_\tau^u$	1.000	2.538	0.394	1.000	2.538	0.394	1.000	2.538	0.394	1.000	2.538	0.394	1.000	2.539	0.394
$\hat{N}_g^s / \hat{N}_g^u$	0.5	1.2692	0.1970	---	---	---	0.0000	0.0000	0.0000	1.5000	3.8077	0.5909	0.833	2.115	0.328

Table 4a: Income and Capital Taxation with Heterogeneous Workers, Equal Demand for Public Service

a^s, a^u	0.2, 0.2											
	(a)			**(b)**			**(c)**			**(d)**		
η_{sk}, η_{uk}	**0.5, 0**			**-0.5, 0**			**0, 0.5**			**0, -0.5**		
υ_s, υ_u	**3, 3**	**5.5, 0.5**	**0.5, 5.5**	**3, 3**	**5.5, 0.5**	**0.5, 5.5**	**3, 3**	**5.5, 0.5**	**0.5, 5.5**	**3, 3**	**5.5, 0.5**	**0.5, 5.5**
Capital Tax Rate (τ_k)	0.0145	0.0311	-0.0132	-0.0684	-0.0255	-0.0842	-0.0171	0.0116	-0.0430	0.0381	0.0458	0.0143
λ	0.9889	0.9885	0.9944	1.0182	1.0166	1.0090	1.0135	1.0051	1.0174	0.9903	0.9958	0.9873
g^{**}	0.1998	0.2031	0.1957	0.1919	0.1972	0.1904	0.1939	0.1995	0.1900	0.1999	0.2014	0.1980
Relative Income Tax Rate, $\left(\frac{\tau^{**}}{\tau^*}\right)$	0.9399	0.8680	1.0582	1.3205	1.1238	1.3906	1.0705	0.9486	1.1796	0.8203	0.7854	0.9306
Relative Public Service, $\left(\frac{g^{**}}{g^*}\right)$	1.0136	1.0251	0.9912	0.9734	0.9953	0.9640	0.9837	1.0072	0.9620	1.0137	1.0167	1.0029
Relative Utility, Skilled $\left(\frac{U^{s^{**}}}{U^{s^*}}\right)$	1.0131	1.0282	0.9879	0.9365	0.9762	0.9220	0.9846	1.0106	0.9610	1.0354	1.0425	1.0133
Relative Utility, Skilled $\left(\frac{U^{u^{**}}}{U^{u^*}}\right)$	1.0195	1.0412	0.9826	0.9126	0.9682	0.8920	0.9769	1.0151	0.9423	1.0485	1.0582	1.0178
Relative Welfare, $\left(\frac{W^{**}}{W^*}\right)$	1.00001	0.99999	0.99998	0.99993	0.99999	0.99989	0.99996	1.00000	0.99988	1.00001	1.00000	1.00000
$\hat{N}^s_{\tau_k}$	0.3696	0.4103	0.1689	-0.4025	-0.4341	-0.1820	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
$\hat{N}^u_{\tau_k}$	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3815	0.1648	0.4421	-0.3612	-0.1594	-0.4171

Table 4b: Income and Capital Taxation with Heterogeneous Workers, Demand for Public Service only by Skilled Workers

a^s, a^u	**0.4, 0**											
	(a)			**(b)**			**(c)**			**(d)**		
η_{sk}, η_{uk}	**0.5, 0**			**-0.5, 0**			**0, 0.5**			**0, -0.5**		
υ_s, υ_u	**3, 3**	**5.5, 0.5**	**0.5, 5.5**	**3, 3**	**5.5, 0.5**	**0.5, 5.5**	**3, 3**	**5.5, 0.5**	**0.5, 5.5**	**3, 3**	**5.5, 0.5**	**0.5, 5.5**
Capital Tax Rate (τ_k)	0.0151	0.0319	-0.0139	-0.0731	-0.0262	-0.0896	-0.0179	0.0120	-0.0450	0.0394	0.0468	0.0145
λ	0.9884	0.9882	0.9942	1.0195	1.0171	1.0097	1.0141	1.0052	1.0183	0.9900	0.9957	0.9869
g^{**}	0.2081	0.2083	0.2041	0.2040	0.2038	0.2020	0.2033	0.2051	0.1994	0.2069	0.2060	0.2052
Relative Income Tax Rate, $\left(\frac{\tau^{**}}{\tau^{*}}\right)$	0.9372	0.8651	1.0616	1.3455	1.1279	1.4201	1.0742	0.9471	1.1909	0.8132	0.7804	0.9290
Relative Public Service, $\left(\frac{g^{**}}{g^{*}}\right)$	1.0105	1.0216	0.9941	0.9905	0.9994	0.9838	0.9872	1.0058	0.9715	1.0047	1.0101	0.9997
Relative Utility, Skilled $\left(\frac{U^{s^{**}}}{U^{s^{*}}}\right)$	1.0196	1.0414	0.9824	0.9097	0.9679	0.8888	0.9767	1.0153	0.9416	1.0486	1.0584	1.0177
Relative Utility, Skilled $\left(\frac{U^{u^{**}}}{U^{u^{*}}}\right)$	1.0100	1.0212	0.9902	0.9450	0.9799	0.9334	0.9882	1.0083	0.9697	1.0297	1.0346	1.0113
Relative Welfare, $\left(\frac{W^{**}}{W^{*}}\right)$	0.99996	0.99993	1.00001	1.00002	1.00000	1.00003	1.00003	0.99999	1.00003	0.99998	0.99997	1.00000
$\hat{N}^{s}_{\tau_k}$	0.3694	0.4100	0.1690	-0.4046	-0.4345	-0.1831	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
$\hat{N}^{u}_{\tau_k}$	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3818	0.1647	0.4430	-0.3608	-0.1592	-0.4170

Table 4c: Income and Capital Taxation with Heterogeneous Workers, Demand for Public Service only by Unskilled Workers

a^s, a^u	0, 0.4											
	(a)			(b)			(c)			(d)		
η_{sk}, η_{uk}	0.5, 0			-0.5, 0			0, 0.5			0, -0.5		
υ_s, υ_u	3, 3	5.5, 0.5	0.5, 5.5	3, 3	5.5, 0.5	0.5, 5.5	3, 3	5.5, 0.5	0.5, 5.5	3, 3	5.5, 0.5	0.5, 5.5
Capital Tax Rate (τ_k)	0.0140	0.0304	-0.0127	-0.0644	-0.0247	-0.0796	-0.0164	0.0113	-0.0411	0.0370	0.0449	0.0140
λ	0.9893	0.9887	0.9946	1.0171	1.0160	1.0084	1.0129	1.0050	1.0165	0.9906	0.9959	0.9878
g^{**}	0.1923	0.1982	0.1881	0.1814	0.1911	0.1803	0.1855	0.1943	0.1815	0.1933	0.1971	0.1914
Relative Income Tax Rate, $\left(\frac{\tau^{**}}{\tau^{*}}\right)$	0.9423	0.8707	1.0553	1.2996	1.1200	1.3659	1.0672	0.9499	1.1699	0.8266	0.7901	0.9322
Relative Public Service, $\left(\frac{g^{**}}{g^{*}}\right)$	1.0164	1.0285	0.9886	0.9591	0.9916	0.9474	0.9805	1.0086	0.9538	1.0220	1.0229	1.0058
Relative Utility, Skilled $\left(\frac{U^{s**}}{U^{s*}}\right)$	1.0083	1.0191	0.9920	0.9568	0.9823	0.9468	0.9903	1.0074	0.9753	1.0250	1.0309	1.0099
Relative Utility, Skilled $\left(\frac{U^{u**}}{U^{u*}}\right)$	1.0662	1.1308	0.9447	0.7379	0.9118	0.6752	0.9214	1.0463	0.8068	1.1470	1.1692	1.0522
Relative Welfare, $\left(\frac{W^{**}}{W^{*}}\right)$	1.00008	1.00007	0.99994	0.99969	0.99997	0.99960	0.99987	1.00003	0.99966	1.00010	1.00006	1.00003
$\hat{N}^{s}_{\tau_k}$	0.3698	0.4106	0.1688	-0.4008	-0.4338	-0.1811	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
$\hat{N}^{u}_{\tau_k}$	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3812	0.1648	0.4412	-0.3616	-0.1595	-0.4172

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