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# Coordinated Public Input Provision as a Tool for Redistribution under International Outsourcing

Thomas Aronsson  
Umeå University, Sweden

and

Erkki Koskela  
University of Helsinki and HECER

Discussion Paper No. 281  
November 2009

ISSN 1795-0562

# Coordinated Public Input Provision as a Tool for Redistribution under International Outsourcing\*

## Abstract

This paper concerns public input provision as a means of redistribution under outsourcing by using a model-economy comprising two countries, North and South, where firms in the North may outsource part of their low-skilled labor intensive production to the South. We consider two interrelated issues: (i) the incentives for each country to modify the provision of public input goods in response to international outsourcing, and (ii) whether international outsourcing justifies policy cooperation with respect to public input provision. If the public input good is substitutable for (complementary with) outsourced labor, then outsourcing contributes to increase (decrease) the provision by the northern government. For the southern government, the optimal policy response depends on the size of outsourced labor. We also analyze how policy cooperation with respect to provision of public input goods can be designed to increase the overall social welfare.

**JEL classification:** H21, H25, J31, J62.

**Keywords:** Outsourcing, public input goods, policy coordination.

Thomas Aronsson

Department of Economics  
Umeå University  
SE – 901 87 Umeå  
SWEDEN

e-mail: [thomas.aronsson@econ.umu.se](mailto:thomas.aronsson@econ.umu.se)

Erkki Koskela

Department of Economics  
University of Helsinki  
P.O. Box 17 (Arkadiankatu 7)  
FI-00014 University of Helsinki  
FINLAND

e-mail: [erkki.koskela@helsinki.fi](mailto:erkki.koskela@helsinki.fi)

\* The authors would like to thank Tomas Sjögren for helpful comments and suggestions. Aronsson would also like to thank The Bank of Sweden Tercentenary Foundation, The Swedish Council for Working Life and Social Research and The National Tax Board for research grants. Koskela thanks The Academy of Finland (grant No. 1217622) for financial support and Department of Economics, Umeå University, for good hospitality.

## 1. Introduction

Along with the process of international integration, firms in industrialized economies have found it increasingly attractive to outsource the production of labor intensive components. One important motivation for this behavior is to exploit cost advantages by locating this production in countries with lower wages. There is now a substantial body of empirical evidence showing that international outsourcing leads to more wage-inequality by increasing the skill-premium in countries that outsource production abroad.<sup>1</sup> This suggests that the appearance of international outsourcing provides new challenges for redistributive public policy in such economies, as it may create additional demand for redistribution. The need for understanding the implications of international outsourcing for redistribution policies is further emphasized by the fact that outsourcing also influences the income prospects of the residents, as well as the scope for redistribution policy, in the (low-wage) “host countries” that gain employment opportunities for their own domestic labor force.<sup>2</sup> The present paper examines the role of public input goods as a means for redistribution in the presence of outsourcing. Our analysis is based on a model-economy comprising two countries, North and South, where the firms in the North may outsource part of their low-skilled labor intensive production to the South. This model will be used to address two interrelated research questions: (i) whether, and how, each such country modifies its provision of public input goods in response to outsourcing in the absence of any policy cooperation, i.e. if the resource allocation is interpretable as the outcome of a noncooperative Nash game between the two national governments, and (ii) whether the appearance of international outsourcing justifies policy cooperation with respect to public input provision.

Why is it interesting to analyze public input goods in this particular context? First, as public input provision can be designed to enhance the productivity of domestic labor, it

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<sup>1</sup> See, e.g., Feenstra and Hanson (1999, 2003), Hijzen et al. (2005), Hsieh and Woo (2005), Hijzen (2007), Egger and Egger, (2006), Munch and Skaksen (2009), Riley and Young (2007) and Geishecker and Görg (2008).

<sup>2</sup> Goldberg and Pavcnik (2007) survey the empirical literature on the effects of globalization on inequality in developing countries. Their discussion suggests that globalization has meant increased inequality. However, the concept of “increased globalization” reflects a number of phenomena such as, e.g., trade liberalization, increased capital mobility and increased international outsourcing, meaning that the effects of globalization on inequality do not only reflect effects of outsourcing. At present, there is not much evidence regarding the effects of outsourcing.

may be used as an indirect instrument to influence the level of outsourcing.<sup>3</sup> As the level of outsourcing directly affects the wage distribution both in the North and the South, this argument suggests that public input provision constitutes a means for each national government to avoid undesirable distribution effects, or strengthen desirable distribution effects, of international outsourcing. Second, public input goods constitute natural supplements to redistributive income taxation, which is the type of instrument that the (very scarce) existing literature dealing with optimal policy responses to outsourcing has typically addressed.<sup>4</sup> It is, therefore, interesting to examine the remaining role for public input provision when the income tax is optimally chosen. This is precisely what we will do below.

Our study is related to a paper by Aronsson and Koskela (2009c), which deals with optimal nonlinear labor and capital income taxation in a two-country overlapping generations economy where the firms in one of the countries (the North) may outsource part of the low-skilled labor intensive production to the other (the South). Their results show that the government in the North responds to international outsourcing by implementing a more progressive labor income tax (higher marginal taxation of high-income earners relative to low-income earners) and higher marginal capital income taxation of all individuals than it would otherwise have done. The intuition is that this policy response leads to less outsourcing which, in turn, contributes to a more equal wage distribution. The South, on the other hand, has an incentive to stimulate outsourcing, as increased outsourcing leads to more wage-equality in the southern economy. The optimal policy response to outsourcing by the southern government is, nevertheless, ambiguous in general. If the level of outsourcing is sufficiently small, also the southern government responds to outsourcing by implementing a more progressive labor income tax and increased marginal capital income taxation, although for a different reason: this policy response reduces the wage paid to low-skilled labor in the South which, in turn, increases the level of outsourcing. Furthermore, as the government in each country neglects that its tax policy affects the wage-distribution in the other country (via the level of outsourcing),

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<sup>3</sup> There is a large literature dealing with different aspects of public input provision in model-economies without outsourcing. See, e.g., Hillman (1978), McMillan (1979), Feehan (1989), Feehan and Matsumoto (2000), Matsumoto (1998, 2001, 2004) and Aronsson and Wekhe (2008).

<sup>4</sup> See, e.g., Aronsson and Koskela (2009a) and Keuschnigg and Ribi (2009). These studies focus on policy responses by governments in high-wage economies, i.e. countries that outsource part of their labor intensive production, while disregarding the policy implications for the (low-wage) host countries that receive foreign production structure.

it follows that the tax policy governed by a noncooperative equilibrium is suboptimal from the perspective of society as a whole. Therefore, tax policy cooperation (if properly designed) leads to higher social welfare.

The present study uses a framework similar to that of Aronsson and Koskela (2009c), although it focuses on public input provision instead of tax policy. To our knowledge, there are only a few earlier studies on public input provision under international outsourcing. Egger and Falkinger (2006) consider a two-country economy where final goods producers outsource intermediate goods production, and focuses on the location choices of intermediate goods producers. Here, public infrastructure investments constitute means of increasing a country's attractiveness for intermediate goods producers. The results show that increased public infrastructure investments have a positive effect on the number of domestic intermediate goods producers, meaning that international outsourcing declines. Furthermore, by attracting firms, each national government imposes a negative externality on the other (which loses firms), suggesting that an uncoordinated equilibrium leads to overprovision of public infrastructure relative to the first best resource allocation.<sup>5</sup> Aronsson and Koskela (2009b) consider an economy with a single jurisdiction, where the firms outsource production to other countries (i.e. a partial model for the "North"), and where part of the low-skilled labor force is subject to involuntary unemployment. In their framework, the policy problem facing the government is represented by an optimal income tax model extended by a factor-augmenting public input good. Their results show, among other things, that the government responds to international outsourcing by increased provision of the public input good.

Our study is based on a static two-country model, where one of the countries may outsource low-skilled labor intensive production to the other. In each such country, the policy-problem faced by the government is based on an extension of the two-type optimal income tax model originally developed by Stern (1982) and Stiglitz (1982), where individual ability is private information. The policy instruments are a nonlinear labor income tax and a public input good that directly affects the productivity of the two types of

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<sup>5</sup> See also the related study by Martin and Rogers (1995), who analyze the effects of public infrastructure on industrial location. They show, among other things, that differences in domestic infrastructure can explain the direction of industrial relocation. However, they do not address the optimal choice of public infrastructure.

labor.<sup>6</sup> Our focus will be on the incentives underlying public input provision, and we start by characterizing the provision made by each national government in a noncooperative Nash equilibrium, in which each national government treats the policy-variables of the other country as exogenous. As the level of outsourcing directly affects the wage-distribution in both countries in our model, while each national government may influence the level of outsourcing via public input provision, it follows that the noncooperative Nash equilibrium is suboptimal from the perspective of society as a whole. As a consequence, we also examine how policy cooperation with respect to the provision of public input goods can be used to increase the social welfare.

To our knowledge, there are no earlier studies dealing with the redistributive role of public input goods in a multi-country framework, in which there is a distinction between countries that outsource production abroad and countries that receive employment opportunities for their own labor force via outsourcing. Therefore, the main contribution of the present paper is to fill this gap. As such, our study also provides a natural complement to the paper by Aronsson and Koskela (2009c), which is based on a similar (although dynamic) framework to analyze the optimal tax responses to international outsourcing. The outline of the paper is as follows. Section 2 describes the model and characterizes the outcome of private optimization. In Section 3, we describe the decision-problem facing each national government and analyze public input provision in a noncooperative Nash equilibrium. The welfare effects of policy cooperation are addressed in Section 4. The results are summarized and discussed in Section 5.

## 2. The Model

Consider an economy comprising two countries, which will be referred to as North ( $n$ ) and South ( $s$ ). We assume that North outsources part of its production to South, which will be explained more thoroughly below. Now, we describe the consumers and firms as well as the outcome of private optimization.

### 2.1 Consumers

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<sup>6</sup> As our study is based on a static model, it does not contain capital formation and capital income taxation. To simplify the analysis, we also abstract from tax competition for mobile capital. For a survey on theories of tax competition, see Wilson (1999).

In each country, there are two types of immobile<sup>7</sup> 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. As the number of individuals of each ability-type is not important for our understanding of the optimal policy responses to outsourcing, it will be normalized to one in what follows.

The utility function facing ability-type  $i$  in country  $j$  is given by

$$u_j^i = u(c_j^i, z_j^i) \quad (1)$$

where  $c$  denotes consumption and  $z$  leisure. Leisure is, in turn, defined as a time endowment,  $H$ , less the time spent in market work,  $l$ . Let  $w$  denote the before-tax hourly wage rate. The individual budget constraint can then be written as

$$w_j^i l_j^i - T_j(w_j^i l_j^i) = c_j^i \quad (2)$$

in which  $T_j(w_j^i l_j^i)$  represent the income tax payment. Note that the tax function may vary between the countries. The consumer price is normalized to one.

The first order condition for work hours becomes

$$u_{j,c}^i w_j^i (1 - T_j'(w_j^i l_j^i)) - u_{j,z}^i = 0 \quad (3)$$

where we have used  $u_{j,c}^i = \partial u_j^i / \partial c_j^i$  and  $u_{j,z}^i = \partial u_j^i / \partial z_j^i$ , while  $T_j'(w_j^i l_j^i)$  is the marginal income tax rate.

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<sup>7</sup>

As long as real world labor mobility is costly for the individuals, this assumption is not particularly restrictive for the analysis to be carried out below. In fact, even if we were to add imperfect labor mobility to the model, the policy incentives associated with outsourcing derived below would still be present. With perfect labor mobility, on the other hand, things change dramatically: in that case, the factor prices would become equalized among countries, meaning that the incentives for outsourcing would vanish.

## 2.2 Production

Turning to the production side we assume that each country is characterized by identical competitive firms producing a homogenous good under constant returns to scale using labor of both ability-types. There is also a factor augmenting public input good, which works to increase the labor productivity of both ability-types. One of the countries, referred to as North ( $j=n$ ), locates part of its production in the other country, referred to as South ( $j=s$ ). We assume that the firms in the North partly use unskilled labor from the South in their production and have to pay the Southern low-skilled wage rate for their services.

### *Production in the North*

The production function of the representative firm is written as

$$F_n = F_n(a_n^1(g_n)l_n^1 + \delta l_{ns}^1, a_n^2(g_n)l_n^2) \quad (4)$$

where  $g$  denotes the public input good, and  $l_{ns,t}^1$  the low-skilled labor (measured in work hours) by residents in the South that are used by northern firms. The function  $a_j^i(g_j)$  is increasing in  $g_j$ .<sup>8</sup> The parameter  $\delta$  captures the idea that foreign labor may not be a perfect substitute for domestic labor; if foreign labor is a less than perfect substitute for domestic labor, we have  $\delta \in (0,1)$ .

We assume that the production function is increasing and strictly concave in each of its two “basic arguments”, i.e.

$$\begin{aligned} \frac{\partial F_n(\cdot)}{\partial (a_n^1(g_n)l_n^1 + \delta l_{ns}^1)} = F_{n,1} > 0, \quad \frac{\partial F_n(\cdot)}{\partial (a_n^2(g_n)l_n^2)} = F_{n,2} > 0 \quad \text{and} \\ \frac{\partial^2 F_n(\cdot)}{(\partial a_n^1(g_n)l_n^1 + \delta l_{ns}^1)^2} = F_{n,11} < 0, \quad \frac{\partial^2 F_n(\cdot)}{(\partial a_n^2(g_n)l_n^2)^2} = F_{n,22} < 0, \end{aligned}$$

and that the second order cross-derivative is positive, i.e.  $F_{n,12} > 0$ , meaning that the two basic arguments are technical complements. It is also characterized by constant return to

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<sup>8</sup> See, e.g., Matsumoto (2001) for a similar approach to public input provision.

scale in the same two basic arguments. These properties imply that outsourced labor,  $l_{ns}^1$ , is substitutable for domestic low-skilled labor,  $l_n^1$ , and complementary with domestic high-skilled labor,  $l_n^2$ .<sup>9</sup> As a consequence, increased outsourcing leads to increased domestic wage-inequality, which is in line with empirical evidence (see footnote 1).

There is also a capacity aspect of outsourcing, as the firm needs to build costly capacity abroad. We assume that while some activities are easy to outsource, other activities are more costly. Therefore, the marginal cost of outsourcing increases in the scope of activities to outsource, so that there is a capacity cost of outsourcing,  $\psi(l_{ns}^1)$ , which is increasing and convex, i.e.  $\psi'(l_{ns}^1) > 0, \psi''(l_{ns}^1) \geq 0$ . This formulation captures the idea that outsourcing may necessitate costly investments into the establishment of network of suppliers in relevant host-countries.

The objective function facing the firm at any time,  $t$ , can be written as

$$\pi_n = F_n(a_n^1(g_n)l_n^1 + \delta l_{ns}^1, a_n^2(g_n)l_n^2) - w_n^1 l_n^1 - w_n^2 l_n^2 - \psi(l_{ns}^1) - w_s^1 l_{ns}^1.$$

As before,  $w_n^1$  and  $w_n^2$  denote the before-tax wage rates paid to low-skilled and high-skilled labor, respectively, in the North. The variable  $w_s^1$  denotes the before-tax wage rate paid to low-skilled labor the South, i.e. the wage rate that northern firms must pay to outsourced labor. The first order conditions are given by

$$a_n^1(g_n)F_{n,1}(a_n^1(g_n)l_n^1 + \delta l_{ns}^1, a_n^2(g_n)l_n^2) - w_n^1 = 0 \quad (6)$$

$$a_n^2(g_n)F_{n,2}(a_n^1(g_n)l_n^1 + \delta l_{ns}^1, a_n^2(g_n)l_n^2) - w_n^2 = 0 \quad (7)$$

$$\delta F_{n,1}(a_n^1(g_n)l_n^1 + \delta l_{ns}^1, a_n^2(g_n)l_n^2) - \psi'(l_{ns}^1) - w_s^1 = 0. \quad (8)$$

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<sup>9</sup> Ethier (2005) uses a production function with similar properties (yet based on a specific functional form assumption) to study the effects of globalization on the skill-premium. See also Koskela and Stenbacka (in press), who examine the effects of outsourcing for trade-union wage formation by using a production function where outsourcing is substitutable for low-skilled labor and complementary with high-skilled labor.

Note that equation (8) implicitly defines the amount of outsourced labor as a function of the labor supplied by the domestic low-ability and high-ability type, respectively, the public input good and the before-tax wage rate paid to low-ability labor in the South, i.e.

$$l_{ns}^1 = l_{ns}^1(l_n^1, l_n^2, g_n, w_s^1). \quad (9)$$

In equation (9), the sign-indicator above each argument shows the qualitative comparative statics effect. The ambiguity with respect to the public input good arises because public input provision directly increases the productivity of both types of domestic labor which, in turn, correlate with outsourcing in opposite directions. To be more specific, one can show that the partial effect on outsourced labor in equation (9) following an increase in the public input good is negative, if the following condition is satisfied;  $a_n^1(g_n)|F_{n,11}| > a_n^2(g_n)|F_{n,12}|$ , where  $a_n^i(g_n) = \partial a_n^i(g_n) / \partial g_n$ . This condition is interpretable to mean that an increase in  $g_n$  reduces the marginal product of outsourcing. The greater  $a_n^1(g_n)$  relative to  $a_n^2(g_n)$ , or the weaker the degree of complementary between the two types of domestic labor (i.e. the smaller  $F_{n,12}$ ), the more likely it is that this condition is fulfilled. In this case, we refer to the public input good as being substitutable for outsourcing. Conversely, the partial effect of increased public input provision in equation (9) is positive, if the inequality goes in the opposite direction, in which case an increase in the public input good contributes to increase the marginal product of outsourcing. The underlying mechanism is either that an increase in the public in the public input good has a relatively large effect on the measure of “effective high-ability labor”,  $a_n^2(g_n)l_n^2$ , or that the degree of complementary (measured by  $F_{n,12}$ ) is relatively large. In this case, therefore, we refer to the public input good as being complementary with outsourcing.

### *Production in the South*

Let  $l_s^1 = l_{ds}^1 + l_{ns}^1$  be the total labor supply in the South, where  $l_{ds}^1$  is the low-skilled labor supplied to domestic production in the southern economy. The production in the South is also characterized by constant returns to scale in its basic arguments, and the function is written as

$$F_s = F_s(a_s^1(g_s)(l_s^1 - l_{ns}^1), a_s^2(g_s)l_s^2). \quad (10)$$

Equation (10) is assumed to have the same general properties as the production function in the North, i.e. each production factor is characterized by a positive and diminishing marginal product, and the two production factors are technical complements ( $F_{s,12} > 0$ ).<sup>10</sup>

The objective function of the representative firm is given by

$$\pi_s = F_s(a_s^1(g_s)(l_s^1 - l_{ns}^1), a_s^2(g_s)l_s^2) - w_s^1(l_s^1 - l_{sn}^1) - w_s^2l_s^2.$$

The first order conditions become

$$a_s^1(g_s)F_{s,1}(a_s^1(g_s)(l_s^1 - l_{ns}^1), a_s^2(g_s)l_s^2) - w_s^1 = 0 \quad (11)$$

$$a_s^2(g_s)F_{s,2}(a_s^1(g_s)(l_s^1 - l_{ns}^1), a_s^2(g_s)l_s^2) - w_s^2 = 0. \quad (12)$$

Equations (9) and (11) implicitly define the low-skilled wage rate in the South as a function of work hours and provision of public input goods in both countries, i.e.

$$w_s^1 = w_s^1(l_s^1, l_s^2, g_s, l_n^1, l_n^2, g_n). \quad (13)$$

The intuition behind equation (13) is straight forward. For the variables accruing to the South, the influence of  $l_s^1$  reflects a labor supply effect on the wage rate (due to concavity of the production function), whereas the qualitative effect of  $l_s^2$  is due to complementary between unskilled and skilled labor. The effects of labor hours by northern residents,  $l_n^1$  and  $l_n^2$ , follow from the properties of the production function in the North in combination with equation (9) above.

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<sup>10</sup> Note that our model is based on the assumption that the skilled-labor concept does not differ between the North and South. Goldberg and Pavcnik (2007) argue that developed and developing countries may differ in the sense that low-skilled labor intensive jobs outsourced from developed countries appear to be skilled-labor intensive relative to the domestic production from the perspective of developing countries. Although we abstract from possible differences in the skilled-labor concept here, this idea is clearly worthwhile to address in future research.

The ambiguity with respect to the effect of the public input good of the North is analogous to the ambiguous effect that this variable has in terms of outsourcing in equation (9). If the public input good of the North is substitutable for outsourcing in the sense described in the interpretation of equation (9) above, then equation (13) implies  $\partial w_s^1 / \partial g_n < 0$ . The intuition is, of course, that reduced outsourcing means increased domestic labor supply by the low-ability type in the South and, therefore, a lower wage rate. By analogy, if the public input good of the North is complementary with outsourcing, then  $\partial w_s^1 / \partial g_n > 0$ .

Turning to the effect of the public input good of the South,  $g_s$ , in equation (13), the ambiguous effect is due to an indirect relationship between  $g_s$  and the marginal product of southern low-ability labor, which may counteract the direct positive effect of  $g_s$  on this marginal product. This is seen by differentiating equation (11) with respect to  $w_s^1$  and  $g_s$ , which gives

$$\frac{\partial w_s^1}{\partial g_s} = \frac{a_s^1(g_s)F_{s,1} + a_s^1(g_s) \left[ a_s^1(g_s)F_{s,11} + a_s^{2'}(g_s)F_{s,12} \right]}{\Omega} \quad (14)$$

where  $\Omega = 1 + [a_s^1(g_s)]^2 F_{s,11} [\partial l_{ns}^1 / \partial w_s^1] > 0$ .

In equation (14), the expression within square brackets can be either positive or negative, as an increase in the public input good increases the effective labor input of both ability-types which, in turn, have indirect effects on the marginal product of low-ability labor. As our study attempts to capture the effects of a productivity-enhancing public input, we assume that this indirect effect is never strong enough to dominate the direct productivity increase of the public good summarized by the first term on the right hand side of equation (14). To be more specific, we add the following assumption;

$$\mathbf{A1:} \quad a_s^1(g_s)F_{s,1} > \left| a_s^1(g_s) \left[ a_s^1(g_s)F_{s,11} + a_s^{2'}(g_s)F_{s,12} \right] \right| \Leftrightarrow \frac{\partial w_s^1}{\partial g_s} > 0$$

### 3. Public Provision in a Noncooperative Equilibrium

In this section, we begin by a presentation of the decision-problem facing each national government. We will then turn to the public input provision in a noncooperative Nash equilibrium, where each national government treats the decision-variables facing the other national government as exogenous.

Each national government is assumed to face the following general social welfare function;<sup>11</sup>

$$W_j = W_j(u_j^1, u_j^2) \quad (15)$$

for  $j=n, s$ , which allows for a unique welfare weight attached to the utility function of each ability-type.

The informational assumptions are conventional: the government observes the income of each individual, 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, therefore, like to prevent the high-ability type from mimicking the low-ability type in order to gain from redistribution. The self-selection constraint that may bind then becomes

$$u_j^2 = u(c_j^2, z_j^2) \geq u(c_j^1, H - \phi_j l_j^1) = \hat{u}_j^2 \quad (16)$$

where  $\hat{u}_j^2$  denotes the utility of the mimicker and  $\phi_j = w_j^1 / w_j^2 < 1$  is the wage ratio, i.e. the relative wage rate. Note that the mimicker faces the same income and consumption point as the low-ability type and, therefore, pays as much tax as the low-ability type. However, as the mimicker is more productive than the low-ability type, he/she spends more time on

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<sup>11</sup> Another approach would be to assume that the government aims at maximizing the utility of one particular ability-type subject to a minimum utility restriction for the other. If we were to use this alternative approach, all qualitative results derived below would remain unchanged.

leisure. We can interpret  $\phi_j l_j^1$  as the labor that the mimicker needs to supply in order to reach the same income as the low-ability type. By using the first order conditions for the firm, the wage ratio can be written as

$$\phi_j = \phi_j(l_j^1, l_j^2, g_j, l_{ns}^1). \quad (17)$$

In particular, note that  $\partial\phi_n/\partial l_{ns}^1 < 0$  and  $\partial\phi_s/\partial l_{ns}^1 > 0$ , suggesting that increased outsourcing leads to more wage-inequality in the North and less wage-inequality in the South.

By using the consumers' budget constraints and the objective function of the firm, we can write the national public budget constraint for the North and South, respectively, as follows;<sup>12</sup>

$$F_n(a_n^1(g_n)l_n^1 + \delta l_{ns}^1, a_n^2(g_n)l_n^2) - c_n^1 - c_n^2 - g_n - \psi(l_{ns}^1) - w_s^1 l_{ns}^1 \quad (18a)$$

$$F_s(a_s^1(g_s)(l_s^1 - l_{ns}^1), a_s^2(g_s)l_s^2) - c_s^1 - c_s^2 - g_s + w_s^1 l_{ns}^1. \quad (18b)$$

Equation (18a) and (18b), respectively, implies that output is used for private and public consumption. The final term on the right hand side of each equation arises because outsourcing gives rise to an income effect, which differs between the countries. This is so because part of the income generated by the North accrues to residents in the South.

### 3.1 Public Input Provision in the North

Following the convention in earlier literature on the self-selection approach to optimal taxation, the decision-problem facing each national government is written as a direct decision-problem. Therefore, the government in the North behaves as if it chooses  $l_n^1$ ,  $c_n^1, l_n^2, c_n^2$  and  $g_n$  to maximize the Lagrangean

$$L_n = W_n + \lambda_n[u_n^2 - \hat{u}_n^2] + \gamma_n[F_n - c_n^1 - c_n^2 - g_n - \psi(l_{ns}^1) - w_s^1 l_{ns}^1]$$

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<sup>12</sup> Note that the government is the owner of the production factor that is perceived as fixed by the firm.

The government in the North recognizes that  $l_{ns}^1$ ,  $w_s^1$  and  $\phi_n$  are determined by equation (9), (14) and (17), respectively, and it treats corresponding decision-variables of the southern government (i.e.  $l_s^1$ ,  $c_s^1$ ,  $l_s^2$ ,  $c_s^2$  and  $g_s$ ) as exogenous. The first order conditions for  $l_j^1$ ,  $c_j^1$ ,  $l_j^2$  and  $c_j^2$  are presented in the Appendix.

We begin the analysis by deriving the welfare effect for the North of a small increase in the amount of outsourced labor,  $l_{ns}^1$ . By using the first order conditions for the firm, we can derive

$$\Lambda_n = \frac{\partial L_n / \partial l_{ns}^1}{\gamma_n} = \frac{\lambda_n \hat{u}_{n,z}^2 l_n^1}{\gamma_n} \frac{\partial \phi_n}{\partial l_{ns}^1} < 0. \quad (19)$$

Equation (19) means that increased outsourcing leads to more wage-inequality and, therefore, reduces welfare in the North. Now, recall from equations (9) and (14) that the government in the North may influence  $l_{ns}^1$  via  $l_n^1$  and  $l_n^2$ , which it controls via the income tax, and by adjusting the public input good,  $g_n$ . We can derive the following effect on outsourcing from an increase in the public input good;

$$\frac{dl_{ns}^1}{dg_n} = \frac{\partial l_{ns}^1}{\partial g_n} + \frac{\partial l_{ns}^1}{\partial w_s^1} \frac{\partial w_s^1}{\partial l_n^1}.$$

Therefore, an increase in the public input good influences the level of outsourcing via two channels: first, a direct effect (measured by equation (9) with  $w_s^1$  held constant) and, second, an indirect effect via  $w_s^1$ . To be able to relate the total effect of the public input good on the level of outsourcing to whether the public input good is complementary with, or substitutable for, outsourcing, we add the assumption that the direct effect of the public input good on the level of outsourcing always dominates the indirect effect via the southern wage rate. This assumption is based on the idea that the amount of southern labor used by northern firms is small relative to the aggregate number of work hours supplied by the low-skilled in the South, which means that the behavior of northern firms has a relatively modest effect on the wage rate facing the low-skilled in the South. This assumption is summarized as follows;

$$\mathbf{A2.} \quad \text{sign} \frac{dl_{ns}^1}{dg_n} = \text{sign} \frac{\partial l_{ns}^1}{\partial g_n}.$$

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

$$\gamma_n [a_n^{1'}(g_n)F_{n,1} + a_n^{2'}(g_n)F_{n,2} - 1] = -\lambda_n \hat{u}_{n,z}^2 l_n^1 \frac{\partial \phi_n}{\partial g_n} - \gamma_n \left[ \Lambda_n \frac{dl_{ns}^1}{dg_n} - \frac{\partial w_s^1}{\partial g_n} l_{ns}^1 \right]. \quad (20)$$

Equation (20) is written such as to emphasize the incentives to deviate from the first best policy rule given by  $a_n^{1'}(g_n)F_{n,1} + a_n^{2'}(g_n)F_{n,2} - \gamma = 0$ . The first term on the right hand side appears because a change in the public input good directly affects the wage ratio and, therefore, the incentive for the high-ability type to mimic the low-ability type.<sup>13</sup> The interpretation is that the national government has an incentive to overprovide the public input good relative to the first best policy rule, if an increase in the public input good leads to a more equal wage distribution, i.e. if  $\partial \phi_n / \partial g_n > 0$ . The analogous argument for underprovision follows if an increase in the public input good leads to more wage-inequality, so  $\partial \phi_n / \partial g_n < 0$ .

The second term on the right hand side is due to the appearance of outsourcing and represents, therefore, the effect that outsourcing has on the policy rule for the public input good. It will be referred to as the direct effect of outsourcing.<sup>14</sup> This effect comprises two parts. The first arises via the self-selection constraint, as an increase in the public input good affects the level of outsourcing and, therefore, the wage ratio. As such, it also influences the incentives for the high-ability type of becoming a mimicker. The second is a budget effect due to that outsourcing gives rise to a discrepancy between production and income: an increase in the public input good in the North directly affects the wage rate paid to low-ability labor in the South and, therefore, the payment for foreign labor services by northern firms. The optimal policy response to outsourcing by the northern government can then be summarized as in Proposition 1;

<sup>13</sup> A similar effect is derived by Matsumoto (2001).

<sup>14</sup> Outsourcing may also have indirect effects on the other terms in equation (20), i.e. the terms that would be part of the policy rule for public provision also in the absence of outsourcing.

**Proposition 1.** *Under assumption A2, and if the public input good is substitutable for (complementary with) outsourcing, then the direct effect of outsourcing from the North to the South contributes to increase (decrease) the optimal provision of the public input good in the North.*

The intuition behind Proposition 1 is as follows. If the public input good is substitutable for outsourcing, then the government in the North may reduce the level of outsourcing by increasing the provision of the public input good. This policy response leads to less outsourcing, which contributes to a more equal domestic wage distribution and, therefore, a relaxation of the self-selection constraint.<sup>15</sup> It also contributes to reduce the southern wage rate for low-ability labor and, therefore, the payments for foreign labor services by domestic firms. If the public input good is complementary with outsourcing, on the other hand, the opposite policy response will follow: the government in the North may, in this case, reduce the level of outsourcing as well as the payments for foreign labor services by lowering the provision of the public input good.

### 3.2 Public Input Provision in the South

The policy problem in the South is written such that the government chooses  $l_s^1, c_s^1, l_s^2, c_s^2$  and  $g_s$  to maximize the Lagrangean

$$L_s = W_s + \lambda_s [u_s^2 - \hat{u}_s^2] + \gamma_s [F_s - c_s^1 - c_s^2 - g_s + w_s^1 l_{ns}^1]$$

subject to equations (10), (14) and (17). The government in the South treats the decision-variables of the northern government as exogenous. The first order conditions for  $l_s^1, c_s^1, l_s^2$  and  $c_s^2$  are presented in the Appendix.

As we did for the North, we begin the analysis by deriving the welfare effect for the South of a small increase in the amount of outsourced labor,  $l_{ns}^1$ . We have

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<sup>15</sup> Aronsson and Koskela (2009b) derive a similar incentive for public input provision in an economy with equilibrium unemployment.

$$\Lambda_s = \frac{\partial L_s / \partial l_{ns}^1}{\gamma_s} = \frac{\lambda_s}{\gamma_s} \hat{u}_{s,z}^2 l_s^1 \frac{\partial \phi_s}{\partial l_{ns}^1} > 0. \quad (21)$$

Therefore, as increased outsourcing from the North to the South leads to less wage-inequality in the South, it also contributes to increase southern welfare. The first order condition for public input provision can now be written as

$$\gamma_s [a_s^1(g_s) F_{s,1} + a_s^2(g_s) F_{s,2} - 1] = -\lambda_s \hat{u}_{s,z}^2 l_s^1 \frac{\partial \phi_s}{\partial g_s} - \gamma_s [\Lambda_s \frac{\partial l_{ns}^1}{\partial w_s^1} + l_{ns}^1] \frac{\partial w_s^1}{\partial g_s}. \quad (22)$$

Also in this case, we have written the first order condition in a way that characterizes the incentives to deviate from the first best policy rule. The first term on the right hand side of equation (22) is analogous to, and has the same interpretation as, the corresponding effect for the North described above.

The second term on the right hand side represents the direct effect of outsourcing on the policy rule for the public input good. This effect differs from its counterpart for the North, as the southern government is only able to influence the level of outsourcing via the wage rate paid to low-ability labor. The reason is that the government in the South can only affect the level of outsourcing indirectly via the wage rate paid to low-ability labor. Furthermore, the term within the square bracket cannot be signed unambiguously, as a decrease in  $w_s^1$  contributes to more outsources (which leads to higher welfare for the South via a relaxation of the self-selection constraint) as well as to lower factor income from abroad (which leads to lower welfare in the South). We can summarize the following result;

**Proposition 2.** *Suppose that assumption A1 is fulfilled, so  $\partial w_s^1 / \partial g_s > 0$ .*

(i) *If  $\Lambda_s (\partial l_{ns}^1 / \partial w_s^1) + l_{ns}^1 < 0$ , then the direct effect of outsourcing from the North to the South contributes to decrease the optimal provision of the public input good in the South.*

(ii) *If  $\Lambda_s (\partial l_{ns}^1 / \partial w_s^1) + l_{ns}^1 > 0$ , then the direct effect of outsourcing from the North to the South contributes to increase the optimal provision of the public input good in the South.*

The first part of Proposition 2 captures the case where the size of outsourced labor is small enough to imply that the budget effect is always dominated by the redistribution effect that outsourcing gives rise to. In this case, there is an incentive for the government in the South to provide a smaller public input good than it would otherwise have done. The intuition is that a lower public input good leads to more outsourcing from the North to the South which, in turn, contributes to relax the self-selection constraint facing the southern government. The second part of Proposition 2 captures the case where the budget effect is large enough to dominate: the government in the South then responds to outsourcing by increasing the provision of the public input good, as this leads to a greater budgetary gain in terms of income from abroad.

#### 4. Policy Cooperation

Since the policy implemented by either country affects the well-being of the residents in the other country as well, the noncooperative equilibrium is not efficient from the perspective of society as a whole. Therefore, policy cooperation (if designed appropriately) will lead to higher welfare. We consider policy reforms designed to target the provision of the public input good, where the noncooperative Nash equilibrium is treated as the initial, prereform, equilibrium.

Suppose that policy cooperation is governed by a utilitarian objective

$$W = W_n + W_s \quad (28)$$

in which we give equal weight to the national welfare functions. By recalling that the noncooperative Nash equilibrium means that each national government has made an optimal policy choice conditional on the policies chosen by the other country, one can derive the following global welfare effects of changes in the provision of the public input good in each country;

$$\frac{\partial W}{\partial g_n} = \frac{\partial W_s}{\partial g_n} = \gamma_s \left[ \Lambda_s \frac{dl_{ns}^1}{dg_n} + \frac{\partial W_s^1}{\partial g_n} l_{ns}^1 \right] \quad (29a)$$

$$\frac{\partial W}{\partial g_s} = \frac{\partial W_n}{\partial g_s} = \gamma_n \left[ \Lambda_n \frac{\partial l_{ns}^1}{\partial w_s^1} - l_{ns}^1 \right] \frac{\partial w_s^1}{\partial g_s} \quad (29b)$$

In addition, note that (by the Envelope Theorem)

$$\frac{\partial W}{\partial c_j^i} = 0 \text{ for } i = 1, 2, \text{ and } j = n, s,$$

in the noncooperative Nash equilibrium, as private consumption does not give rise to international externalities. Therefore, any change in private consumption induced by a change in the public input good has no first order welfare effect in the initial equilibrium.

We have derived the following result;

**Proposition 3.** (i) *Under assumption A2, and if the public input good is substitutable for (complementary with) outsourcing, it follows that decreased (increased) public input provision in the North leads to higher welfare in the South.* (ii) *Under assumption A1, and if  $\Lambda_n (\partial l_{ns}^1 / \partial w_s^1) - l_{ns}^1 > 0$  ( $< 0$ ), it follows that increased (decreased) public input provision in the South leads to higher welfare in the North.*

Proposition 3 shows the conditions under which a small increase or decrease in the provision of the public input good by each national government leads to higher global welfare and, in this sense, whether each national government overprovides or underprovides the public input good from the perspective of society as a whole. The first part means that the North overprovides the public input good in a noncooperative equilibrium, if the public input good is substitutable for outsourcing, which is meant to imply that the marginal product of outsourced labor is declining in the public input good.<sup>16</sup>

The second part of Proposition 3 relates the public input provision by the southern government to the size of outsourced labor,  $l_{ns}^1$ . If the size of outsourced labor is small

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<sup>16</sup> Egger and Falkinger (2006) also derive an analogous “overprovision result”, although by focusing on the relationship between outsourcing leads to international firm mobility. However, if the public input good is complementary with outsourcing – meaning that the marginal product of outsourced labor increases with the level of the public input good – we obtain the opposite result; namely that the North underprovides the public input good in the noncooperative equilibrium. This situation may arise if the degree of complementarity between the two types of domestic labor in the northern economy is relatively strong.

enough to imply that the budget cost for the North of an increase in the southern low-skilled wage rate is small, so that the gain of reduced outsourcing for the North dominates the loss in terms of income payments to foreign residents, then the North would gain if the government in the South increases its public input provision. In this case, therefore, the South underprovides the public input good in the noncooperative equilibrium. The intuition is that increased public input provision in the South leads to an increase in the wage rate paid to low-ability labor in the South (according to assumption A1) and, therefore, to reduced outsourcing from the North to the South. This is welfare improving for the North as it contributes to reduced wage-inequality in the northern economy. If the size of outsourced labor is large enough, we have the opposite result; namely, that the South overprovides the public input good in a noncooperative equilibrium. The reason is that the budgetary cost to the northern government of an increase in  $w_s^l$  in this case may dominate the distributional gain of less outsourcing for the North. As a consequence, the northern government would benefit from a decline in  $w_s^l$ , which can be accomplished by decreased public input provision in the South.

## 5. Summary and Discussion

This paper concerns the role of public input provision as a means of redistribution in the presence of outsourcing by using a model-economy comprising two countries, North and South, where firms in the North may outsource part of their low-skilled labor intensive production to the South. Our model addresses two issues: the incentives for each national government to adjust its provision of public input goods in response to outsourcing in the absence of any policy cooperation, and whether international outsourcing justifies policy cooperation with respect to the provision of public input goods.

The results show that if the public good is substitutable for outsourcing in the sense that the marginal product of labor decreases with the provision of the public input good, then outsourcing of low-skilled labor intensive production from the North to the South increases the optimal provision of public input good in the North. The opposite policy incentive arises if the public input good is complementary with outsourcing; let be that this situation seems to be less realistic. For the South, the optimal policy response serves to

balance two counteracting effects; a direct effect of outsourcing on the domestic wage distribution and a budget effect as residents of the South receive income paid by northern firms. If the direct welfare effect of outsourcing via the wage distribution dominates the budget effect – in which case the level of outsourced labor is relatively small – the government in the South responds to outsourcing by decreasing its provision of the public input good. On the other hand, if the budget effect dominates (which it may do if the level of outsourced labor is large enough), we obtain the opposite result that the South responds to outsourcing by increased public provision.

Policy cooperation is assumed to be governed by a Utilitarian utility sum over the countries. We examine whether a small increase or decrease in the provision of the public input good by each national government leads to higher global welfare and, in this sense, whether each national government overprovides or underprovides the public input good from the perspective of society as a whole. The results show that the North overprovides the public input good in a noncooperative equilibrium, if the public input good is substitutable for outsourcing. This means that a small increase in the public input good leads to higher welfare in the South. The opposite result follows if the public input good is complementary with outsourced labor. By analogy to the results discussed above, whether the government in the South overprovides or underprovides the public input good from the perspective of society as a whole in the noncooperative equilibrium depends on the level of outsourcing. If the size of outsourced labor is small enough to imply that the budget cost for the North of an increase in the southern low-skilled wage rate is small, so that the gain of reduced outsourcing for the North dominates the loss in terms of income payments to foreign residents, then the North would gain if the government in the South increases its public input provision. In this case, therefore, the South underprovides the public input good in the noncooperative equilibrium.

Future research might take several new directions. For instance, we have completely neglected the role of non-competitive wage formation. If the North is thought of as a European economy, it would clearly be relevant to allow trade-unions to affect wage formation for low-skilled workers and, as a consequence, allow for equilibrium unemployment among the low-skilled in the North.<sup>17</sup> As trade-unions may attempt to push

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<sup>17</sup> Such an extension may also include product market imperfections. There is a growing literature dealing with relationships between non-competitive wage formation, product market imperfections,

up the wage rate above the competitive level, there will most likely be an even stronger incentive for firms in the North to outsource production capacity to the South. In addition, it is not necessarily the case that low-skilled labor intensive jobs outsourced from a developed economy are perceived as low-skilled labor intensive jobs also in a developing economy. To be more specific, differences in skill-distributions may imply that outsourcing contributes to more wage-inequality both in the North and South. The incentives facing the southern government will, in this case, differ from those described in the paper. We leave these and other extensions for future research.

## Appendix

### *The North*

The first order conditions for  $l_n^1$ ,  $c_n^1$ ,  $l_n^2$ ,  $c_n^2$ , and  $g_n$ , respectively, can be written as

$$-\frac{\partial W_n}{\partial u_{n,z}^1} u_n^1 + \lambda_n \hat{u}_{n,z}^2 \left[ \phi_n + l_n^1 \frac{\partial \phi_n}{\partial l_n^1} \right] + \gamma_n \left[ w_n^1 - \frac{\partial w_s^1}{\partial l_n^1} l_{ns}^1 + \Lambda_n \frac{dl_{ns}^1}{dl_n^1} \right] = 0 \quad (\text{A1})$$

$$\frac{\partial W_n}{\partial u_{n,c}^1} u_{n,c}^1 - \lambda_n \hat{u}_{n,c}^2 - \gamma_n = 0 \quad (\text{A2})$$

$$\left[ -\frac{\partial W_n}{\partial u_{n,z}^2} + \lambda_n \right] u_{n,z}^2 + \lambda_n \hat{u}_{n,z}^2 l_n^1 \frac{\partial \phi_n}{\partial l_n^1} + \gamma_n \left[ w_n^2 - \frac{\partial w_s^1}{\partial l_n^2} l_{ns}^1 + \Lambda_n \frac{dl_{ns}^1}{dl_n^2} \right] = 0 \quad (\text{A3})$$

$$\left[ \frac{\partial W_n}{\partial u_{n,c}^2} + \lambda_n \right] u_{n,c}^2 - \gamma_n = 0. \quad (\text{A4})$$

### *The South*

The first order conditions for  $l_s^1$ ,  $c_s^1$ ,  $l_s^2$ ,  $c_s^2$ , and  $g_s$ , respectively, can be written as

$$-\frac{\partial W_s}{\partial u_s^1} u_s^1 + \lambda_s \hat{u}_s^2 \left[ \phi_s + l_s^1 \frac{\partial \phi_s}{\partial l_s^1} \right] + \gamma_s \left[ w_s^1 + \frac{\partial w_s^1}{\partial l_s^1} l_{ns}^1 + \Delta_s \frac{\partial l_{ns}^1}{\partial l_s^1} \right] = 0 \quad (\text{A5})$$

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globalization and outsourcing, although so far with a focus on issues other than redistribution via optimal income taxation. See, e.g., Naylor (1998, 1999) and Lommerud et al. (2003).

$$\frac{\partial W_s}{\partial u_{s,c}^1} u_{s,c}^1 - \lambda_n \hat{u}_{s,c}^2 - \gamma_s = 0 \quad (\text{A6})$$

$$-\left[ \frac{\partial W_s}{\partial u_s^2} + \lambda_s \right] u_{s,z}^2 + \lambda_s \hat{u}_{s,z} l_s^1 \frac{\partial \phi_s}{\partial l_s^2} + \gamma_s \left[ w_s^2 + \frac{\partial w_s^1}{\partial l_s^2} l_{ns}^1 + \Delta_s \frac{\partial l_{ns}^1}{\partial w_s^1} \frac{\partial w_s^1}{\partial l_s^1} \right] = 0 \quad (\text{A7})$$

$$\left[ \frac{\partial W_s}{\partial u_{s,c}^2} + \lambda_s \right] u_{s,c}^2 - \gamma_s = 0. \quad (\text{A8})$$

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