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Unemployment and Capital Tax Competition

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Abstract

We introduce labor market imperfections into the capital tax competition literature to study the equilibrium tax formulae and their efficiency in the presence of unemployment. Since we allow for some labor market imperfections, the standard conclusions of the tax competition literature would be generalized in the case of non-full employment. Our first result shows that even when head taxes on immobile residents are available, the optimal capital tax rate for jurisdictional governments is not zero. Our second finding is that decentralized equilibrium might be characterized by the overprovision of local public goods when the labor market is imperfect.

Keywords: tax competition, unemployment, trade union, efficiency wage, job search, fixed wage

JEL Classification Number: H21, H71, J64

1 Introduction

There is an extensive literature on the efficiency properties of a system of competing local jurisdictions. One strand of this literature is capital tax competition[1]. The simplest models involve perfectly mobile capital, a local fixed factor, and the provision of a local public good by jurisdictional governments with revenue raised by a source-based tax on locally employed capital. The major conclusions of the literature are (i) when head taxes on immobile residents are available, the optimal capital tax rate for jurisdictional governments is zero, and (ii) when head taxes are restricted to impose, the capital tax rate set by jurisdictional governments is low compared with the efficient level. We can easily detect the intuition behind the first result in Zodrow and Mieszkowski (1983). In a standard small-open economy, each jurisdiction perceives that it faces a perfectly elastic supply of capital, and that any tax on mobile capital will be shifted to immobile residents, as will the excess burden attributed to the tax-induced outflow of capital. The logic behind the second result is given by Wildasin (1989). He identifies the source of the inefficiency in the tax competition model as a fiscal externality; although a tax increase in any jurisdiction affects the other jurisdictions' fiscal budgets, the jurisdictional government does not take that into account.

Much of this literature has assumed a perfect regional labor market. This is somewhat surprising since jurisdictions have a strong interest in the issue of attracting investment to boost regional employment. More specifically, jurisdictions often compete for mobile capital to create jobs in their region. Recent studies that address these issues within a particular unemployment model have departed from the assumption of full employment in their fiscal competition analysis [see Lejour and Verbon (1996), Fuest and Huber (1999), Richter and Schneider (2001), Boadway et al. (2002), Koskela and Schob (2002), Lozachmeur (2003), and Leite-Monteiro et al. (2003)]. We generalize this literature by modeling labor market imperfections in a variety of settings. The features that differentiate our model from those in the literature is that we take several types of unemployment as an object of study, putting particular emphasis on the efficiency-wage and job-search models of unemployment that have not been covered in previous studies[2]. One may expect that unemployment would

[1] There is a large body of research on capital tax competition. A partial list includes Zodrow and Mieszkowski (1986), Wilson (1986), and Wildasin (1989). See Wilson (1999) Zodrow (2003), and Wildasin and Wilson (2003) for a general review of the tax competition model.

[2] The exception is Boadway et al. (2002) who incorporate search unemployment into their tax competition framework. However, as it will become clear later, since the Boadway et al. model posits wage posting as the wage determination rule, the matching externalities are internalized, and therefore, the effects of matching externalities on tax competition cannot be explored. Since that model has no matching externality, with mobile firms and immobile

be of special importance to most countries, and that the underlying causes of unemployment differ from country to country. In such countries it would be reasonable to assume that the labor market is imperfect, and that residents face the fear of unemployment originating from different causes.

Not surprisingly, labor economists have developed a variety of theories of non-competitive wage determination, which we consider in this paper[3]. In the present study, we focus on the consequences of labor market imperfections due to four distinct reasons behind the central questions dealt within the literature, i.e., (i) whether jurisdictional governments choose a non-zero tax rate on mobile capital when they are allowed to use a head tax on immobile residents, and (ii) whether jurisdictional governments undersupply public goods when they rely only on taxation of mobile capital. Our paper relies on the models of efficiency wages, fixed wages, the presence of trade unions, and the job search to explain why wages are not flexibly adjusted in the labor market. Since, given labor market imperfections, a head tax on employed and unemployed residents will distort the resource allocation, jurisdictional governments will choose a non-zero tax rate for mobile capital even when allowed to use a head tax. A second set of results concerns the efficiency of local public good provision when a head tax is not available. As the degree of labor market imperfections becomes significant, a jurisdiction may induce negative externality by exporting unemployment. It is at this point that the positive and negative externalities associated with the use of capital taxes can be compared by the jurisdiction. Throughout this paper we are able to provide an intuitive basis for our results using the notions of fiscal (positive) and unemployment-exporting (negative) externalities.

The organization of this paper is as follows. In the next section, we will depart from the full-employment model developed by Zodrow and Mieszkowski (1986) in their seminal work. Deferring the discussion of various generalizations until later, our basic model follows the standard tax competition model with an efficiency wage model of unemployment. Section 3 describes two distinct approaches that justify the existence of involuntary unemployment. Here, after first introducing the fixed wage model, we will then analyze the model of union wage bargaining in the framework of tax competition. In particular, a so-called monopoly-union model, where the union sets the wage rate and the firm sets the amount of employment, is employed to clarify the effects of labor market imperfections on the decentralized equilibrium, as in the polar case of a bargaining model. We will show that the results derived by these extensions are in line with those obtained in the efficiency wage model of unemployment.

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workers, an under-provision of public transfer takes place, as can be found in traditional tax competition models.

[3]See reviews of the unemployment literature by Nickell (1990) and Bean (1994) among others.

In section 4, we offer another cause of unemployment by using a model of frictional unemployment in the tax competition framework. Section 5 provides a discussion, and Section 6 offer some conclusions.

2 Tax Competition and Efficiency Wage

The fundamental idea underlying efficiency wage models is that firms set wages and gain some benefit from paying higher wages which offset the direct cost. Although the benefits arising from paying higher wages are considered to arise in a number of ways, we simply follow Yellen (1984) and Akerlof and Yellen (1986), and assume that higher wages improve morale and increase productivity.

2.1 The Model

Preferences. The basic model throughout this paper is one of symmetric tax competition among small jurisdictions. There are n identical jurisdictions/regions, denoted by subscript $i = 1, 2, ..., n$. In each jurisdiction, there are immobile residents with strictly quasi-concave preferences $U_i(x_i, g_i) = x_i + v(g_i)$ $[v'(g_i) > 0, v''(g_i) < 0]$ defined over consumption of a private numeraire good x and a local public good g. Without any loss of generality, we assume that each jurisdiction has a continuum of individuals/workers of size 1.

Technology. The production of private goods in jurisdiction i is conducted by a large number of identical firms and requires using capital and labor. The aggregate production function in jurisdiction i is $F[e_i(w_i)L_i, K_i]$, where e refers to effort, L to employment, and K to the amount of capital. Effort is an increasing function of the wage rate, w_i; $e_i'(w_i) > 0, e_i''(w_i) < 0$. The economy has a fixed stock of capital, $\bar{K}$, which is perfectly mobile among jurisdictions. The total supply of capital in each period is fixed at $\bar{K}$ such that

$$\bar{K} = \sum_{i=1}^{n} K_i. \tag{1}$$

As in most tax competition literature, we assume that residents in jurisdiction i own the fraction $\lambda_i \in (0, 1)$ of capital stock in the economy. We also assume $\sum_i \lambda_i = 1$, so that all capital income is distributed to the capital owners (residents).

Jurisdictional Government. A jurisdictional government provides local public goods, g_i, which yield benefits to its residents. Private goods can be used as an input to produce local public goods, and units can be chosen so that the public goods provision in jurisdiction i can be measured in terms of units of private goods. The budget constraint on a jurisdictional government requires that the cost of providing local public goods must be equal to the sum of the revenue from both capital tax and head tax;

$$g_i = \tau_i K_i + h_i, \tag{2}$$

where τ is the (unit) capital tax rate, and h is the head tax on residents.

Firms. Since we have considered symmetric jurisdictions, in the following model, the subscript i is suppressed. The firm chooses the wage rate as well as the amounts of capital and employment to solve

$$\max_{w,K,L} \quad F[e(w)L, K] - wL - (\rho + \tau)K,$$

where ρ is the market net return on capital. The first-order conditions are

$$\begin{aligned} eF_L &= w, & (3)\\ e'F_L &= 1, & (4)\\ F_K &= \rho + \tau, & (5) \end{aligned}$$

where the derivatives of F with respect to the first and second arguments are denoted by F_L and F_K. (3) and (4) lead to a wage equation in the form

$$e(w) = we'(w). \tag{6}$$

We denote the wage rate determined by (6) as $\bar{w}$. Substituting $w = \bar{w}$ into the first-order conditions, the demands for labor and capital employments are determined by

$$\begin{aligned} e'(\bar{w})F_L[e(\bar{w})L, K] &= 1, & (7)\\ F_K[e(\bar{w})L, K] &= \rho + \tau. & (8) \end{aligned}$$

(7) and (8) now implicitly define $L = L(\tau)$ and $K = K(\tau)$ with

$$\begin{pmatrix} dL/d\tau \\ dK/d\tau \end{pmatrix} = \frac{1}{|A|} \begin{pmatrix} -e'F_{LK} \\ ee'F_{LL} \end{pmatrix}. \tag{9}$$

Note that competition among jurisdictions is expressed by the assumption that each jurisdictional government takes ρ as given. As the second-order condition is assumed to hold, i.e., $|A| \equiv ee'(F_{LL}F_{KK} - F_{LK}^2) > 0$, (9) shows that

$$\frac{dK}{d\tau} = \frac{F_{LL}ee'}{|A|} < 0 \tag{10}$$

and

$$sgn\left(\frac{dL}{d\tau}\right) = -sgn(F_{LK}). \tag{11}$$

Residents/Workers. Each worker is endowed with one unit of labor and supplies it inelastically when he/she is employed. The residents are classified into two types of workers: employed ($j = e$) and unemployed ($j = u$). Since we have assumed identical individuals in the jurisdiction, all employed and unemployed workers earn a return from the capital and dividends of firms' profits even though the jurisdictional government taxes them equally. Residents in jurisdiction i are endowed with shares in firms located in that jurisdiction, and each resident's shares entitle him/her to the same proportion of the sum of profits of all firms in jurisdiction i. Unemployment is seen as merely an unfortunate accident befalling each worker, in which those fortunate enough to be employed receive wages while the jobless workers earn no wage income. Thus, the budget constraints of the employed and unemployed workers are given by

$$x^j = \begin{cases} w + \pi + \rho\lambda\bar{K} - h & \text{if} \quad j = e \\ \pi + \rho\lambda\bar{K} - h & \text{if} \quad j = u \end{cases} \tag{12}$$

where $\pi \equiv F(eL, K) - wL - (\rho + \tau)K$.

2.2 Decentralized Equilibrium

The jurisdictional government maximizes the utilitarian form of welfare in its jurisdiction,

$$W = \mu u^u + (1 - \mu)u^e \tag{13}$$

subject to (2) and (12), where $u^u \equiv x^u + v(g)$ and $u^e \equiv x^e + v(g)$. In (13), μ represents the unemployment rate in the jurisdiction, $\mu = 1 - L$, since we have assumed the jurisdictional population to be 1. Thus, the employment rate is, thus, $1 - \mu$. This formulation of the objective function of jurisdictional government can be justified by the interpretation that collective decisions about the tax rates are assumed to be taken by a majority vote at the jurisdictional level.

Since the head tax and capital tax rates are jurisdictional government choice variables, the first-order conditions for h and τ will be

$$\frac{\partial W}{\partial h} = v' - 1 = 0 \tag{14}$$

$$\frac{\partial W}{\partial \tau} = eF_L\frac{dL}{d\tau} + (F_K - \rho - \tau + \tau v')\frac{dK}{d\tau} - K + Kv' = 0 \tag{15}$$

To derive the optimal capital tax rate for jurisdictional governments when a head tax is available, we use (5), (14) and (15) to obtain

$$\tau = -\frac{eF_L(dL/d\tau)}{dK/d\tau}. \tag{16}$$

From (10) and (11), we now have the first result.

Proposition 1. Assume that jurisdictional governments can use a head tax on immobile residents in the efficiency wage–tax competition model. If $F_{LK} > 0$, jurisdictional governments provide subsidies on capital, $\tau < 0$. If $F_{LK} = 0$, they choose zero tax rate, $\tau = 0$, and if $F_{LK} < 0$, they impose a tax on capital, $\tau > 0$.

The basic argument as to why jurisdictional governments choose a non-zero tax rate on capital can be made as follows: when $F_{LK} > 0$, an increase in K accompanied by a reduction in τ increases employment, L, since $dL/d\tau < 0$. That is, a reduction in the tax rate has a positive impact on a resident's welfare in the jurisdiction by reducing the unemployment rate, so that the jurisdictional government chooses a negative tax rate on capital. The simplest case is when $F_{LK} = 0$, since the capital tax rate has no impact on the amount of capital located in the jurisdiction, and thus has no power to raise employment. In that case, a jurisdictional government does not use the capital tax as a policy variable, and sets the tax rate as $\tau = 0$. When $F_{LK} < 0$, a reduction in the tax rate increases the amount of capital in the jurisdiction, K. However, in that case an increase in K raises the unemployment rate, $1 - L$, since $dL/d\tau > 0$. Since residents lose their jobs when jurisdictional government decreases capital tax rate to attract capital into the jurisdiction, in this case, the jurisdictional government chooses a positive tax rate to protect jobs.

Now we consider the efficiency of local public goods provision when governments are restricted from using a head tax on residents ($h = 0$ and $\tau > 0$). From (15), we have

$$v' = \frac{K - \frac{dL}{d\tau}F_L}{K + \frac{dK}{d\tau}\tau}. \tag{17}$$

We follow the literature and assume that we are on the left-side of a Laffer curve, $1 + (dK/d\tau)(\tau/K) > 0$. Then, using (9) and (17), we have the second result as follows.

Proposition 2. Assume that jurisdictional governments are restricted from using a head tax on immobile residents in the efficiency wage–tax competition model. When $F_{LK} \geq 0$, jurisdictional governments choose an inefficiently low tax rate on capital, $v' > 1$. However, if $F_{LK} < 0$, then they might choose a higher tax rate compared with the efficient level, $v' < 1$.

Proposition 2 implies that when capital inflow creates new jobs, $F_{LK} \geq 0$, local public goods are undersupplied. However, when capital substitutes for labor, and capital inflow induced by the capital tax rate reduction eliminates jobs in the region, $F_{LK} < 0$, jurisdictional government might choose an inefficiently high tax rate. Specifically, the condition sufficient to motivate them to choose an inefficiently high tax rate is given by

$$\frac{F_{LK}}{ee'F_{LL}} > \tau.$$

The sources of inefficiency may be identified by two kinds of externalities, i.e., (i) positive (fiscal) externality and (ii) negative (unemployment-exporting) externality. In our model, so-called fiscal externality exists; each jurisdictional government ignores the external effects of its tax change on other jurisdictions' tax revenue [Wildasin (1989)]. The existence of fiscal externality leads to an under-taxation on capital since it causes positive externality.

In the environment of an imperfect labor market there is a second source of inefficiency that might cause negative externality. When $F_{LK} < 0$, a change in the capital tax rate in jurisdiction i affects the well-being of the residents of another jurisdiction j, by changing the unemployment rate in that jurisdiction. However, jurisdictional government i does not account for this external effect in its decision-making. Since an increase in the capital tax rate causes negative externality in the other jurisdiction j [$F_{LK}(\partial K/\partial \tau) > 0$], and in cases where such negative externality dominates the positive (fiscal) externality, the equilibrium tax rate will be set at an inefficiently high level.

3 Extensions

Since the literature on the causes of unemployment is so vast, with different authors employing a bewildering variety of model specifications and often coming to different conclusions, we here extend the model to allow for such desperate reasons so as to explain the resulting involuntary unemployment. This is not a merely formal extension. Section 5 discusses the effects of labor market imperfections on the equilibrium properties for which those extensions are crucial.

3.1 Fixed Wage

A number of authors have pointed to the possible effects on unemployment of labor market regulations such as minimum wage provisions [Bazen and Martin

(1991)]. The simple fixed wage model can describe this type of unemployment.

The basic setup and notation of our previous section can be preserved here, except for the production function. We assume that the production function is now simply given by $F(L, K)$, where L is the labor employment, and K is the amount of capital employed in the jurisdiction. Denoting the exogenously fixed wage paid to employed workers as $\bar{w}$, the first-order conditions for maximum profit with respect to L and K are $F_L = \bar{w}$ and $F_K = \rho + \tau$. These two equations determine K and L as functions of τ. Differentiating these equations yields:

$$\frac{dL}{d\tau} = -\frac{F_{LK}}{|A|} \tag{18}$$

$$\frac{dK}{d\tau} = \frac{F_{LL}}{|A|} < 0, \tag{19}$$

where $|A| \equiv F_{LL}F_{KK} - F_{LK}^2 > 0$.

As in Section 2, jurisdictional government maximizes $W = \mu u^u + (1-\mu)u^e$, subject to (2) and (12). Since (18) and (19) have the same properties as (10) and (11), the characterization of the decentralized resource allocation is essentially no different from that in the case of an efficiency wage model of unemployment, meaning that (16) holds again, and that Proposition 1 applies. In addition, using exactly the same method of proof, it is now apparent that Proposition 2 can now be extended to the case where unemployment results from a fixed wage rate being exogenously set.

3.2 Monopoly Trade Union

The basic model of union wage bargaining involves a union with some preferences regarding wage and employment rates. To clarify the effects of labor market distortion on the equilibrium allocation of resources in the tax competition model, we here incorporate a regional monopoly union into the wage bargaining process, i.e., we assume the union has full bargaining power.

3.2.1 The Model

Technology. The basic setup and notation of the previous section can still be preserved here. The production of private goods requires using capital and labor with constant returns to scale technology, $F(L, K) = Lf(k)$, where L and K are the amounts of labor and capital, respectively, and $k \equiv K/L$. In the following analysis, we use the Cobb-Douglas type of technology represented by $F(L, K) = K^a L^{1-a}$, where $0 < a < 1$.

Firms. Profit-maximizing input decisions imply

$$\rho + \tau = f'(k) = ak^{a-1}, \tag{20}$$

$$w = f(k) - f'(k)k = (1-a)k^a. \tag{21}$$

(20) implicitly defines $k = k(\tau)$ with

$$k'(\tau) \equiv \frac{\partial k}{\partial \tau} = \frac{1}{f''(k)} = \frac{1}{a(a-1)k^{a-2}} < 0. \tag{22}$$

Regional trade union. In each jurisdiction, there is a single trade union. We assume that the union pursues two goals: high wages and a high rate of employment. A regional monopolistic trade union bargains over wages and the employment rate by accounting for the labor demand determined by (20) and (21). Formally, the optimization problem for the union is to maximize the objective function of the wage and employment rates represented by

$$V = \left[\beta(w - w^*)^\sigma + (1-\beta)(1-\mu)^\sigma\right]^{1/\sigma}, \tag{23}$$

subject to $(1-\mu) = (w^*/w)^{1/a}$, where $-\infty < \sigma < 1$ and $\beta \geq 0$. In (23), w^* denotes the competitive wage, and $1-\mu$ represents the employment rate in the region, $1-\mu = L$.

The particular shape of the convex indifferent curves generated by a CES objective function depends on the value of σ. As $\sigma \to -\infty$, any substitution between wages and employment is impossible in the limit for the union. The CES utility function becomes the Cobb-Douglas function for $\sigma = 0$, so that the union's objective function has a constant unit elasticity of substitution. In the limiting case of $\sigma \to 1$, the indifference curves are straight lines, so that wages and employment are perfect substitutes.

The first-order condition is given by

$$(1-\beta)(1-\mu)^\sigma = a\beta[1-(1-\mu)^a]^{\sigma-1}[(1-a)k^a]^\sigma. \tag{24}$$

Notice that, in this model, full employment equilibrium as examined in the traditional tax competition model can be described by assuming $\beta = 0$, since we obtain $\mu = 1$ as $\beta = 0$ in (24). (24) yields the unemployment rate schedule $\mu(k)$ with

$$\mu'(k) \equiv \frac{d\mu}{dk} = -\frac{a\sigma}{\sigma(1-L^a) + aL^a(\sigma-1)} \frac{L(1-L^a)}{k}. \tag{25}$$

From (22) and (25), we can obtain the effects of local tax changes on the unemployment rate as follows[4]:

[4]We might also consider a fourth scenario, i.e., the case of $\hat{\sigma} \leq \sigma < 1$. However, we

Case 1: $\sigma < 0$. $\mu'(k) < 0$, so that μ increases as τ increases.

Case 2: $\sigma = 0$. $\mu'(k) = 0$, so that μ has no relationship to τ.

Case 3: $0 < \sigma < \hat{\sigma} \equiv a/(1/L^a - (1-a))$. $\mu'(k) > 0$, so that μ decreases as τ increases.

The decision to attract investment by reducing tax rates is often motivated by a concern for fighting unemployment and enhancing job creation. This case corresponds to Case 1. However, it might also be the case that capital and labor are in a strong substitutable relationship, and that capital expels labor from the job market. It is in Case 3 that invested capital raises the unemployment rate.

Households. Using exactly the same assumptions for the residents' preference, the utility function is given by $u = x + v(g)$. In the residents' budget constraint, there is a slight difference compared with that in the efficiency wage model since we have assumed a constant-return technology, so that the firms are unable to raise their profits:

$$x^j = \begin{cases} w + \rho\lambda\bar{K} - h & \text{if } j = e, \\ \rho\lambda\bar{K} - h & \text{if } j = u. \end{cases} \tag{26}$$

3.2.2 Equilibrium

Defining the maximization problem for a jurisdictional government as

$$\begin{aligned} \max_{\tau,h} \quad W &= \mu u^u + (1-\mu)u^e \\ &= (1-\mu)[f(k) - kf'(k)] + \rho\lambda\bar{K} - h + v[\tau(1-\mu)k + h], \end{aligned}$$

we have the first-order conditions for h as

$$\frac{\partial W}{\partial h} = v'(g) - 1 = 0 \tag{27}$$

To derive optimal tax formulae, (22) and (25) permit us to establish the effect of a change in τ as follows:

$$\frac{\partial W}{\partial \tau} = -\mu'(k)k'(\tau)w - k(1-\mu) + v'(g)\left[(1-\mu)k + \tau k'(\tau)\left(-\mu'(k)k + (1-\mu)\right)\right] \tag{28}$$

exclude this case from the following analysis since the second-order condition for the union's optimization problem is not satisfied. See Ogawa and Tamai (2004) for the second-order condition of this model.

W evaluate equation (28) at $\tau = 0$ so as to derive the optimal capital tax rate for jurisdictional government when a head tax is available. Substituting $\tau = 0$ and $v'(g) = 1$ into (28), we have

$$\frac{\partial W}{\partial \tau}|_{\tau=0} = -w\mu'(k)k'(\tau). \tag{29}$$

From (29), the equilibrium capital tax rates when a head tax is available are obtained as follows.

Proposition 3. Assume that jurisdictional governments can impose a head tax on immobile residents in the monopoly union–tax competition model. When $\sigma < 0$, those governments provide subsidies to capital, $\tau < 0$. If $\sigma = 0$, then they choose a zero tax rate, $\tau = 0$. If $0 < \sigma < \hat{\sigma}$, they impose a tax on capital, $\tau > 0$.

This result is in line with Proposition 1 and shows that, in general, non-zero capital tax rates are chosen when a labor market is unionized. The logic behind this result is analogous to that in Proposition 1. With $\sigma < 0$, jurisdictional governments provide subsidies to capital since a capital inflow caused by a decrease in the capital tax rate increases the demand for labor so that the unemployment rate declines, $\mu'(k) < 0$. By contrast, when $\sigma > 0$, the demand for labor, and thus the employment rate, decreases due to the capital inflow, $\mu'(k) > 0$. This motivates jurisdictional governments to choose a positive tax rate on mobile capital.

Now we consider the efficiency of local public goods provision when the governments are restricted to using a head tax on residents, $(h = 0, \tau > 0)$. From (28), we have

$$v'(g) = \frac{k(1-\mu) + \mu' k' w}{k(1-\mu) - \mu' k' \tau k + \tau k'(1-\mu)} = \frac{1 - \eta\epsilon\left(\frac{1-a}{a}\frac{r+\tau}{\tau}\right)}{1 + \epsilon + \eta\epsilon}, \tag{30}$$

where $\eta \equiv [d(1-\mu)/dk][k/(1-\mu)]$ is the elasticity of the employment rate with respect to the capital located in the region, and $\epsilon \equiv (\partial k/\partial \tau)(\tau/k) < 0$ is the capital demand elasticity with respect to the tax rate. When the labor market is perfect, $\eta = 0$, (30) is reduced to the conventional result of underprovided public goods, $v'(g) = 1/(1+\epsilon) > 1$. However, if the labor market is not perfect, from (30), we obtain the following result.

Proposition 4. Assume that jurisdictional governments cannot impose a head tax on immobile residents in the monopoly union–tax competition model. When $\sigma \leq 0$, the government chooses an inefficiently low capital tax rate. However, when $\sigma > 0$, it might choose an inefficiently high tax rate on capital[5].

Proposition 4 is subject to an interpretation analogous to that in Proposition 2. With $\sigma \leq 0$, the effects of positive externality exceed those of negative externality caused by an increase in the capital tax, so that the capital tax rate is set at a level lower than the optimal level. The opposite might occur in the case of $\sigma > 0$. Specifically, as σ approaches to $\hat{\sigma}$, a jurisdictional government is likely to choose an inefficiently high rate of capital tax.

4 Job Search and Recruiting Friction

This section focuses another cause of unemployment, i.e., job search/recruiting friction, which has been considered to be a major cause of unemployment in the field of labor/macroeconomics [Petrongolo and Pissarides (2001)] and urban/regional economics [Sato (2001), Wasmer and Zenou (2002), and Smith and Zenou (2003)]. In a modern labor market, unmatched agents co-exist simultaneously in both parties, composing a matching process (i.e., unemployed workers and vacant jobs), due to information imperfections with respect to potential trading partners, heterogeneity, congestion resulting from large numbers, and other similar factors. Traditionally, labor and macro economists have used the term *friction* as a generic term to refer to these factors, and have shown that friction theoretically exerts a significant influence on a labor market.

In this paper, for the sake of expositional simplicity, a static model of tax competition with search unemployment, is presented although it is possible to develop a dynamic model that has similar properties [see Sato (2004)].

4.1 The Model

In each jurisdiction, there are a finite number m of firms, where m is assumed to be determined exogenously and is common to all jurisdictions. Each firm determines the number of vacant positions to open. Let $\theta_{ij} \in (0, +\infty)$ represent the number of vacancies opened by firm j in jurisdiction i ($j = 1, \ldots, m$ and $i = 1, \ldots, n$).

In the economy, there is search and recruiting friction. Hence, workers are either employed or unemployed, and vacancies are either filled or remained vacant. In order to model the job search environment, we apply the "matching approach", which reduces the complicated exchange process to a well-behaved function that yields the number of productive matches formed in terms of the

[5] See Ogawa and Tamai (2004) for detailed proof.

number of workers looking for jobs and the number of vacancies supplied by firms [see Mortensen and Pissarides (1999) and Pissarides (2000)]. Such a function is referred to as the "matching function", and is a modeling device similar to a production function or other aggregate functions. Here, since the workers are assumed to be immobile, the job search is local. Hence, the number of successful matches in each jurisdiction, M_i, is determined only by the number of workers, and that of vacancies in jurisdiction i. More concretely, M_i is determined by the matching function $M(l_i, \theta_i)$, which is defined on $0 < M(l_i, \theta_i) \leq \min[l_i, \theta_i]$, where l_i denotes the number of potential workers in jurisdiction i, and $\theta_i = \sum_{j=1}^{m} \theta_{ij}$. Here, since l_i is normalized to one, the number of successful matches is given as follows:

$$M_i = M(1, \theta_i).$$

We assume that securing a job is equally likely for all workers in a certain jurisdiction. The probability that each worker will find a job, $p(\theta_i)$, is then represented as follows:

$$p(\theta_i) = \frac{M_i}{1} = \frac{M(1, \theta_i)}{1}.$$

Similarly, finding a worker to fill vacancy is equally likely for all firms. Hence, the probability of a successful match for each vacancy is $p(\theta_i)/\theta_i$ because

$$\frac{p(\theta_i)}{\theta_i} = \frac{M_i}{\theta_i}. \tag{31}$$

This implies that when firm j in jurisdiction i opens θ_{ij} vacancies, $\theta_{ij} p(\theta_i)/\theta_i$ of these vacancies are expected to be filled, and $\theta_{ij}[1 - p(\theta_i)/\theta_i]$ are expected to remain vacant. $p(\theta_i)$ is assumed to be strictly increasing in its argument, twice differentiable, strictly concave, and $\lim_{\theta_i \to 0} p(\theta_i) = 0$.

Firms post vacancies and search for workers to employ. We suppose that a firm must buy k units of capital in order to open a vacancy, where k is a positive constant. According to the matching function, M_i, productive matches are created. We assume that each productive match produces y units of numeraire good, where y is assumed to be exogenous. The gain from a filled job is then $y - w_{ij} - (\rho + \tau_i)k$, and that from a vacancy is $-(\rho + \tau_i)k$, where w_{ij}, ρ, and τ_i are the wage rate of firm j in jurisdiction i, the market interest rate, and the capital tax rate imposed by the jurisdictional government i, respectively. Analogous to the model of Boadway et al. (2002), before paying the costs of posting a vacancy, a firm is not sure whether the vacancy will be filled. Consequently, the firm forms expectations regarding its profit under (31). The expected profit of firm j is calculated as follows:

$$\pi_{ij} = \frac{\theta_{ij} p(\theta_i)}{\theta_i}(y - w_{ij}) - \theta_{ij}(\rho + \tau_i)k. \tag{32}$$

Each worker is endowed with one unit of labor and supplies it inelastically when he/she is employed and obtains a wage w_{ij}. Since workers in jurisdiction i are endowed with shares in firms located in that jurisdiction, income from the shares d_i is given by $d_i = \sum_{j=1}^{m} \pi_{ij}$. Furthermore, workers in jurisdiction i are endowed with capital, $\lambda_i \bar{K}$, which yields capital income $\rho \lambda_i \bar{K}$.

The utility of a worker employed by firm j in jurisdiction i is thus given by

$$\begin{aligned} u_i^e &= x_{ij}^e + v(g_i) \\ &= w_{ij} + d_i + \rho \lambda_i \bar{K} - h_i + v(g_i), \end{aligned} \tag{33}$$

and the utility of an unemployed worker is given by

$$\begin{aligned} u_i^u &= x_{ij}^u + v(g_i) \\ &= d_i + \rho \lambda_i \bar{K} - h_i + v(g_i). \end{aligned} \tag{34}$$

The wage rate w_{ij} is determined by decentralized Nash bargaining, which imposes a particular division of the matching surplus between the two parties involved in the bargaining process according to the relative bargaining power existing between them. Here, we assume that labor unions are absent, and that each worker independently negotiates the wage rate with a firm[6]. For each worker, the matching surplus is the difference between the utility when employed and that when unemployed: $u_i^e - u_i^u = w_{ij}$. For each firm, the matching surplus is the difference between the profit when it fills a vacancy and that when it fails to do so: $y - w_{ij} - (\rho + \tau_i)k - [-(\rho + \tau_i)k] = y - w_{ij}$. Here, w_{ij} is determined as

$$w_{ij} = \arg\max w_{ij}^{\beta}(y - w_{ij})^{1-\beta},$$

where $\beta \in [0, 1]$ measures the bargaining power of the workers. A simple calculation then yields

$$w_{ij} = \beta y. \tag{35}$$

This implies that β represents the labor share.

From (35), the expected profit of each firm, represented by (32), can be rewritten as follows:

[6]This wage determination rule is commonly found in models using the matching approach. Refer to Mortensen and Pissarides (1999) and Pissarides (2000) for examples.

$$\pi_{ij} = \frac{\theta_{ij} p(\theta_i)}{\theta_i}(1-\beta)y - \theta_{ij}(\rho + \tau_i)k, \tag{36}$$

and the income from shares d_i becomes

$$d_i = \sum_{j=1}^{m} \pi_{ij} = p(\theta_i)(1-\beta)y - \theta_i(\rho+\tau_i)k. \tag{37}$$

From (33), (34), (35), and (37), the expected utility of a worker U_i is given as

$$\begin{aligned} U_i &= p(\theta_i)u_i^e + (1 - p(\theta_i))u_i^u \\ &= p(\theta_i)y - \theta_i(\rho+\tau_i)k + \rho\lambda_i\bar{K} - h_i + v(g_i). \end{aligned} \tag{38}$$

Each firm determines the number of vacancies θ_{ij} in order to maximize its profit (36), taking the interest rate ρ and the capital tax rate τ_i as given. The first-order condition for profit maximization is given by[7]

$$(\rho+\tau_i)k = \left[\frac{p(\theta_i)}{\theta_i} + \frac{\theta_{ij}(p'(\theta_i)\theta_i - p(\theta_i))}{\theta_i^2}\right](1-\beta)\,y.$$

Summing this up with respect to j, we have

$$(\rho+\tau_i)k = \Omega(\theta_i; m)\,(1-\beta)\,y, \tag{39}$$

where $\Omega(\theta_i; m)$ is defined as

$$\Omega(\theta_i; m) \equiv \frac{p(\theta_i)}{\theta_i} + \frac{p'(\theta_i)\theta_i - p(\theta_i)}{m\theta_i}. \tag{40}$$

4.2 Decentralized Policy Making

The jurisdictional government i determines the level of supply of local public goods g_i, the capital tax rate τ_i, the head tax on residents, h_i, and the number of vacancies θ_i in such a manner that it can maximize (38) under its budget constraint,

$$\tau_i\theta_i k + h_i = g_i \tag{41}$$

and (39). Inserting (41) into (38), this is equivalent to determining τ_i, h_i and θ_i so as to maximize $p(\theta_i)y - \theta_i(\rho+\tau_i)k + \rho\lambda_i\bar{K} - h_i + v(\tau_i\theta_i k + h_i)$ under (39).

[7] The second-order condition is satisfied:

$$\frac{\partial^2 \pi_{ij}}{\partial \theta_{ij}^2} = \left[\frac{\theta_{ij}p''(\theta_i)}{\theta_i} + 2\left(1 - \frac{\theta_{ij}}{\theta_i}\right)\frac{p'(\theta_i)\theta_i - p(\theta_i)}{\theta_i^2}\right](1-\beta)y < 0.$$

The last inequality holds because $p''(\theta_i) < 0$, $p'(\theta_i)\theta_i - p(\theta_i) < 0$, and $0 \leq \theta_{ij}/\theta_i \leq 1$, which can be shown by using the assumptions on $p(\theta_i)$.

First-order conditions for the government's maximization are then obtained as follows:

$$p'(\theta_i)y + v'(\tau_i\theta_i k)\tau_i k - (\rho + \tau_i)k - \delta\Gamma(\theta_i; m)(1-\beta)y = 0, \quad (42)$$

$$(v'(\tau_i\theta_i k) - 1)\theta_i + \delta = 0, \quad (43)$$

$$v'(\tau_i\theta_i k) - 1 = 0, \quad (44)$$

where δ is the Lagrangian multiplier, and $\Gamma(\theta_i; m)$ is defined as follows:

$$\begin{aligned} \Gamma(\theta_i; m) &\equiv \frac{\partial\Omega(\theta_i; m)}{\partial\theta_i} \\ &= \frac{p'(\theta_i)\theta_i - p(\theta_i)}{\theta_i^2} + \frac{p''(\theta_i)\theta_i^2 + p(\theta_i) - p'(\theta_i)\theta_i}{m\theta_i^2} \\ &= \frac{(m-1)(p'(\theta_i)\theta_i - p(\theta_i)) + p''(\theta_i)\theta_i^2}{m\theta_i^2} < 0. \end{aligned} \quad (45)$$

(43) and (44) yield $\delta = 0$. Inserting $\delta = 0$ into (42) and using (44), we have $p'(\theta_i)y = \rho k$. Substituting this condition into (39), we have

$$p'(\theta_i)y + \tau_i k = \Omega(\theta_i, m)(1-\beta)y. \quad (46)$$

From (46), we now have the following result.

Proposition 5. Assume that jurisdictional governments can impose a head tax on immobile residents in the job search–tax competition model. A jurisdictional government provides a subsidy to mobile capital, $\tau_i = -\beta p'(\theta_i)y/k < 0$, as $m \to 1$. By contrast, as $m \to +\infty$, the government chooses a positive or negative capital tax rate, $\tau_i = [p(1-\beta)y - p'(\theta_i)y\theta_i]/\theta_i k \gtreqless 0$.

Proof. From (40), we have $\Omega(\theta_i; 1) = p'(\theta_i)$. Substituting $\Omega(\theta_i; 1) = p'(\theta_i)$ into (46), we obtain $\tau_i = \beta p'(\theta_i)y/k$. Similarly, $\Omega(\theta_i; +\infty) = p(\theta_i)/\theta_i$. Substituting $\Omega(\theta_i; +\infty) = p(\theta_i)/\theta_i$ into (46), we obtain $\tau_i = [p(\theta_i)(1-\beta)y - p'(\theta_i)y\theta_i]/\theta_i k$.

Proposition 5 shows that when the number of firms in the region is sufficiently small, jurisdictional governments provide a subsidy to mobile capital, $\tau < 0$. By contrast, the higher the number of firms, the larger the capital tax rate[8].

[8]It is useful to take note of the equilibrium tax rate on capital in extreme cases. When the workers have full bargaining power, $\beta = 1$, the jurisdictional government always provides subsidies to capital, $\tau < 0$. Conversely, when the firms have full bargaining power, $\beta = 0$, the equilibrium tax rate on capital is zero when $m = 1$, and is positive when $m \to +\infty$.

This result can be interpreted as follows. Consider first the case of $m = 1$. If a monopoly firm in the region creates vacancies, it obtains rents by exploiting the capital income from residents. This implies that the capital income of residents when $m = 1$ is smaller than that would be obtained at the efficient equilibrium, $p'(\theta_i)y > \rho k$. In this case, the jurisdictional government can compensate for this gap by providing subsidies to mobile capital. On the other hand, when m reaches a sufficiently large number, the firms in the region are in the competitive market, and the expected marginal revenue, $p'(\theta_i)y$, should be distributed to the capital owners at the margin so that firms are reduced to earning zero profit, although the equilibrium result depends on the elasticity of p with respect to θ.

Now we analyze the efficiency of public goods provision when a jurisdictional government is restricted to imposing a head tax on immobile residents. From (42), we obtain

$$v'(g_i) = 1 + \frac{\rho k - p'(\theta_i)y}{\theta_i \Gamma(\theta_i; m)(1-\beta)y + \tau_i k}. \tag{47}$$

Since the total demand of capital $\sum_{i=1}^{n} \theta_i k$ is equal to the total supply of capital $\bar{K}$,

$$\sum_{i=1}^{n} \theta_i k = \bar{K}. \tag{48}$$

Since our focus is on a symmetric equilibrium, the total number of jobs θ_i is the same among all jurisdictions. Therefore, from (48), we have

$$\theta_i = \theta. \tag{49}$$

Here, we focus on interior solutions, and an interior equilibrium is summarized by $(g_i, \theta_i, \tau_i, \rho)$ that satisfies the jurisdictional government's budget constraint $\tau_i \theta_i k = g_i$, (39), (47), and (49). Note that θ_i is determined only by (49), and hence g_i is determined by $\tau_i \theta_i k = g_i$ if τ_i is determined. Substituting (49) and $\tau_i \theta_i k = g_i$ into (39) and (47), we obtain the following two equations:

$$(\rho + \tau_i)k = \Omega(\theta; m)\,(1-\beta)\,y, \tag{50}$$

$$v'(\tau_i \theta k) = 1 + \frac{rk - p'(\theta)y}{\theta \Gamma(\theta; m)(1-\beta)y + \tau_i k}. \tag{51}$$

Inserting (50) into (51), we obtain

$$v'(\tau_i \theta k) = \frac{[\theta \Gamma(\theta; m) + \Omega(\theta; m)]\,(1-\beta)y - p'(\theta)y}{[\theta \Gamma(\theta; m) + \Omega(\theta; m)]\,(1-\beta)y - \rho k}. \tag{52}$$

4.3 Optimality

The socially optimal allocation is a solution to the maximization of

$$U_i = p(\theta_i)y - g_i + \rho(\lambda_i \bar{K} - \theta_i k) + v(g_i), \tag{53}$$

under $\tau_i \theta_i k = g_i$, (48), and

$$U_j = p(\theta_j)y - g_j + \rho(\lambda_j \bar{K} - \theta_j k) + v(g_j) = \bar{U}. \tag{54}$$

The corresponding first-order conditions give

$$p'(\theta_i) - \rho k = \alpha k, \tag{55}$$

$$\delta_j\{p'(\theta_j) - \rho k\} = \alpha k, \tag{56}$$

$$v'(g_i) = v'(g_j) = 1, \tag{57}$$

where α and δ_j are Lagrangian multipliers associated with (48) and (54), respectively. Comparing (51) and (57), the following two propositions reveal the basic properties of the equilibrium.

Proposition 6. Assume that jurisdictional governments cannot impose a head tax on immobile residents in the job search–tax competition model. If there is only one firm in each jurisdiction, $m = 1$, local public goods are undersupplied.

Proof. When $m = 1$, (40), (45) and (49) give $\Omega(\theta_i; 1) = p'(\theta_i)$ and $\Gamma(\theta_i; 1) = p''(\theta_i)$. Inserting these equations into (52), we find that

$$v'(g_i) = \frac{\theta p''(\theta)(1-\beta)y - p'(\theta)\beta y}{[\theta p''(\theta) + p'(\theta)](1-\beta)y - \rho k}. \tag{58}$$

Because the left-hand side (LHS) of (58) is positive, and the numerator of the right-hand side (RHS) is negative, the denominator of the RHS is negative. By using (50), (58) can be rewritten as follows:

$$v'(g_i) = \frac{\theta p''(\theta)(1-\beta)y - p'(\theta)\beta y}{\theta p''(\theta)(1-\beta)y + \tau_i k}.$$

We can then see that $\theta p''(\theta)(1-\beta)y - p'(\theta)\beta y < \theta p''(\theta)(1-\beta)y + \tau_i k$, which, combined with the fact that the denominator of the RHS of (58) is negative, yields

$$\frac{\theta p''(\theta)(1-\beta)y - p'(\theta)\beta y}{\theta p''(\theta)(1-\beta)y + \tau_i k} > 1.$$

Hence, we have $v'(g_i) > 1$.

The traditional result of tax competition emerges in Proposition 6 simply because the externality associated with the job-opening decision is fully internalized when there is only one firm. When the number of firms is greater than one, we have the following result.

Proposition 7. Assume that jurisdictional governments cannot impose a head tax on immobile residents in the job search–tax competition model. If there is an infinite number of firms in each jurisdiction ($m \to +\infty$), local public goods are over- or under-supplied. When $p'(\theta)y < \rho k$, jurisdictional governments oversupply public goods. By contrast, when $p'(\theta)y > \rho k$, they undersupply them.

Proof. When $m \to +\infty$, (40), (45) and (49) give

$$\begin{aligned}\lim_{m\to+\infty} \Omega(\theta; m) &= p(\theta)/\theta, \\ \lim_{m\to+\infty} \Gamma(\theta; m) &= [p'(\theta)\theta - p(\theta)]/\theta^2.\end{aligned}$$

Plugging these equations into (52), we can see that

$$v'(g_i) = \frac{-p'(\theta)\beta y}{-p'(\theta)\beta y + p'(\theta)y - \rho k}. \tag{59}$$

Because the left-hand side (LHS) of (59) is positive, and the numerator of the right-hand side (RHS) is negative, the denominator of RHS is negative. When $p'(\theta)y < \rho k$, $-p'(\theta)\beta y > -p'(\theta)\beta y + p'(\theta)y - \rho k$ and $v'(g_i) < 1$. When $p'(\theta)y > \rho k$, $-p'(\theta)\beta y < -p'(\theta)\beta y + p'(\theta)y - \rho k$ and $v'(g_i) > 1$.

When the number of firms increases to infinity, each firm's job-opening decision converges to the standard one described in Mortensen and Pissarides (1999) and Pissarides (2000), i.e., each firm opens only one job. Firms open vacancies neglecting their marginal impact on other firms' matching probability, $p'(\theta_i)$. Hence, the marginal revenue from a job opening, $p'(\theta)y$ does not coincide with the marginal cost ρk of creating that opening. When $p'(\theta)y < \rho k$, opening another job is unfavorable to a jurisdiction. Conversely, $p'(\theta)y > \rho k$ implies that it would be beneficial to a jurisdiction to open another job.

These results indicate that capital taxation by one jurisdiction causes a positive or negative externality, since it results in a capital drain on other jurisdictions and increases jobs there. Therefore, we can determine whether local public goods are over-provided by comparing $p'(\theta)y$ to ρk. When $p'(\theta)y < \rho k$, the externality discussed above is negative, i.e., an increase in the capital tax rate in one jurisdiction increases the number of jobs opened in other jurisdictions, which provides negative marginal profits to those jurisdictions. In this case, jurisdictional governments impose too high capital tax rate, and local public goods are over-provided. When $p'(\theta)y > \rho k$, positive externality emerges and each jurisdictional government is over-committed to attracting jobs to its jurisdiction, which implies that capital taxation will be too low, and local public goods will be under-provided.

Since the situations described in Propositions 6 and 7 are both extreme cases, the reality would lie somewhere between them.

5 Discussion

5.1 Non-zero capital tax competition

Though we often observe that jurisdictional governments choose a non-zero tax rate on capital, the pioneering tax competition literature fails to explain this non-zero tax competition, concluding that the optimal capital tax rate for jurisdictional government is zero when head taxes on immobile residents are available. This leads economists to develop models that show jurisdictional governments choosing a non-zero tax rate on mobile capital when allowed to impose a head tax on immobile residents. Non-zero capital tax competition has also attracted much attention for its normative aspects, since the use of capital taxes generates a distortion in the capital market so that capital would be misallocated among jurisdictions [Bucovetsky and Wilson (1991), Coates (1993), DePater and Myers (1994) and Ogawa (2000) among others][9].

What this paper stresses as the reason why tax competition models cannot explain jurisdictional governments' practice of setting non-zero capital tax rates is that the behavior of governments is analyzed in the framework of a perfect labor market. All unemployment models provided in this paper consistently show that jurisdictional governments choose non-zero tax rates on capital even when taxation on residents is available. This result makes clear the possibility that jurisdictional governments use capital tax as a strategic policy variable, and choose a positive or negative tax rate on capital in a context of labor market

[9] Bucovetsky and Wilson (1991) developed a model with large regions and elastic labor supply to show that capital taxation is utilized. By assuming two large jurisdictions, the result of non-zero capital taxation is also derived by DePater and Myers (1994). Coates (1993) shows that jurisdictional governments provide subsidies when they compete repeatedly for mobile capital, and Ogawa (2000) also demonstrates that they provide subsidies when capital mobility is imperfect.

imperfections.

We allow for several types of labor market imperfections, but we derive their common features from our study; when capital inflow increases the labor demand of firms, jurisdictional governments choose a positive tax rate. By contrast, when the capital inflow reduces the labor demand of firms, the jurisdictional government provides a subsidy to mobile capital.

5.2 Race to the Bottom?

The result of a non-zero capital tax can also be found in the case of a monopoly union model proposed by Boeters and Schneider (1999) and Richter and Schneider (2001). Assuming that unemployment results from wage bargaining, Koskela and Schob (2002) also show that it is rational for jurisdictional governments to tax mobile capital at its source when labor markets are imperfect. They consider the effects of a revenue-neutral tax reform that changes both capital-income and labor taxes, but do not address the question of a *race to the bottom*, i.e., whether jurisdictional governments engage in wasteful competition for mobile capital through reductions in tax rates and public spending. In this paper we have addressed this question in the context of labor market distortions and have examined under what conditions a *race to the bottom* is triggered.

By considering some of the causes of labor market imperfections, we can clarify the conditions that yield an over- or under-provision of public goods. Specifically, the extensions provided in this paper exaggerate the differences among critical factors that affect the optimality of public goods provision. For instance, as shown in a trade union-tax competition model, not only production technology affects the efficiency of public goods provision (as shown in the efficiency wage-tax competition model), but the preferences of trade union play also a critical role in resource allocation. Furthermore, by employing the job search-tax competition model, we are able to obtain a new insight into the fact that the number of firms in the region affects the efficiency of public goods provision.

While we were able to demonstrate the differences among factors that affect the equilibrium properties, we also found a similarity in the mechanisms behind the results in efficiency obtained under different labor market environment. Whether a *race to the bottom* is on or off depends on whether the positive (fiscal) externality generated by capital taxation is smaller or greater than the negative externalities, although those externalities might prevail in different ways depending on the unemployment model we adopt.

6 Concluding Remarks

This paper examines the consequences of labor market imperfections for the standard conclusions of the capital tax competition literature. Under the simple tax competition framework, we have considered four factors that lead to labor market distortion: efficiency wage; fixed wage; monopoly union; and job search.

We first proved that, in all cases, a decentralized equilibrium is characterized by a non-zero tax rate on capital, even though jurisdictional governments are allowed to use a head tax. What is necessary for creating non-zero capital taxation result is that the capital inflow induced by a reduction in the capital tax rate should affect the demand for labor. If capital is substituted for labor, jurisdictional governments choose a positive tax rate on mobile capital. In contrast, if capital inflow increases the demand for labor, a capital subsidy will be used as a policy instrument.

A second result concerns the efficiency of public goods provision when the government is restricted in taxing immobile residents. Our result shows that a tax competition equilibrium would not be socially optimal, and points out the possibility that to achieve the Pareto Optimum requires that capital tax rates be decreased from the equilibrium tax rates chosen in a decentralized equilibrium.

We trust that our paper will serve as a benchmark case to obtain a better understanding of the effects of various types of labor market distortions on the equilibrium of the tax competition model. A number of useful extensions of the model can be made. For instance, though the various sources of labor market imperfections are incorporated into the model, both an implicit contract and an insider-outsider model of employment are ignored[10]. The present model assumes no distortions in the capital market, although capital does not freely move across jurisdictions due to transaction costs [Lee (1997) and Ogawa (2000)]. The evaluation of tax competition in the presence of labor market imperfections should be affected by assuming the Leviathan objective for governments [Edwards and Keen (1996) and Rauscher (1998)]. In section 4, edogenizing the job search or recruiting intensity will be important, since decisions regarding the search intensity affect the matching probability, and thus the matching externality [Petrongolo and Pissarides (2001)]. Furthermore, following DePater and Myers (1994), incorporating a non-price-taking jurisdictional government, which accounts for the effects of tax changes on the price of capital, should not be ignored, since the market capital price plays a critical role in the result arrived at section 4. These topics all remain important future investigations.

[10]See Blanchard and Summers (1986) and Lindbeck and Snower (1986) for the basic insider-outsider model. For the implicit contract model of unemployment, see the original studies of Baily (1974), Gordon (1974), and Azariadis (1975).

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Basic findings and their significance

In this paper, we introduce the various types of labor market imperfections into the capital tax competition literature to examine equilibrium tax formulae and their efficiency in the presence of unemployment. Especially, we place particular emphasis on the efficiency-wage and job-search models of unemployment that have not been covered in previous studies.

Our first finding is that even when head taxes on immobile residents are available, the optimal capital tax rate for a jurisdictional government is not zero. Our second finding is that a decentralized equilibrium might be characterized by the overprovision of local public goods when the labor market is imperfect.

Since we posit several causes that generate unemployment, we are able to demonstrate differences in the factors that affect equilibrium properties, e.g., production technologies, preferences of the union, and the number of firms competiting in the region. We also find a similarity in the mechanisms underlying the results on efficiency obtained under different labor market environments. Whether a so-called *race to the bottom* is on or off depends on whether the positive (fiscal) externality generated by capital taxation is smaller or greater than the negative externalities, although negative externalities might prevail in different ways depending on the unemployment model we adopt.