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# ABSTRACT

## Optimal Redistributive Taxation and Provision of Public Input Goods in an Economy with Outsourcing and Unemployment*

This paper concerns optimal redistributive income taxation and provision of a public input good in a two-type model with a minimum wage policy implemented for the low-ability type, where firms may outsource part of the production process abroad, and where outsourcing is substitutable for domestic low-ability labor. Our results show that the incentives for the government to relax the self-selection constraint and to increase the employment among the low-skilled reinforce each other in terms of marginal income taxation; both of them contribute to increase the marginal income tax rate implemented for the low-ability type and decrease the marginal income tax rate implemented for the high-ability type. The appearance of equilibrium unemployment also constitutes an incentive to implement a tax on outsourcing. Without a direct instrument for taxing outsourcing, the government may reduce the amount of resources spent on outsourcing by increased provision of the public input good, which leads to less wage inequality and increased employment.

JEL Classification: H21, H25, J31, J62

Keywords: outsourcing, optimal nonlinear taxation, public goods, unemployment

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## 1. Introduction

During the latest decades, international outsourcing has become an increasingly important aspect of production. International outsourcing means that part of the production activity – typically production carried out by low-skilled labor - is located to another country. Large wage differences across countries are most likely important explanations for this behavior, as the production costs may be substantially reduced if part of the production is located to a country with lower wages.[1] As outsourcing may deteriorate the income and/or employment prospects for the low-skilled in countries that undertake outsourcing, it may also create more demand for redistribution and other welfare policies.[2] Therefore, a basic question is how the public sector ought to adjust its tax and expenditure policies in response to international outsourcing. Although earlier research addresses some of the implications that international outsourcing may have for unemployment and welfare policy (see below), it is fair to say that very little attention has been paid to the implications of outsourcing for optimal redistributive taxation and provision of public goods.

The purpose of the present paper is to analyze redistributive nonlinear taxation and provision of a public input good in an economy with involuntary unemployment, where the firms may outsource part of their production to other countries. Such a study is interesting for several reasons. First, many countries have been characterized by relatively high unemployment rates for a long time, especially among low-skilled labor, while at the same time production activities have been moved abroad to a greater extent than before.[3] Therefore, if outsourcing leads to reduced demand for low-skilled labor, this suggests that the policy implications of outsourcing and involuntary unemployment ought to be analyzed simultaneously. Second, as earlier literature shows that both outsourcing and involuntary unemployment have important implications for optimal tax policy, it is clearly interesting from a theoretical perspective to combine them in the context of optimal redistributive taxation. Finally, the role of public input provision in this particular context is that such provision enhances the productivity of domestic labor and may, therefore, also reduce the level of outsourcing.[4] As a consequence, if public input provision leads to less outsourcing,

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1 For a wide range of industries, wage differences across countries constitute central explanations for outsourcing of production; see e.g. Amiti and Wei (2005), Rishi and Saxena (2004) and Sinn (2007).

2 See e.g. Keuschnigg and Ribi (2009).

3 See Stefanova (2006) for the East-West dichotomy of outsourcing.

4 See Egger and Falkinger (2006).

it may also contribute to less wage inequality and/or increased domestic employment. This argument suggests that public input goods are interesting to analyze in connection with outsourcing.

There are only a few earlier studies dealing with optimal redistributive taxation in connection with outsourcing. Aronsson and Koskela (2009) examine the implications of outsourcing of low-skill activities in the context of an optimal income tax model with two ability-types and a competitive labor market. The results show that if the government is able to control outsourcing via a direct tax instrument, then outsourcing will not by itself modify the policy rules for marginal income taxation. However, without a direct instrument to tax outsourcing, the optimal policy response to outsourcing is to implement a lower marginal income tax rate for the low-ability type and a higher marginal income tax rate for the high-ability type, which means that outsourcing contributes to a more progressive income tax structure. The intuition is that increased labor tax progression leads to a lower level of outsourcing which, in turn, implies less wage inequality. Keuschnigg and Ribi (2009) investigate the consequences of outsourcing for unemployment insurance and redistributive linear taxation in an economy where firms may outsource part of the production by low-skilled labor to another country. They show, among other things, that the gains from outsourcing can be made Pareto-improving by using a redistributive linear income tax, and they also characterize the optimal redistribution and unemployment insurance policies.[5]

To our knowledge, there are no earlier studies on redistributive nonlinear taxation, where outsourcing and involuntary unemployment are addressed simultaneously.[6] The present paper is based on the two-type optimal income tax model with asymmetric information between the government and the private sector developed by Stern (1982) and

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[5] Wage and employment responses to labor taxation and/or specific labor tax reforms in economies with outsourcing and involuntary unemployment are analyzed by Koskela and Schöb (2008) and Koskela and Poutvaara (2008a, 2008b, 2009). Ethier (2005) addresses the policy tradeoff between a lower skill premium and employment among the low-skilled in a country undertaking outsourcing as well as carries out a comparative statics analysis in the context of an international equilibrium.

[6] Earlier literature on optimal nonlinear taxation in economies with involuntary unemployment addresses a variety of issues such as the redistributive role of minimum wages and unemployment insurance (e.g., Marceau and Boadway, 1994; Boadway and Cuff, 2001), characterization of employment-motives for using labor income taxation and capital income taxation (e.g., Aronsson and Sjögren, 2003; Aronsson et al., 2009), and optimal labor tax progression (Fuest and Huber, 1997; Aronsson and Sjögren, 2004a, 2004b). See also the related literature dealing with optimal linear taxation in economies with involuntary

Stiglitz (1982), which is here augmented by the possibility for domestic firms to spend resources on international outsourcing and by allowing for involuntary unemployment among the low-skilled. Following Marceau and Boadway (1994), we assume that a minimum wage policy is implemented for the low-ability type which, in turn, gives rise to unemployment at the equilibrium. A minimum wage approach to imperfect competition in the labor market is clearly relevant from a practical policy perspective, as many countries apply minimum wage policies at present.[7] A minimum wage model has also theoretical appeal, as it provides a simpler alternative to some of the models with trade-unionized labor markets applied in earlier literature on optimal taxation under imperfect competition in the labor market.[8]

The set of policy instruments facing the government in our study contains a nonlinear income tax, a minimum wage, a public input good and an unemployment benefit (treated as fixed). The public input good appears as an externality production factor for the firms. In a way similar to Aronsson and Koskela (2009), we also distinguish between (i) a situation where the government can control the resources spent on outsourcing via a direct tax instrument, and (ii) a situation where a direct tax instrument for controlling outsourcing is not available. This distinction is reasonable: whereas the former case is appealing from a welfare economic point of view (as we are dealing with normative aspects of taxation), the argument behind the latter case is more practical because international agreements may limit the availability of such instruments in practice. However, by contrast to Aronsson and Koskela (2009), who analyze an economy with full employment for both ability-types, the distinction between Cases (i) and (ii) above is also relevant in the sense of highlighting an employment-related motive for the government to exercise control over the resources spent on outsourcing.

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unemployment, e.g. Bovenberg and van der Ploeg (1996), Boeters and Schneider (1999) and Koskela and Schöb (2002).

7 See Dolado et al. (1996) for a comparative empirical study of the consequences for employment of using minimum wages. The empirical evidence is mixed, and no strong evidence of adverse effects on employment is found except possibly for young workers.

8 Real world labor markets may contain a variety of mechanisms - such as minimum wage legislation and wage bargaining between trade-unions and firms – that give rise to involuntary unemployment. From our perspective, and except for the convenience argument presented above, it does not matter so much which mechanism is chosen, since they all imply similar employment-related incentives for tax and expenditure policies.

The outline of the study is as follows. In section 2, we describe the decision-problems facing private agents, i.e. consumers and firms, and the outcome of private optimization. We also describe the labor market (with a minimum wage imposed on the low-ability type) and the outcome in terms of employment. Section 3 concerns the optimal tax and expenditure problem in Case (i), where the government has access to a tax on outsourcing. The results show that the incentive to relax the self-selection constraint and the incentive to increase the number of employed low-ability individuals reinforce each other in terms of tax policy: the government implements a positive marginal income tax rate for the low-ability type, a negative marginal income tax rate for the high-ability type and a positive tax on outsourcing, respectively. For the public input good, these two policy incentives counteract each other: the desire to relax the self-selection constraint provides an incentive to underprovide the public input good relative to the first best policy rule, whereas the desire to increase employment provides an incentive for overprovision. Section 4 concerns optimal income taxation and public provision in Case (ii), where the government lacks a direct tax instrument attached to outsourcing, meaning that the income tax and the public input good will (at least in part) serve as indirect instruments to reduce the level of outsourcing. Our results show that the incentive to reduce outsourcing does not directly affect the policy rule underlying the marginal income tax rate implemented for the low-ability type, while it may change the marginal income tax rate implemented for the high-ability type in either direction. The incentive for the government to reduce outsourcing contributes to increased provision of the public input good. The results are summarized and discussed in section 5.

## 2. The Model

In this section, we present the decision-problems facing private agents, i.e. consumers and firms. We also describe the labor market and characterize the outcome of private optimization. The government's decision-problem and the outcome in terms of optimal taxation and provision of the public input good are addressed sections 3 (for Case (i)) and 4 (for Case (ii)).

### 2.1. *Consumers*

There are two types of consumers; a low-ability type (denoted by superindex 1) and a high-ability type (denoted by superindex 2). The distinction between ability-types refers to productivity, which is interpreted to mean that the high-ability type faces a higher before tax wage rate than the low-ability type. We denote the number of individuals of each ability-type by $\bar{n}^1$ and $\bar{n}^2$, respectively.

The utility function facing ability-type $i$ ($i$=1,2) is given by

$$u^i = u(c^i, z^i) \tag{1}$$

where $c$ is consumption and $z$ leisure. Leisure is, in turn, defined as a time endowment, $H$, less the time spent in market work, $l$. Let $w^i$ denote the hourly gross wage rate and $T(w^i l^i)$ the income tax payment by ability-type $i$. The individual budget constraint can then be written as

$$w^i l^i - T(w^i l^i) - c^i = 0\,. \tag{2}$$

The first order condition for the hours of work becomes

$$u_c^i w^i (1 - T'(w^i l^i)) - u_z^i = 0 \tag{3}$$

where $T'(w^i l^i) = \partial T(w^i l^i) / \partial (w^i l^i)$ is the marginal income tax rate.

Finally, as we indicated above, some low-ability agents may become unemployed due to the minimum wage policy (see below). Each unemployed individual is assumed to receive an unemployment benefit, $b$, and consume the maximum amount of leisure. Therefore, the utility facing an unemployed individual becomes $u^u = u(b, H)$, where the superindex "$u$" refers to "unemployed".

**2.2. *Production***

We assume that the production side of the economy contains one sector[9] with identical competitive firms producing a homogenous good.[10] The representative firm uses three variable inputs – domestic labor of each ability-type and the amount of resources outsourced to production abroad - together with a public input good (which appears as an externality production factor) to produce a homogenous good. Production is characterized by decreasing returns to scale in the three production factors controlled by the firm. The production function is written as $F(L^1, L^2, M, G)$, where $L^i$ represents the total number of work hours by ability-type *i*, measured as the hours of work per employee times the number of employed persons, whereas *M* denotes the resources spent on outsourcing and *G* represents the public input good. The function $F(\cdot)$ increases in each argument, and the second order derivatives $F_{L^1L^1}(\cdot)$, $F_{L^2L^2}(\cdot)$, $F_{MM}(\cdot)$ and $F_{GG}(\cdot)$ are all negative.

Skilled and unskilled labor are assumed to be technical complements in production, i.e. $F_{L^1L^2}(L^1, L^2, M, G) > 0$. Following Koskela and Stenbacka (2007), we also assume that outsourcing is substitutable for unskilled labor and complementary with skilled labor; therefore, $F_{L^1M}(L^1, L^2, M, G) < 0$ and $F_{L^2M}(L^1, L^2, M, G) > 0$, which means that outsourcing leads to wage inequality (as long as the before tax wage rates are determined by marginal productivity).[11] In a study dealing with the effects of globalization on the skill premium, Ethier (2005) uses a production function with similar properties to analyze the choice between international outsourcing and in-house production. We assume that while some activities are easy to outsource, other activities are more costly to outsource. Therefore, the marginal cost of outsourcing increases in the scope of activities to outsource, meaning that there is a cost associated with outsourcing, $\psi(M)$, which is increasing and convex, i.e. $\psi'(M) > 0, \psi''(M) \geq 0$. This captures the idea that outsourcing may necessitate costly investments into the establishment of network of suppliers in relevant host-countries. The public input good will be assumed to increase the marginal productivity of both skilled and

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9 See also, e.g., Arndt (1997) and Kohler (2004).

10 Therefore, we abstract from possible product market imperfections in what follows. Lommerud et al. (2009) analyze a model based on monopolistic competition to determine how unionization affects international outsourcing.

11 Empirical support for the idea that outsourcing leads to more inequality is provided by, e.g., Feenstra and Hanson (1999), Haskel and Slaughter (2001), Hijzen, Görg and Hine (2005), Hijzen (2007), Egger and Egger (2006), Munch and Skaksen (2009), Riley and Young (2007), Geishecker and Görg (2008) and Wood (1998). See also Gaston (2002) for a theoretical analysis.

unskilled labor, which means $F_{L^1G}(L^1, L^2, M, G) > 0$ and $F_{L^2G}(L^1, L^2, M, G) > 0$, whereas outsourcing and the public input good are weak substitutes in the sense that $F_{MG}(L^1, L^2, M, G) \leq 0$.[12]

The objective function facing the firm can be written as

$$\pi = F(L^1, L^{2,}, M, G) - w^1 L^1 - w^2 L^2 - \psi(M) - tM$$

where *t* is a tax per unit of the resources spent on outsourcing (which may, or may not, be operative). The first order conditions become

$$F_{L^1}(L^1, L^2, M, G) - w^1 = 0 \tag{4}$$

$$F_{L^2}(L^1, L^2, M, G) - w^2 = 0 \tag{5}$$

$$F_M(L^1, L^2, M, G) - \psi_M(M) - t = 0. \tag{6}$$

As mentioned in the introduction, we consider two possible cases with regards to the tax on outsourcing; Case (i) means that this tax is operative, i.e. part of the set of tax instruments facing the government (section 3), whereas Case (ii) means that it is not operative and, therefore, set equal to zero (section 4).

### 2.3. *The Labor Market*

As we indicated above, the labor market for high-skilled labor is assumed to be competitive, meaning that the equilibrium condition becomes $L^2 = \overline{n}^2 l^2$. Low-skilled

[12] In real world economies, outsourcing often means that firms move part of their production structure and employ (primarily low-skilled) labor abroad. Therefore, if domestic public input goods contribute to increased productivity of the domestic production factors, increased public provision means, ceteris paribus, a stronger incentive for domestic production relative to outsourcing. Our assumption that outsourcing and the public input good are weak substitutes aims to capture this idea in a simple way. See also Egger and Falkinger (2006) for a theoretical model where increased domestic investment in public infrastructure leads to reduced outsourcing. The idea that public capital may enhance the productivity of domestic factors and increase the domestic output is consistent with the empirical evidence presented by Lynde and Richmond (1992) based on US data, and Otto and Voss (1994) based on Australian data. Note also that that most of the qualitative results derived below would still apply if outsourcing and the public input good are complements in the production function, provided that the degree of complementary is low relative to the degree of complementary between the public input good and domestic labor.

workers, on the other hand, are subject to a minimum wage, i.e. $w^1_{\min}$**,** which is decided upon by the government. The minimum wage is assumed to imply a binding constraint in what follows, so $w^1 = w^1_{\min}$.

To be able to derive expressions for the marginal income tax rates comparable to those derived in earlier studies on optimal redistributive income taxation under imperfect competition in the labor market, let us rewrite equation (4) such that

$$F_{L^1}(n^1 l^1, \bar{n}^2 l^2, M, G) - w^1_{\min} = 0 \tag{7}$$

where $n^1$ is interpretable as the number of employed persons of the low-ability type. As the binding minimum wage exceeds the market clearing wage rate, it follows that some low-ability individuals are unemployed, i.e. $n^1 < \bar{n}^1$. We can then use equation (7) to solve for $n^1$ as a function of variables that the government controls via public policy (the government controls $l^1$, $l^2$ and $M$ via taxation, see below);

$$n^1 = n^1(\overset{-}{l^1}, \overset{+}{l^2}, \overset{-}{M}, \overset{+}{G}, \overset{-}{w^1_{\max}}). \tag{8}$$

In equation (8), the constant $\bar{n}^2$ has been suppressed for notational convenience, and the sign above each argument indicates the comparative statics effect. With the assumptions made above, therefore, an increase in the hours of work per low-ability employee, increased resources spent on outsourcing and an increase in the minimum wage, respectively, tends to decrease the number of employed low-ability individuals, whereas an increase in the hours of work per high-ability individual or an increase in the public input good tends to increase the number of employed low-ability individuals, ceteris paribus.

## 3. Optimal Taxation and Public Provision in Case (i)

In this section, we analyze the optimal policy rules for marginal income taxation, taxation of outsourcing and provision of the public input good, respectively, that will

follow from the model set out above. The government is assumed to face the following general social welfare function;[13]

$$W = W(n^1u^1, \bar{n}^2u^2, (\bar{n}^1 - n^1)u^u) \tag{9}$$

in which we may give a separate welfare weight to each agent-type, whereas identical individuals are subject to equal treatment.

The informational assumptions are conventional: the government knows the income of each individual as well as the number of individuals of each ability-type, whereas ability is private information. This means that the government is not able to observe whether any given worker is a low-ability or high-ability type. By concentrating on the 'normal' case, where redistribution means income transfers from the high-ability to the low-ability type, one would like to prevent the high-ability type from mimicking the employed low-ability type in order to gain from redistribution. The self-selection constraint that may bind then becomes[14]

$$u^2 = u(c^2, z^2) \geq u(c^1, H - \phi l^1) = \hat{u}^2 \tag{10}$$

where $\hat{u}^2$ denotes the utility of the mimicker, and $\phi = w^1 / w^2 < 1$ is the wage ratio (relative wage rate). Note that the mimicker faces the same income and consumption point and, therefore, pays as much tax as the employed low-ability type. However, as the mimicker is more productive than the low-ability type, he/she spends more time on leisure. By using the first order conditions for the firm, one can see that $\phi$ is a function of $l^2$, $M$, $G$ and $w^1_{\min}$, i.e.

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[13] Another approach (which is common in earlier literature on the self-selection approach to optimal income taxation) is to assume that the government aims at maximizing the utility of one agent-type subject to minimum utility restrictions for the others. If we were to use this alternative approach (instead of using the social welfare function), all qualitative results derived below would remain unchanged.

[14] This formulation, which only applies when the mimicker is employed, was also used by Marceau and Boadway (1994) in their study of minimum wage policy and unemployment insurance as means for redistribution. It is based on the assumption that the utility facing an employed low-ability type always exceeds the utility facing an unemployed individual. As a consequence, if the self-selection constraint in (10) is binding, it follows that the utility of the high-ability type always exceeds the utility facing an unemployed individual.

$$\phi = \phi(l^2, M, G, w^1_{\min}) = \frac{w^1_{\min}}{F_{L^2}(n^1 l^1, \bar{n}^2 l^2, M, G)} \tag{11}$$

in which $n^1$ is determined by equation (8). To interpret equation (11), note first that the effect of $l^1$ on the wage ratio is zero, because the hours of work per employee and the number of employed persons are perfect substitutes in terms of the production function. With the assumptions made above, one can show that an increase in the minimum wage leads to less wage inequality, i.e. $\partial\phi / \partial w^1_{\min} > 0$, while an increase in the public input good leads to more wage inequality, so $\partial\phi / \partial G < 0$. The effects on the wage ratio of the other variables can be either positive or negative in general. However, by adding the assumption that the direct effect of $l^2$ and $M$, respectively, on $w^2 = F_{L^2}(n^1 l^1, \bar{n}^2 l^2, M, G)$ dominates the corresponding indirect effect that arises via $n^1$, then $\partial\phi / \partial l^2 > 0$ and $\partial\phi / \partial M < 0$, meaning that an increase in the hours of work by the high-ability type reduces the wage inequality, whereas an increase in the resources spent on outsourcing leads to more wage inequality. These properties appear to us to be reasonable and will be used in what follows. Therefore, we have added the following assumption;

**A1:** $\dfrac{\partial\phi}{\partial l^2} > 0$ and $\dfrac{\partial\phi}{\partial M} < 0$.

By using the short notation $T^i = T(w^i l^i)$, the budget constraint of the government is given by

$$\pi + n^1 T^1 + \bar{n}^2 T^2 + tM - (\bar{n}^1 - n^1)b - G = 0$$

where the production price of the public good (i.e. the marginal rate of transformation between the public good and the private consumption good) has been normalized to one for notational convenience. The term $\pi$ represents possible pure profits, which we assume accrue to the government, as the government is the owner of the factor treated as fixed by the firm. Another equivalent formulation would be to assume that the government taxes

away all pure profits. The component $(\bar{n}^1 - n^1)b$ represents the public expenditure on unemployment benefits.

Note that $T(\cdot)$ is a general income tax in the sense that it may be used to implement any desired combination of $l^1$, $c^1$, $l^2$, and $c^2$. It is, therefore, convenient to follow earlier comparable literature by using $l^1$, $c^1$, $l^2$, and $c^2$, instead of the parameters of $T(\cdot)$, as direct decision-variables for the government. Similarly, since the government can use $t$ to exercise perfect control over $M$ (given that it also exercises control over $l^1$, $l^2$, $G$ and $w^1_{\min}$), we may also use $M$ as a direct decision-variable in what follows. By using the private budget constraint and the objective function of the firm, we may rewrite the budget constraint of the government to read

$$F(n^1 l^1, \bar{n}^2 l^2, M, G) - n^1 c^1 - \bar{n}^2 c^2 - (\bar{n}^1 - n^1)c^u - \psi(M) - G = 0. \qquad (12)$$

The government's decision-problem will be to choose tax and expenditure policies in order to maximize the social welfare function, presented in equation (9), subject to the self-selection constraint and budget constraint given by equations (10) and (12), respectively, as well as subject to equations (8) and (11), which determine the number of employed persons of the low-ability type and the wage ratio, respectively. The Lagrangean corresponding to the optimal tax and expenditure problem can now be written as

$$L = W + \lambda[u^2 - \hat{u}^2] + \gamma[F - n^1 c^1 - \bar{n}^2 c^2 - (\bar{n}^1 - n^1)c^u - \psi(M) - G]$$

where $F = F(n^1 l^1, \bar{n}^2 l^2, M, G)$. The government's first order conditions for work hours, private consumption and outsourcing, which are the conditions governing the optimal tax structure, are presented in the Appendix 1.

### 3.1. Marginal income tax rates and the tax on outsourcing

We are now in the position to analyze how the simultaneous appearances of equilibrium unemployment and outsourcing affect the optimal tax structure. The marginal income tax rate implemented for the low-ability type might be derived by combining

equations (3), (A1) and (A2), whereas the marginal income tax rate implemented for the high-ability type is derived by combining equations (3), (A3) and (A4). The tax rate on outsourcing can be derived by combining equations (6) and (A5). Now, let

$$MRS^{i}_{z,c} = \frac{u^{i}_{z}}{u^{i}_{c}} \text{ and } M\hat{R}S^{2}_{z,c}\,\frac{\hat{u}^{2}_{z}}{\hat{u}^{2}_{c}}$$

denote the marginal rate of substitution between leisure and private consumption for ability-type *i* and the mimicker, respectively. In addition, to shorten the notation, define the value that the government attaches to the private utility gain of going from unemployment to employment measured in terms of public funds

$$\Delta = \frac{1}{\gamma}\left[\frac{\partial W}{\partial(n^{1}u^{1})}u^{1} - \frac{\partial W}{\partial((\overline{n}^{1}-n^{1})u^{u})}u^{u}\right].$$

Then, by using $\lambda^{*} = \lambda\hat{u}^{2}_{c}/\gamma$, the marginal income tax rates and the tax on outsourcing can be written as

$$T^{'}(w^{1}l^{1}) = \frac{\lambda^{*}}{w^{1}n^{1}}[MRS^{1}_{z,c} - \phi M\hat{R}S^{2}_{z,c}] - \frac{1}{w^{1}n^{1}}[T^{1}+b+\Delta]\frac{\partial n^{1}}{\partial l^{1}} \tag{13}$$

$$T^{'}(w^{2}l^{2}) = -\frac{\lambda}{\gamma w^{2}\overline{n}^{2}}\hat{u}^{2}_{z}l^{1}\frac{\partial\phi}{\partial l^{2}} - \frac{1}{w^{2}\overline{n}^{2}}[T^{1}+b+\Delta]\frac{\partial n^{1}}{\partial l^{2}} \tag{14}$$

$$t = -\frac{\lambda}{\gamma}\hat{u}^{2}_{z}l^{1}\frac{\partial\phi}{\partial M} - [T^{1}+b+\Delta]\frac{\partial n^{1}}{\partial M}\,. \tag{15}$$

The main difference between, on the one hand, equations (13)-(15) and, on the other, the corresponding results derived by Aronsson and Koskela (2009) for an economy with a competitive labor market refers to the final term in each equation above, which appears because each tax instrument can be used to influence the number of employed persons. To sign this effect, we use the first order condition for the minimum wage

$$\lambda\hat{u}^{2}_{z}\overbrace{\frac{\partial\phi}{w^{1}_{\min}}}^{+}l^{1} + \gamma[T^{1}+b+\Delta]\overbrace{\frac{\partial n^{1}}{\partial w^{1}_{\min}}}^{-} = 0\,. \tag{16}$$

The first term on the left hand side of equation (16) is clearly positive, as an increase in the minimum wage leads to an increase in the wage ratio (i.e. reduced wage inequality). Therefore, since an increase in the minimum wage also contributes to reduce the number of employed persons, i.e. $\partial n^1 / \partial w^1_{\min} < 0$, we have $T^1 + b + \Delta > 0$.

We have derived the following result;

**Proposition 1.** *Suppose that the government can control outsourcing via a direct tax instrument. With the assumptions made above, it follows that*

*(i) the government implements a positive marginal income tax rate for the low-ability type, a negative marginal income tax rate for the high-ability type and a positive tax on outsourcing, and*

*(ii) the employment effect (captured by the final term in each tax formula) provides an incentive for the government to implement a higher marginal income tax rate for the low-ability type, a lower marginal income tax rate for the high-ability type and a higher tax on outsourcing, ceteris paribus.*

If the mimicker has flatter indifference curves in income-consumption space that the low-ability type, so $MRS^1_{z,c} > \phi \hat{MRS}^2_{z,c}$, Proposition 1 follows by observing that $\partial \phi / \partial l^2 > 0$, $\partial \phi / \partial M < 0$, $\partial n^1 / \partial l^1 < 0$, $\partial n^1 / \partial l^2 > 0$ and $\partial n^1 / \partial M < 0$ by our earlier assumptions, and that $T^1 + b + \Delta > 0$ according to equation (16). As a consequence, the redistributive component (via the self-selection constraint) and corrective component (via the employment effect) work in the same direction in each tax formula.

To be able to provide a more through interpretation of the second part of the proposition, note that $T^1 + b + \Delta > 0$ measures the social value of increased employment among the low-skilled. As a consequence, there is an incentive for the government to use tax policy to increase the number of employed persons, which is captured by the final term on the right hand side of each tax formula. The final term on the right hand side is positive in equation (13), negative in equation (14) and positive in equation (15), respectively, whereas each of these terms would have been equal to zero under full employment (where $n^1 = \bar{n}^1$). The intuition is that a higher marginal income tax rate for the employed low-

ability type contributes to reduce the hours of work supplied by each employed low-ability individual; a lower marginal income tax rate implemented for the high-ability type leads to increased hours of work by the high-ability type; and a higher tax on outsourcing leads to less outsourcing. Each such change implies, in turn, that $n^1$ increases.[15] However, note that the second part of the proposition does not necessarily mean that the government implements a higher marginal income tax rate for the low-ability type, a lower marginal income tax rate for the high-ability type and a higher tax on outsourcing than it would have done under full employment, since the effects of public policy on the wage distribution are clearly different here than they would have been with a market clearing wage rate for the low-ability type.

It is interesting to compare the expressions for the marginal income tax rates derived above with those in earlier studies on optimal redistributive income taxation under imperfect competition in the labor market. Equations (13) and (14) are similar to the policy rules for marginal income taxation derived by Aronsson and Sjögren (2003) in an economy without outsourcing, with the exception that union wage setting is the mechanism behind the unemployment in their study. The main difference by comparison with their study is that we are in this case able to sign the employment-effect in each tax formula, i.e. how the incentive for the government to increase the employment modifies the use of marginal income taxation. In addition, and by comparison with Aronsson and Koskela (2009), we are also able to address (and sign the qualitative contribution of) an employment-related motive for taxing outsourcing.

### 3.2. Provision of the public input good

The first-order condition for the public input good can be written as

$$F_G(\cdot)-1=-\frac{\lambda}{\gamma}\hat{u}_z^2 l^1\frac{\partial\phi}{\partial G}-[T^1+b+\Delta]\frac{\partial n^1}{\partial G}. \tag{17}$$

[15] It is important to observe that the increased marginal income tax rate of the low-ability type caused by the employment effect in equation (13) would also follow under the weaker assumption that the hours of work per employee and the number of employed persons are imperfect substitutes in terms of the production function.

Equation (17) means that the optimal provision of the public good deviates from the first best policy rule, i.e. $F_G(\cdot)-1=0$, because a change in the public input good directly affects (i) the wage distribution and (ii) the number of employed persons. To be more specific, increased provision of the public input good reduces the wage ratio (i.e. leads to more wage inequality), $\partial\phi/\partial G<0$, and increases the number of employed persons of the low-ability type, $\partial n^1/\partial G>0$**.** One can think of the first term on the right hand side of equation (17) as capturing the wage distribution effect of public provision, which operates via the self-selection constraint, whereas the second term captures the employment effect.

We summarize the main qualitative insight from equation (17) as follows;

**Proposition 2.** *If the government can control outsourcing via a direct tax instrument, it will underprovide (overprovide) the public input good relative to the first best policy rule if the wage distribution effect of public provision dominates (is dominated by) the employment effect in the sense that*

$$-\frac{\lambda}{\gamma}\hat{u}_z^2 l^1\frac{\partial\phi}{\partial G}>(<)\,[T^1+b+\Delta]\frac{\partial n^1}{\partial G}.$$

*The employment effect contributes unambiguously to increase the provision of the public input good.*

The mechanisms behind Proposition 2 are that increased public provision has two counteracting effects: it makes the income distribution more unequal (by increasing the wage rate facing the high-ability type given the minimum wage rate facing the low-ability type) and increases the employment. The relative strength of these two effects then determines whether the optimal policy rule means overprovision or underprovision relative to the first best policy rule.

## 4. Optimal Taxation and Public Provision in Case (ii)

A possible objection to the analysis set out above is that a national government may not necessarily be able to exercise full control over the resources spent on outsourcing.

Therefore, in this section, we analyze optimal income taxation and provision of the public input good in Case (ii), where the government lacks a direct instrument to tax outsourcing.

The firm's first order conditions for low-skilled labor and outsourcing can now be written as (with $t = 0$)

$$F_{L^1}(n^1 l^1, \bar{n}^2 l^2, M, G) - w^1_{\min} = 0 \tag{18}$$

$$F_M(n^1 l^1, \bar{n}^2 l^2, M, G) - \psi_M(M) = 0\,. \tag{19}$$

By solving equation system (18) and (19) for $n^1$ and $M$, we have

$$n^1 = \tilde{n}^1(l^1, l^2, G, w^1_{\min}) = n^1(l^1, l^2, M(l^2, G, w^1_{\min}), G, w^1_{\min}) \tag{20}$$

$$M = M(l^2, G, w^1_{\min}) \tag{21}$$

in which the constant $\bar{n}^2$ has been suppressed. The expression after the second equality in equation (20), i.e. the function $n^1(\cdot)$, is based on equation (8) and distinguishes between direct effects of $l^1$, $l^2$, $G$ and $w^1_{\min}$ on the number of employed persons and the indirect effects of these variables via $M(\cdot)$, whereas the function $\tilde{n}^1(\cdot)$ is the corresponding reduced form. This decomposition of employment effects will be used in the tax formulas below.

With the assumptions made in Section 2, one can show that an increase in the minimum wage leads to increased outsourcing, while an increase in the public input good leads to reduced outsourcing, i.e. $\partial M / \partial w^1_{\min} > 0$ and $\partial M / \partial G < 0$. An increase in the hours of work supplied by the high-ability type, on the other hand, may either increase or decrease the amount of resources spent on outsourcing, meaning that $\partial M / \partial l^2$ can be either positive or negative. Note also that $\partial M / \partial l^1 = 0$ by the assumptions made earlier, because the two effects via which the hours of work supplied by the low-ability type affect outsourcing - a direct effect and an indirect effect via the number of employed persons - cancel out. We will return to the properties of equation (21) below.

The optimal tax and expenditure problem can be written as if the government chooses $l^1$, $c^1$, $l^2$, $c^2$, $G$ and $w^1_{\min}$ to maximize the Lagrangean

$$L = W + \lambda[u^2 - \hat{u}^2] + \gamma[F - n^1c^1 - \bar{n}^2c^2 - (\bar{n}^1 - n^1)c^u - \psi(M) - G]$$

subject to equations (8), (11) and (21). The marginal income tax rates are derived by using equation (3) and equations (A6)-(A9) in the Appendix 2. To analyze the optimal income tax structure, it is useful to begin by discussing the first order condition for the minimum wage, which can be written as

$$\lambda \hat{u}_z^2 \frac{d\phi}{dw^1_{\min}} l^1 + \gamma[T^1 + b + \Delta]\frac{dn^1}{dw^1_{\min}} = 0\,. \tag{22}$$

The derivatives of the wage ratio and the number of employed persons of the low-ability type, respectively, with respect to the minimum wage in equation (22) can be decomposed into two parts; a direct effect (with $M$ held constant) and an indirect effect via equation (21). By using equations (11) and (21), we have

$$\frac{d\phi}{dw^1_{\min}} = \left.\frac{\partial \phi}{\partial w^1_{\min}}\right|_{M=M^0} + \frac{\partial \phi}{\partial M}\frac{\partial M}{\partial w^1_{\min}} \gtrless 0 \tag{23}$$

$$\frac{dn^1}{dw^1_{\min}} = \left.\frac{\partial n^1}{\partial w^1_{\min}}\right|_{M=M^0} + \frac{\partial n^1}{\partial M}\frac{\partial M}{\partial w^1_{\min}} < 0 \tag{24}$$

where each direct effect is conditioned on the second best optimal level of outsourcing, $M^0$. Therefore, by the assumptions made above, the total effect on the number of employed persons of an increase in the minimum wage is unambiguously negative, whereas the total effect on the wage ratio wage can be either positive or negative. For purposes of interpretation, let us add the assumption that the positive direct effect of the minimum wage on the wage ratio dominates the negative indirect effect via the change in outsourcing, so that $d\phi / dw^1_{\min} > 0$. More formally;

**A2:** $sign\ \dfrac{d\phi}{dw^1_{\min}} = sign\ \left.\dfrac{\partial\phi}{\partial w^1_{\min}}\right|_{M=M^0} > 0$.

In this case, and by analogy to the analysis carried out in the previous section, we can use equation (22) to show that $T^1 + b + \Delta > 0$, which will be useful below.

### 4.1. Marginal income tax rates

As the social welfare function is equal to the Lagrangean at the second best optimum, we can use $\Lambda = [\partial L / \partial M]/\gamma$ to measure the welfare effect of a marginal increase in the resources spent on outsourcing. The marginal income tax rates can then be written as

$$T'(w^1 l^1) = \frac{\lambda^*}{w^1 n^1}[MRS^1_{z,c} - \phi M\hat{R}S^2_{z,c}] - \frac{1}{w^1 n^1}[T^1 + b + \Delta]\left.\frac{\partial n^1}{\partial l^1}\right|_{M=M^0} \tag{25}$$

$$T'(w^2 l^2) = -\frac{\lambda}{\gamma w^2 \bar{n}^2}\hat{u}^2_z l^1 \left.\frac{\partial\phi}{\partial l^2}\right|_{M=M^0} - \frac{1}{w^2\bar{n}^2}[T^1 + b + \Delta]\left.\frac{\partial n^1}{\partial l^2}\right|_{M=M^0} - \frac{\Lambda}{w^2\bar{n}^2}\frac{\partial M}{\partial l^2}. \tag{26}$$

Equation (25) means that the formula for the marginal labor income tax rate implemented for the low-ability type remain as in Case (i), where the government had access to a direct instrument to tax outsourcing, whereas equation (26) contains an additional incentive effect due the relationship between $l^2$ and $M$. The intuition as to why a corresponding relationship between $l^1$ and $M$ is absent in equation (25) was discussed in connection to equation (21) above: a change in the hours of work per employed low-ability individual will not affect the total number of hours worked by the low-ability type, as the hours of work per employee and the number of employed persons are perfect substitutes in terms of the production function. To interpret the final term on the right hand of equation (26), we take the derivative of the Lagrangean with respect to $M$ and use $F_M(\cdot) - \psi_M(\cdot) = 0$ from equation (19) to derive

$$\Lambda = \frac{1}{\gamma}\frac{\partial L}{\partial M} = \frac{\lambda}{\gamma}\hat{u}^2_z \frac{\partial\phi}{\partial M} l^1 + \left[T^1 + b + \Delta\right]\frac{\partial n^1}{\partial M} < 0. \tag{27}$$

We can then interpret equations (25) and (26) as follows;

> **Proposition 3.** *Suppose that the government does not have access to a direct tax on outsourcing. With the assumptions made above, the marginal income tax formula for the low-ability type remains as in Section 3 (i.e. where a direct tax on outsourcing was available). The relationship between the hours of work supplied by the high-ability type and the level of outsourcing provides an incentive for the government to increase (decrease) the marginal income tax rate implemented for the high-ability type if* $\partial M / \partial l^2 > 0$ *(*$< 0$*).*

It is interesting to compare equations (25) and (26) with the corresponding marginal income tax rates derived by Aronsson and Koskela (2009) in an economy with full employment. They show that the lack of a direct tax instrument for outsourcing provides an incentive for the government to implement a lower marginal income tax rate for the low-ability type and a higher marginal income tax rate for the high-ability type, i.e. a more progressive tax structure.

With a binding minimum wage for the low-ability type, on the other hand, there is no direct additional effect of outsourcing on the marginal labor income tax rate implemented for the low-ability type, whereas the direct effect of outsourcing on the marginal income tax rate implemented for the high-ability type can be either positive or negative, as the effect of an increase in the hours of work by the high-ability type may either increase or decrease the amount of resources spent on outsourcing. The intuition behind this ambiguity is that an increase in the hours of work supplied by the high-ability type will both have a direct positive effect on outsourcing due to complementarity between high-skilled labor and outsourcing, and a negative effect on outsourcing due to the relationship between $l^2$ and $n^1$. The latter relationship would, of course, vanish under full employment, where $n^1 = \overline{n}^1$.

### 4.2 Provision of the public input good

Finally, turning to the provision of the public input good, we have

$$F_G(\cdot)-1=-\frac{\lambda}{\gamma}\lambda\hat{u}_z^2 l^1\left.\frac{\partial\phi}{\partial G}\right|_{M=M^0}-[T^1+b+\Delta]\left.\frac{\partial n^1}{\partial G}\right|_{M=M^0}-\Lambda\frac{\partial M}{\partial G}. \qquad (28)$$

The following result can be derived from equation (28);

> **Proposition 4.** *Without a direct instrument to tax outsourcing, there is an incentive for the government to use the public input good to reduce the level of outsourcing. With the assumptions made above, this incentive effect – summarized by the third term on the right hand side of equation (28) - works to increase the provision of the public input good, ceteris paribus.*

Note that the first two terms on the right hand side of equation (28) are analogous to the formula for public provision that applies when the government can tax outsourcing directly, i.e. equation (17). The intuition behind Proposition 4 is straight forward: an increase in $G$ contributes to reduce $M$ (as it leads to increased domestic employment), which is desirable by the results derived earlier.

## 5. Summary and Discussion

We have analyzed redistributive nonlinear taxation and provision of a public input good in an economy with equilibrium unemployment, where firms outsource part of their production abroad. Our study is based on an extension of the two-type optimal income tax model here augmented with a minimum wage policy directed towards the low-ability type (which, if binding, gives rise to equilibrium unemployment among the low-skilled) as well as an option for domestic firms to outsource part of the productive resources. The policy instruments facing the government also include a nonlinear income tax, a public input good and a direct tax on the resources subject to outsourcing, where the latter instrument is either operative, Case (i); or not operative, Case (ii).

In Case (i), where a direct tax on outsourcing is operative for the government, the presence of outsourcing does directly affect the policy rules for marginal income taxation and provision of the public input good. Instead, the results show that the government may

both relax the self-selection constraint and increase employment among the low-skilled by implementing a positive marginal income tax rate for the low-ability type and a negative marginal income tax rate for the high-ability type. By a similar argument, the optimal tax on outsourcing is positive, since a lower level of outsourcing implies less wage inequality (which contributes to relax the self-selection constraint) and increased employment among the low-skilled. In other words, the appearance of equilibrium employment strengthens the argument for taxing low-ability labor and subsidizing high-ability labor at the margin as well as strengthens the motive for taxing outsourcing. For the public input good, the incentive to relax the self-selection constraint by influencing the wage distribution and the incentive to increase the number of employed low-ability individuals affect the optimal policy in opposite directions: the government will overprovide (underprovide) the public input good relative to the first best policy rule if the employment effect dominates (is dominated by) the wage distribution effect.

In Case (ii), where the direct tax on outsourcing is not operative (i.e. equal to zero), income taxation and public provision become indirect instruments for influencing the amount of resources spent on outsourcing. According to our results, the appearance of outsourcing may change the marginal income tax rate implemented for the high-ability type in either direction, depending on whether an increase in the labor supply by the high-ability type leads to more or less outsourcing. The qualitative contribution of the latter mechanism is ambiguous in general, because high-ability labor is complementary both with low-ability labor and outsourcing. On the other hand, the desire to reduce outsourcing provides an unambiguous incentive to increase the provision of the public input good.

Future research might take several new directions. We shall point out two of them. First, as we use a static model, we have completely neglected the role of capital income taxation as a means to affect the resources spent on outsourcing. If domestic labor and domestic capital are complements in production – and as long as the government lacks a direct instrument for controlling outsourcing – capital income taxation might be a useful tool to increase the productivity of domestic labor and, therefore, influence the employment, wage inequality and outsourcing simultaneously. Second, the resources that domestic firms spend on outsourcing will give rise to welfare effects in other countries. This suggests that uncoordinated policies might be inefficient from the perspective of

society as a whole, and that outsourcing provides an argument for policy coordination. We leave these and other extensions for future research.

# Appendices

### *Appendix 1*

The first order conditions governing the optimal tax structure in Section 3 are

$$-\frac{\partial W}{\partial(n^1u^1)}u_z^1n^1+\lambda\hat{u}_z^2\left[\phi+l^1\frac{\partial\phi}{\partial l^1}\right]+\gamma[w^1n^1+(T^1+b+\Delta)\frac{\partial n^1}{\partial l^1}]=0 \tag{A1}$$

$$\frac{\partial W}{\partial(n^1u^1)}u_c^1n^1-\lambda\hat{u}_c^2-\gamma n^1=0 \tag{A2}$$

$$-\left[\frac{\partial W}{\partial(\overline{n}^2u^2)}\overline{n}^2+\lambda\right]u_z^2+\lambda\hat{u}_z^2l^1\frac{\partial\phi}{\partial l^2}+\gamma[w^2\overline{n}^2+(T^1+b+\Delta)\frac{\partial n^1}{\partial l^2}]=0 \tag{A3}$$

$$\left[\frac{\partial W}{\partial(\overline{n}^2u^2)}\overline{n}^2+\lambda\right]u_c^2-\gamma\overline{n}^2=0 \tag{A4}$$

$$\lambda\hat{u}_z^2l^1\frac{\partial\phi}{\partial M}+\gamma[F_M(\cdot)-\psi_M(M)+(T^1+b+\Delta)\frac{\partial n^1}{\partial M}]=0\,. \tag{A5}$$

### *Appendix 2*

The first order conditions governing the optimal tax structure in Section 4 can be written as

$$-\frac{\partial W}{\partial(n^1u^1)}u_z^1n^1+\lambda\hat{u}_z^2\left[\phi+l^1\frac{\partial\phi}{\partial l^1}\bigg|_{M=M^0}\right]+\gamma[w^1n^1+(T^1+b+\Delta)\frac{\partial n^1}{\partial l^1}\bigg|_{M=M^0}]=0 \tag{A6}$$

$$\frac{\partial W}{\partial(n^1u^1)}u_c^1n^1-\lambda\hat{u}_c^2-\gamma n^1=0 \tag{A7}$$

$$-\left[\frac{\partial W}{\partial(\overline{n}^2u^2)}\overline{n}^2+\lambda\right]u_z^2+\lambda\hat{u}_z^2l^1\frac{\partial\phi}{\partial l^2}\bigg|_{M=M^0}+\gamma[w^2\overline{n}^2+(T^1+b+\Delta)\frac{\partial n^1}{\partial l^2}\bigg|_{M=M^0}+\Lambda\frac{\partial M}{\partial l^2}]=0 \tag{A8}$$

$$\left[\frac{\partial W}{\partial(\overline{n}^2u^2)}\overline{n}^2+\lambda\right]u_c^2-\gamma\overline{n}^2=0\,. \tag{A9}$$

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