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Rocha-Akis, Silvia

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Labour tax policies and strategic offshoring under unionised oligopoly*

Silvia Rocha-Akis[†]

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Abstract — *In a model with a unionised immobile labour force we analyse how labour taxes and transfers towards unemployed workers are optimally chosen when a welfare maximising government faces oligopolistic and partly mobile firms. We consider two polar types of government: one whose objective consists of maximising the sum of domestic producer's and consumers' surplus and one that aims at maximising employed and unemployed workers' payoffs. We show that depending on the combination of foreign labour costs, the degree of domestic union bargaining power, and the sunk costs of relocation, the former type of government may choose to set taxes so as to induce an outward relocation of production.*

Keywords: outward FDI; import competition; wage bargaining; oligopoly; labour taxation; redistribution; political economy

JEL-Classification: H30; J30; J50; L13

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[†] Vienna University of Economics and B.A., UZA 4, room B 318 A, Nordbergstrasse 15, 1090 Vienna, Austria, silvia.rocha@wu-wien.ac.at

1 Introduction

In recent years, many industrialised countries have experienced considerable outward relocation of production activities. Not surprisingly, due to its direct impact on employment, offshoring has become an increasingly important topic in public debate, particularly in countries that are characterized by high unemployment and low job creation.¹ The sectors predominantly affected by offshoring consist among others of car manufacturing and automotive components, machinery, metalworking, and electronic appliances. Recently also impersonal services that can be delivered electronically over longer distances such as financial, legal and information services have experienced a rise in offshoring. The chosen destinations suggest that a key determinant for the choice of production location is the cost of labour. Consequently, trade unions are frequently blamed for the trend in moving production to lower wage countries.² Yet, the competitiveness of a location is also part of the scope of responsibility of the government. Being in charge of redistributive policy, which is financed in part by distortionary labour taxation, the government also affects the profitability and competitiveness of firms through its impact on labour costs (Alesina and Perotti (1997)). As is well known from the tax incidence literature, the presence of unions implies that a part of the wage tax burden is shifted from employees to employers resulting in higher wage costs and higher unemployment (e.g. Lockwood (1990), Goerke (1999), Koskela (2001), and Nickell (2003)). This is particularly evident in some European countries. Accordingly, a frequent policy recommendation expressed by the OECD is to reduce labour taxes.³ However, in contemplating such a reduction, governments are obviously concerned about its implications on welfare and on the capacity of implementing social insurance and redistributive policies.⁴ This is the focus of our paper which builds upon two strands of literature, namely the literature on foreign direct investment (FDI) and the literature on non-competitive labour markets and taxation. The question we address is whether, in the presence of unemployment, governments should choose their labour tax and redistributive policies so as to discourage mobile firms from offshoring.

Most of the literature analysing the welfare implications of (inward or outward) FDI in the presence of unionised labour markets focuses on the conflict of interest between unions and firms without considering public policy (e.g. Zhao (1995,

¹We refer to offshoring as the shift of a *final* stage of production, such as the assembly of a final product. In the literature, the terms offshoring and outsourcing are frequently used interchangeably where the latter refers to contracting out some production stage to outside providers, that is, it applies only to intermediate products.

²Even though the number of union members in the OECD has declined in the last two decades, the share of employed whose remuneration and working conditions are directly or indirectly determined by collective bargaining is considerable. In the EU it ranged from 30% in the UK, 68% in Germany, 90% in Belgium, Finland, France and Sweden, to 95% in Austria in the year 2000 (OECD 2004).

³See OECD (2006, 1994). For a discussion on the tax systems in the European Union, the effects of tax reforms, and the tax burden on labour in particular, see Joumard (2001).

⁴In the EU25, labour tax revenues, which represent around half of total tax receipts, finance most of the social welfare programs in these countries (see European Commission (2006)).

1998), Naylor and Santoni (1998), Skaksen and Sørensen (2001), Lommerud et al. (2003) Skaksen (2004)). Exceptions are Bughin and Vannini (1995), Leahy and Montagna (2000), and Skaksen (2005) who quantify the potential welfare gain of inward FDI which serves as a measure for a subsidy. Another strand of literature analyses the incentives of governments to attract inward FDI by means of capital taxes. As noted by Desai et al. (2004), studies on the effect of tax policy on the location of FDI focus almost exclusively on corporate income taxes. To our knowledge, with the exceptions of Andersen (2003) and Aronsson and Sjögren (2004), the role of distortionary labour taxation on the cost side of mobile firms and its welfare implications have received little attention. In the spirit of the latter, we assume that firms shift their production offshore not because of capital tax considerations but, rather, because they want to have access to lower labour input costs which in turn are affected by the way the labour market is organised as well as by labour tax and unemployment insurance policies.

Our model extends Bughin and Vannini's (1995) FDI model by incorporating a government that collects taxes from wage income which it uses to redistribute to the unemployed originating from the presence of a labour union. The tax rate and the transfer are linked together through the government's budget constraint which implies that there is actually just one independent policy instrument. Additionally to a non-competitive labour market the government faces non-competitive firms which differ regarding their mobility. We focus on a domestic market in which a domestically-located branch plant of a foreign-owned Multinational Enterprise (MNE) competes for market shares with a domestic firm. The MNE is assumed to be more 'footloose' than the domestic firm; accordingly, it may relocate its plant across the jurisdiction's border whereas the domestic firm is assumed to be immobile. In our framework, labour taxation affects the product market competition since it influences the cost conditions under which firms compete. Consequently, an asymmetric situation may arise in which the MNE relocates its plant abroad and exports its output to the domestic market thereby competing with the domestic firm under different cost conditions. Being able to influence the mobile firm's location decision, the government must choose its optimal labour tax and transfer policy so as to generate the highest level of welfare. We thus focus on the interactive behavior of mobile and immobile firms, the union and the government. The questions addressed include the following: How does relocation affect domestic welfare? What role does union bargaining strength play? Which tax policy is preferable from the point-of-view of workers, the unemployed, the domestic firm, and the MNE?

There is a consensus that the recent economic transformations, often referred to as globalisation, which originate from the increased mobility of resources, affect workers in different ways than they affect firms. Indeed, international relocations of production are frequently believed to generate distributive effects expressed in productivity gains and higher profits but also in lower wages and job destruction in the source countries. Therefore, we allow the government to attribute different weights to the rents of producers and consumers, on the one hand, and to the rents going to employed and unemployed workers in the form

of net labour income and unemployment benefits, on the other hand. It turns out that the answers to the questions addressed, critically depend on the government's choice of weights. A government that is mainly concerned about the domestic producer and consumer rents chooses a low tax rate and/or transfer in order to expand output. We show that if the mobile firm's incentive to relocate is sufficiently strong - as measured by the sunk relocation costs, the domestic employers' union bargaining strength, and foreign labour costs - the government can induce a relocation without raising taxes too much. The stronger are the incentives for the mobile firm to move production abroad, the more likely it is that the domestic producer and consumers are better off if the mobile firm produces abroad rather than at home. The reason is that, confronted with import competition from the lower wage country, it is optimal for the government to counteract the distortion in the domestic labour market by setting lower taxes, thereby increasing the competitiveness of the domestic firm vis-à-vis the relocated competitor. Indeed, as we shall see, output may increase to such an extent that the domestic producer and the consumers are better off when the competing firm offshores. If, however, the government places sufficient weight on workers' incomes it is optimal for the government to set its policy instruments so as to discourage the mobile firm from relocating.

These results are in marked contrast to those of Bughin and Vannini (1995) who in a similar framework, albeit without a public sector, analyse the effect of inward FDI on welfare. In their model the domestic union is indifferent as to whether a relocation takes place or not as long as the foreign MNE is unionised if it produces in the host country. The reason is that the competitive wage, which in their model is the union threat point, adjusts to the different market outcome so as to leave domestic employment and the union rent unchanged. The domestic firm, on the other hand, is unambiguously better off when the competitor produces abroad because in that case the domestic wage remains lower. On the whole, welfare is always lower when the MNE produces in the domestic country rather than abroad.

As mentioned above, a recent contribution by Aronsson and Sjögren (2004) who, in a multi-country model, focus on optimal labour taxation and policy coordination when firms are mobile and labour is unionised is also related to our paper. In their framework firms are perfectly competitive and identical. Moreover, the fact that firms may relocate to another jurisdiction implies that the potential profit obtainable abroad, which is treated as exogenous, can be used as a threat during wage negotiations. Contrary to our model, in a subgame perfect equilibrium a relocation of production doesn't take place. As to the time sequence of events, we assume that the choice of location takes place *prior* to the wage negotiation process. As a result, in contrast to Aronsson and Sjögren (2004), the outside profit is not used by firms as a tool to moderate wage claims during wage bargaining. Rather, the government directly determines the disagreement point of wage negotiations through the choice of the tax and transfer policy. Thus it strategically affects the location decision of the mobile firm.

The link between increased firm mobility and wage tax revenues when workers are assumed to be immobile has also been investigated by Andersen (2003).

The focus is however different as he discusses the role of the institutional labour market structure in maintaining a universal social security system in the face of a heightened need for welfare arrangements. He shows that tighter international integration increases the distortionary consequences of labour taxation, thereby putting the public sector under pressure.

As Bughin and Vannini (1995), Leahy and Montagna (2000) and Lommerud et al. (2003), we take a partial equilibrium approach which presumes that the income of consumers is sufficiently high relative to their expenditures on the goods of the industry under consideration. Our model endogenises wages and unemployment benefits. Therefore, to be strict about the validity of our welfare results, the best way to interpret our model is by considering consumers, producers, employed and unemployed workers to be separate groups.⁵ Although we are aware of the limitations involved, we believe that the present work constitutes a useful first step in capturing the interplay between a government, a union, and mobile and immobile firms, in that it allows us to easily identify combinations of union bargaining strength, foreign labour costs, and relocation costs where an outward relocation could be profitable. Provided that the share of income devoted to the consumption of the good in the relevant market is not too large, the main qualitative results should continue to go through in a more general framework.

Our paper is organised as follows. Section 2 introduces the model. In section 3 we analyse how firms choose their output levels. Section 4 looks at the alternative interactions between the union and the firms and derives the equilibrium wages with and without offshoring. In section 5 we show how the relocation decision depends on the government policy. Finally, section 6 derives the optimal tax policy and carries out welfare comparisons among the different regimes. Section 7 concludes the paper.

2 The model

We focus on a duopoly producing a homogeneous good which is sold in a country referred to as the domestic or host country. Both firms face a unionised labour force. In the background there is a second country, referred to as the foreign country which is exogenous in our model. We depart from a situation where both firms are located in the domestic country. Firm 1 is assumed to be domestically owned and immobile, whereas firm 2 is a branch plant of a foreign-based MNE that has the option of moving production abroad where it can serve the domestic market by means of exports. There is a domestic government that aims to maximise welfare being aware that its tax and transfer policy affects the firms' investment and cross-border location decisions and hence the level of domestic production and employment. The tax revenues are entirely redistributed towards the unemployed.

We analyse two different scenarios. In the first scenario both firms produce in

⁵That is to say, the consumers of the good considered obtain their income from some other source whereas the workers in the industry are not consumers of the goods produced.

the domestic country. In the second scenario the MNE branch has relocated abroad and competes with the immobile domestic firm via exports to the domestic market. Whereas in the former case both firms are subject to wage negotiations with a domestic union, in the latter scenario firm 2 faces exogenously given foreign labour input costs.

Reflecting the time sequence of events, our problem takes the following form: First, the domestic government chooses its tax and transfer policy anticipating its impact on the wage bargaining process and thus on the location decision of the MNE. Subsequently, given the government policy variables, the MNE decides where to set up its plant. Depending on the production location of the mobile firm, the domestic union bargains over the wage rate with either both the domestic and the foreign firm, or with the domestic firm alone, taking into consideration the prevailing given foreign wage rate facing the competitor located abroad. Finally, each firm chooses its optimal output and employment levels given the equilibrium wage rates in both firms. The problem is solved recursively by backwards induction.

3 Output and employment

Both firms produce a homogeneous good in the domestic country facing a linear inverse product demand function of the form:

$$p(Q) = a - cQ \quad (1)$$

where p is the output price and $Q = \sum_{i=1}^2 q_i$ is the sum of individual quantities produced by firms 1 and 2. To simplify computations we assume $a = 2$ and $c = 1$.

Labour is the only factor of production. Each firm i has access to the same technology which is normalised so that 1 unit of output is produced with 1 unit of labour where labour is remunerated at a wage rate of ω_i . Consequently, the profit functions are

$$\pi_i = [p(Q) - \omega_i]q_i, \quad i = 1, 2 \quad (2)$$

Each firm i takes the wage outcome (ω_1, ω_2) resulting from wage bargaining as given and strategically chooses its output level, q_i , so as to maximise its profit. The resulting equilibrium output of firm i is a function of both firms' labour costs and given by

$$q_i(\omega_i, \omega_j) = \frac{2 - 2\omega_i + \omega_j}{3}, \quad i, j = 1, 2, \quad i \neq j \quad (3)$$

reflecting that in strategic quantity-setting behavior the optimal choice of output by firm i depends on the output produced in the competing firm j . The expression for profits can be written as follows

$$\pi_i(\omega_i, \omega_j) = [q_i(\omega_i, \omega_j)]^2, \quad i, j = 1, 2 \quad (4)$$

4 The labour market and union-firm bargaining

In this section we present the features of the domestic labour market and derive the equilibrium domestic wage rate. We begin by analysing the case where both firms produce in the domestic country (section 4.1) and then turn to the scenario where the MNE has moved its plant offshore (section 4.2).

The labour market is characterized by internationally immobile workers. There is a constant total domestic labour force which we normalise to 1. All employed workers are represented by one union. We assume “right-to-manage” wage formation meaning that the firms and the union bargain over the wage rate and, subsequently, each firm i chooses the output and employment level, q_i , unilaterally. Moreover, we abstract from workers’ choices of allocating time between work and leisure and assume that the individual labour supply is inelastic. Workers employed at firm i earn a net-of-tax income $\omega_i(1-\tau)$ where τ is the wage income tax rate. Unemployed workers are entitled to receive net-of-tax unemployment benefits amounting to b .

4.1 The equilibrium wage without relocation

In this case the objective of the union is to maximise the following union rent:

$$\Theta = \sum_{i=1}^2 (\omega_i - \gamma) (1 - \tau) q_i(\omega_i, \omega_j) \quad i = 1, 2, \quad i \neq j \quad (5)$$

for $\omega_i \geq \gamma$ where $\gamma = b/(1-\tau)$ can be interpreted as the gross unemployment benefit level. The level of b and τ , and thus γ , are treated as exogenous by the union as they are chosen by the government at a prior stage. Notice that the union has two opposing goals; on the one hand, it aims at bargaining a wage rate in excess of the gross benefit as high as possible; on the other hand, it strives to achieve a level of employment as high as possible. The objective of each firm, on the other side, is to maximise its profit. It is standard in the literature on union-firm bargaining to allow for exogenous relative bargaining strength during wage contract negotiations making use of the Nash bargaining product

$$\Omega(\omega_i, \omega_j) = \Theta^\alpha \left[\sum_{i=1}^2 \pi_i(\omega_i, \omega_j) \right]^{1-\alpha} \quad (6)$$

This formulation implies that the union and the firms have a relative bargaining power of α and $1-\alpha$, respectively, with $0 < \alpha < 1$.⁶ If there is no agreement as to the splitting of contract rents between the firms and the union, the negotiations break down and each party ends up receiving the fall-back payoff. In

⁶We assume that both firms are represented by a joint bargaining entity, e.g. an employer’s association implying that the firms’ bargaining power is identical. Wage bargaining is thus realized so as to maximise the industry profit, whereas output is decided so as to maximise the individual profit. In effect, firms compete in the output market but they bargain jointly for wages.

particular, an equilibrium wage rate at or below the level of the gross transfer payment that is guaranteed in case of becoming unemployed would bring the negotiations to a halt. In that case workers would become unemployed receiving b and firms would cease production.⁷

Among the total number of workers in the labour force, q_i are employed at firm i and $1 - \sum_{i=1}^2 q_i$ are unemployed. If the labour market were competitive, the prevailing wage rate had to equate total labour supply and demand, $Q(\omega_i, \omega_j)$, and would hence correspond to $\omega_c = 1/2$. Confronted with a situation in which $\gamma < \omega_c$, unemployed individuals would prefer to work under competitive conditions rather than being unemployed, making negotiations futile from the viewpoint of firms and workers. Therefore, we assume that $\gamma \geq 1/2$.

Notice that we are confronted with a symmetric case in the sense that both the good being produced and the labour force are homogeneous. Consequently, the union treats all workers equally so that the equilibrium wage arising from wage bargaining between the firms and the union is going to be identical for all employed workers, regardless of the particular firm they are employed at. Furthermore, according to equation (3) the output level is also symmetric amounting to $q(\omega) = \frac{1}{3}(2 - \omega)$ where $\omega = \omega_i = \omega_j$. As a consequence, the outcome of the bargain will be the wage rate that maximises the following Nash product

$$\Omega(\omega) = \left[2(\omega - \gamma)(1 - \tau)q(\omega) \right]^\alpha \left[2[q(\omega)]^2 \right]^{1-\alpha} \quad (7)$$

resulting in

$$\omega(\alpha, \gamma) = \alpha + \frac{(2 - \alpha)}{2}\gamma \quad (8)$$

with $1/2 \leq \gamma \leq 2$, where the latter constraint guarantees that the negotiated gross wage is larger than or equal to the gross benefit. One can easily verify that the second order condition for a maximum is fulfilled, $\Omega_{\omega\omega} < 0$.

As expected, the wage rate is increasing in α and in γ . Notice that an increase in the labour tax rate reduces the net wage less than one for one as $\frac{\partial[\omega(1-\tau)]}{\partial\tau} = -\alpha$, because a part of the tax burden is shifted on to the employers⁸ in the form of higher wage demands by the union ($\frac{\partial\omega}{\partial\tau} = \frac{(2-\alpha)\gamma}{2(1-\tau)} > 0$). Hence, as in Lockwood (1990), the degree of tax shifting is decreasing in α because the union internalizes the negative consequences of a higher wage on employment, i.e. $\frac{\partial^2\omega}{\partial\alpha\partial\tau} < 0$.

Given the wage rate (8) we can determine the equilibrium output and employment from (3):

$$q(\alpha, \gamma) = \frac{1}{6}(2 - \alpha)(2 - \gamma) \quad (9)$$

An increase in α or γ raises the labour input costs which in turn induces firms to reduce output and thus labour demand in order to counteract the falling profit.

⁷In the course of the analysis we will introduce conditions that guarantee that negotiations do not break down in equilibrium, that is, the union will not settle for a wage rate lower than γ .

⁸If the labour market were competitive with inelastic individual labour supplies an increase in the labour tax would entirely be borne by workers.

Notice that in the absence of union power ($\alpha = 0$) the union is unable to extract any rents so that the equilibrium wage rate corresponds to the gross benefit level. Nevertheless, in equilibrium there is always involuntary unemployment since setting γ at a level that is higher than the competitive wage rate implies $Q(\alpha, \gamma) < 1$.⁹

We proceed by deriving the equilibrium wage arising in case firm 2 moves offshore.

4.2 The equilibrium wage with relocation

If the MNE relocates its branch plant abroad, firms 1 and 2 will choose their output levels according to equation (3) where the foreign wage rate, assumed $1/2 < \omega_2 \leq 2$, is now exogenous. Both the domestic union and the domestic firm anticipate the asymmetric game in the product market and bargain over the domestic wage rate. The Nash bargaining product is given by

$$\Omega(\omega_1, \omega_2) = [(\omega_1 - \gamma)(1 - \tau)q_1(\omega_1, \omega_2)]^\alpha [q_1(\omega_1, \omega_2)]^{2(1-\alpha)} \quad (10)$$

and the equilibrium domestic gross wage rate now results in

$$\omega_1(\alpha, \gamma, \omega_2) = \frac{(2 + \omega_2)\alpha}{4} + \frac{(2 - \alpha)\gamma}{2} \quad (11)$$

where the second order condition for a maximum is fulfilled. As in the previous section the gross unemployment benefit level is bounded from below and from above by the competitive and the equilibrium wage rate, respectively, so that $(\omega_2 - 1)/2 \leq \gamma \leq (2 + \omega_2)/2 := \bar{\gamma}(\omega_2)$.¹⁰ Given α , γ , and ω_2 , the comparison of expressions (8) and (11) reveals that the domestic wage is lower when firm 2 is competing from abroad rather than when both firms produce domestically.

By substituting (11) in (3) we obtain the equilibrium production and employment levels:

$$\begin{aligned} q_1(\alpha, \gamma, \omega_2) &= \frac{(2 - \alpha)}{3} \left[\frac{(2 + \omega_2)}{2} - \gamma \right] \\ q_2(\alpha, \gamma, \omega_2) &= \frac{1}{6} \left[\frac{2(4 + \alpha) - (8 - \alpha)\omega_2}{2} + (2 - \alpha)\gamma \right] \end{aligned} \quad (12)$$

In order to exclude a situation where one of the firms becomes a monopolist, equation (3) requires that $2(\omega_2 - 1) \leq \omega_1(\alpha, \gamma, \omega_2) \leq (2 + \omega_2)/2$ which is essentially a condition that guarantees that the domestic wage does not diverge too much with respect to the foreign wage. The latter constraint is implied by the upper bound for γ whereas the former constraint is always fulfilled if $\omega_2 \leq 1$.

⁹Note that $Q(\alpha, \gamma) < 1$ holds if and only if $\gamma > \frac{1-2\alpha}{2-\alpha}$ which is implied by the condition $\gamma > \frac{1}{2}$ since $0 < \alpha < 1$. As such, we can rule out an excess demand for labour.

¹⁰The restriction $\omega_2 \leq 2$ implies that $\frac{\omega_2-1}{2} \leq \frac{1}{2}$ and $\frac{2+\omega_2}{2} \leq 2$. Taking into account the bounds of γ in the previous section, in the sequel we require $\frac{1}{2} \leq \gamma \leq \bar{\gamma}(\omega_2)$.

Note that an increase in the foreign wage improves the relative competitiveness of the domestic firm and thus boosts its output. Due to rent splitting the domestic wage is also increasing in ω_2 . The total output is given by

$$q_1(\alpha, \gamma, \omega_2) + q_2(\alpha, \gamma, \omega_2) = \frac{1}{6} \left[\frac{2(8 - \alpha) - (4 + \alpha)\omega_2}{2} - (2 - \alpha)\gamma \right] \quad (13)$$

and is decreasing in α , γ , and ω_2 .

We make it a point that in the event of a relocation of firm 2, it is not clear a priori how the domestic and foreign labour costs compare. We ask the following question: given the foreign wage rate, will the domestic wage bargaining parties agree on a wage rate that is higher equal or lower than the foreign wage rate? A symmetric duopoly in the offshoring regime is consistent with $\omega_1(\alpha, \gamma, \omega_2) = \omega_2$ and requires that the labour income tax rate and the unemployment benefit are set such that

$$\gamma = \gamma_s(\alpha, \omega_2) := \frac{(4 - \alpha)\omega_2 - 2\alpha}{2(2 - \alpha)} \quad (14)$$

If the government policy variable lies above this symmetry threshold, $\gamma > \gamma_s(\alpha, \omega_2)$, the domestic firm and union will agree on a higher wage rate than that prevailing abroad thus facing a cost disadvantage. Conversely, if γ is set below the threshold the domestic wage rate will be set at a level that is lower than the foreign wage rate. Note that the symmetry limiting value $\gamma_s(\alpha, \omega_2)$ is decreasing in α . Put differently, the stronger the domestic union, the larger the range of γ that imply a cost advantage to the foreign firm. This illustrates how the government can in fact determine the conditions under which competition takes place.

5 The relocation decision

Firm 2 has the option of producing in the domestic country or abroad. A simple decision rule consists of locating production where the profit net of sunk relocation costs, K , is highest. These costs may capture factors such as putting the infrastructure in place, laying off employees at home, hiring and training new workers, paying legal and consulting fees and the like. As a consequence, the MNE relocates if

$$\pi_2(\alpha, \gamma, \omega_2) - K \geq \pi(\alpha, \gamma) \quad (15)$$

where $\pi_2(\alpha, \gamma, \omega_2)$ denotes the profit of firm 2 if it produces in the foreign country. This condition can be restated as $q_2^2(\alpha, \gamma, \omega_2) - K \geq q^2(\alpha, \gamma)$. Using expressions (9) and (12) we find that a relocation occurs if

$$\gamma \geq \gamma_r(\alpha, \omega_2, K) := \frac{(8 - \alpha)\omega_2 - 6\alpha + \Delta^{-1}(\alpha, \omega_2)K}{4(2 - \alpha)} \quad (16)$$

with $\Delta(\alpha, \omega_2) = \frac{(8 - \alpha)(2 - \omega_2)}{12^2}$. Given the union strength, the foreign wage rate, and the sunk costs, the location choice therefore is determined indirectly by the

governmental choice of the tax and transfer policy.

Note that $1/2 \leq \gamma_r(\alpha, \omega_2, K) \leq \bar{\gamma}(\omega_2)$ if and only if $\underline{K}(\alpha, \omega_2) \leq K \leq \bar{K}(\alpha, \omega_2)$ where $\underline{K}(\alpha, \omega_2) := [\alpha(4 + \omega_2) - 4(2\omega_2 - 1)]\Delta(\alpha, \omega_2)$ and $\bar{K}(\alpha, \omega_2) := (4 + \alpha)(2 - \omega_2)\Delta(\alpha, \omega_2)$.¹¹

It is easily checked that the relocation threshold increases with ω_2 and K and decreases with α so that higher foreign wages, higher relocation costs, and a weaker domestic union increase the range of γ for which firm 2 does not relocate, thus making a relocation less likely, i.e. $\frac{\partial \gamma_r(\alpha, \omega_2, K)}{\partial \omega_2} > 0$, $\frac{\partial \gamma_r(\alpha, \omega_2, K)}{\partial K} > 0$, and $\frac{\partial \gamma_r(\alpha, \omega_2, K)}{\partial \alpha} < 0$.

In the preceding section we identified a threshold for the government policy variable, γ , below and above which the duopoly becomes asymmetric. Specifically, we know that if $\gamma < \gamma_s(\alpha, \omega_2)$ the bargained domestic wage rate in the relocation regime is below the foreign wage rate and vice versa. Obviously, having derived the condition under which firm 2 relocates, it would be interesting to explore whether and how asymmetric labour costs arise in the relocation regime. Straightforward comparison yields that $\gamma_r(\alpha, \omega_2, K) \leq \gamma_s(\alpha, \omega_2)$ if $K \leq K^*(\alpha, \omega_2) := \alpha(2 - \omega_2)\Delta(\alpha, \omega_2)$ where $K^*(\alpha, \omega_2) < \bar{K}(\alpha, \omega_2)$.¹² The implications of this result are summarised in the following two lemmata which will be useful in the sequel.

Lemma 1: *If relocation costs are sufficiently low, namely, $\underline{K}(\alpha, \omega_2) \leq K \leq K^*(\alpha, \omega_2)$, there exists an interval for γ , $\gamma \in]\gamma_r(\alpha, \omega_2, K); \gamma_s(\alpha, \omega_2)[$ where the MNE finds it optimal to relocate abroad even though the equilibrium domestic wage is below the foreign wage after relocation.*

Lemma 1 captures the idea that a decrease in K increases the attractiveness of relocating and thus the mobile firm starts to relocate for lower values of γ , that is, the relocation threshold decreases. A decrease in γ , in turn, reduces the domestic wage rate. If costs are sufficiently low, the MNE shifts production abroad even though it anticipates that wages will be lower in the domestic country than abroad due to the pressure that offshoring imposes on the wage negotiation. Put differently, there is a range of γ where relocation occurs, yet the domestic union moderates its wage claims to such an extent that the domestic firm ends up having a higher market share than the relocating firm.

Figure 1 below illustrates how the level of gross unemployment benefits can be split into three intervals; values of γ between $\underline{\gamma} := 1/2$ and $\gamma_r(\alpha, \omega_2, K)$ give rise to the symmetric equilibrium where both firms produce domestically; if γ takes on a value between $\gamma_r(\alpha, \omega_2, K)$ and $\bar{\gamma}(\omega_2)$, offshoring takes place in which case the threshold $\gamma_s(\alpha, \omega_2)$ determines which of the firms has a competitive advantage. Although there is empirical evidence that increased import competition

¹¹We do not exclude negative costs that may arise from governmental efforts abroad aimed at attracting FDI such as tax concessions, subsidies and other infrastructure facilitation.

¹²At this point it is not relevant for the results whether or not $\underline{K} < K^*$. Note, however, that $\underline{K} < K^*$ requires $\alpha < \bar{\alpha}(\omega_2) := \frac{2(2\omega_2 - 1)}{\omega_2 + 1}$, a condition that shall be of use later on (cf. section 6.1.3).

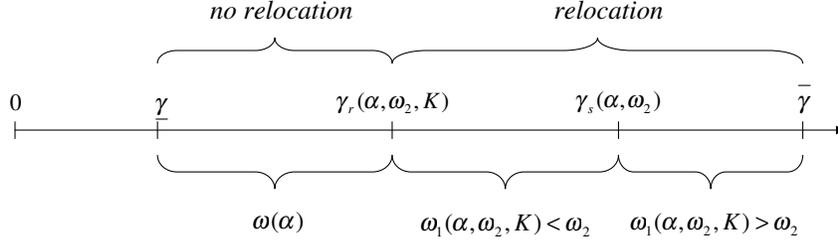


Figure 1: Dependence of the equilibrium wages on the choice of the wage tax rate and the unemployment benefit, given K , α , and ω_2 . In this figure we assume that costs, K , are as low as proposed in lemma 1 so that the relocation threshold, γ_r , is below the symmetry threshold, γ_s , implying that the relocation equilibrium may be consistent with domestic wages being lower than foreign wages.

from low-wage countries in specific sectors tends to reduce wages in those sectors (e.g. Feenstra and Hanson (1996 and 1999), Egger et al (2001), Geishecker (2002)), we do not usually observe that labour costs fall *below* those prevalent in the offshore destination countries. Lemma 2 provides a condition that results in equilibria where the wage rate remains lower in the foreign country than in the domestic country.

Lemma 2: *If relocation costs are sufficiently high, i.e. $K^*(\alpha, \omega_2) < K \leq \bar{K}(\alpha, \omega_2)$, then $\gamma_r(\alpha, \omega_2, K) > \gamma_s(\alpha, \omega_2)$ and a relocation always implies that domestic labour costs are higher than foreign labour costs so that the MNE always increases its market share after relocation.*

Analogous to lemma 1, lemma 2 simply reflects that high relocation costs and high domestic labour costs are two sides of the same coin. By rendering a relocation less attractive, high relocation costs strengthen the bargaining position of the domestic labour union in the sense that the fallback payoff of workers, γ , rises. Figure 2 depicts such a situation.

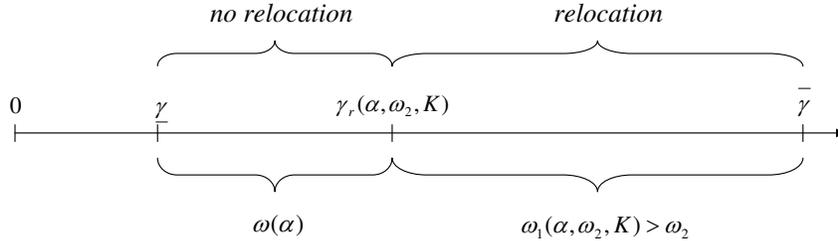


Figure 2: Offshoring under sufficiently high relocation costs (see lemma 2). In this case, in the relocation regime domestic wages are always higher than foreign wages.

6 Government policies

So far, we have highlighted the way in which the government's choice of γ determines the equilibrium. In this section we derive the optimal tax package which consists of the labour income tax rate, τ , and the income accruing to the unemployed in the form of net unemployment benefits, b . Fiscal policy therefore amounts to taxing working individuals and redistributing the proceeds to the non-employed. As in the previous sections, we express τ and b in terms of γ , specifically, $\gamma = b/(1 - \tau)$. For simplicity, we parametrise the objective function of the government using $\beta \in [0, 1]$ as a weight the government attaches to parts of an economic welfare function as measured by the sum of consumer surplus, CS , and domestic producer surplus, PS , the net income accruing to the employed, E , and the net transfers to the unemployed, U .¹³ Specifically, the social welfare function takes the form

$$W = \beta [CS + PS] + (1 - \beta) [E + U] \quad (17)$$

In order to get a better understanding of the forces at work, we only analyse rather polar types of government. In particular, we study 2 cases. First, in section 6.1, we assume that the government chooses its policy variables so as to maximise the sum of consumer and producer surplus ($\beta = 1$). We shall call this type of government the 'pro-business' government. Subsequently, in section 6.2, we derive the optimal policy of a government whose objective consists of maximising the sum of net incomes of employed and unemployed individuals ($\beta = 0$). This we label the 'pro-labour' government.

6.1 The 'pro-business' government: $\beta = 1$

Suppose the government attaches full weight to the sum of domestic consumer and producer surplus. It follows that the objective functions are given by

$$W(\gamma) = \begin{cases} W_n(\gamma) = 2q^2(\gamma) + q^2(\gamma) & \text{if } 1/2 \leq \gamma \leq \gamma_r \\ W_r(\gamma) = 0.5 [q_1(\gamma) + q_2(\gamma)]^2 + q_1^2(\gamma) & \text{if } \gamma_r \leq \gamma \leq \bar{\gamma}(\omega_2) \end{cases} \quad (18)$$

where $W_n(\gamma)$ represents the government's objective function when no relocation takes place, i.e. in the subset of γ between 1/2 and γ_r , and $W_r(\gamma)$ denotes the respective function in the relocation regime, i.e. for γ between γ_r and $\bar{\gamma}(\omega_2)$. In both equations the first term on the right-hand side expresses the consumer

¹³Note that E does not coincide with the union rent and that it takes different values depending on whether offshoring takes place or not. In unionised oligopoly models the union rent is typically included in national welfare as that part of total producer surplus which is incorporated by the union (e.g. Bughin and Vannini (1995), Leahy and Montagna(2000), and Lommerud et al. (2003)). In our framework, the total producer surplus is partly absorbed by employed workers (as *net* wage income) and unemployed workers (as wage tax revenues). In particular, employed workers transfer some of their rents towards unemployed workers. We will explicitly introduce the expressions for CS and PS in section 6.1 and the expressions for E and U in section 6.2. Notice that the weights distinguish our government objective function from standard welfare functions in that they distort the relative rents.

surplus defined as $\int_0^Q p(Q)dQ - pQ$ and the second term represents the profit of the domestic firm. Since in the relocation regime firm 2 serves the domestic market through exports, both $q_1(\gamma)$ and $q_2(\gamma)$ enter the consumer surplus. Note that welfare is increasing in (domestic and total) output, which on its part is decreasing in γ . Thus, it is clear from the outset that the government can improve its objective by reducing γ as long as γ is strictly above its respective lower bound.

6.1.1 No relocation regime

If both firms produce in the domestic country, the Lagrangean can be written as

$$\mathcal{L}(\tau, \gamma, \lambda, \mu_1, \mu_2) = W_n(\gamma) + \lambda B_n(\tau, \gamma) + \mu_1(\gamma - \frac{1}{2}) + \mu_2(\gamma_r - \gamma)$$

where $B_n(\tau, \gamma)$ denotes the government's budget given by

$$B_n(\tau, \gamma) = 2\tau\omega(\gamma)q(\gamma) - \gamma(1 - \tau)[1 - 2q(\gamma)] \quad (19)$$

In words, the government levies a fraction τ of the wage income and redistributes the revenue to the unemployed in the form of unemployment benefits, where $\gamma(1 - \tau)$ is the net benefit and $1 - 2q(\gamma)$ is the level of unemployment when both firms produce in the domestic country. Note that since the equilibrium unemployment is nonnegative, the budget is increasing in the wage tax rate:

$$\frac{\partial B_n}{\partial \tau} = 2\omega(\gamma)q(\gamma) + \gamma[1 - 2q(\gamma)] > 0$$

It immediately follows from the first order condition of the Lagrangean with respect to τ that $\lambda = 0$. Then, the remaining first order conditions are given by

$$\gamma : \quad \frac{dW_n}{d\gamma} + \mu_1 - \mu_2 = 0, \quad (20)$$

$$\lambda : \quad B_n(\tau, \gamma) \geq 0, \quad (21)$$

$$\mu_1 : \quad \gamma - \frac{1}{2} \geq 0, \quad (22)$$

$$\mu_2 : \quad \gamma_r - \gamma \geq 0 \quad (23)$$

It is straightforward to show that an equilibrium where $\gamma > 1/2$ is contradicted by the complementary slackness conditions,¹⁴ implying that the equilibrium policy variable without relocation is given by $\gamma_n = 1/2$. This result conforms with intuition since, as mentioned above, the government can increase its objective by reducing γ . The equilibrium wage and output are thus given by

$$\omega(\alpha) = \frac{1}{4}(2 + 3\alpha) \quad \text{and} \quad q(\alpha) = \frac{1}{4}(2 - \alpha)$$

¹⁴Note that $\gamma > 1/2$ requires that $\mu_1 = 0$ so that condition (20) becomes $\frac{dW_n}{d\gamma} = 6q(\gamma)\frac{\partial q}{\partial \gamma} = \mu_2 < 0$ contradicting the condition that the Lagrange multiplier must be nonnegative.

Recall, however, that even for $\gamma = 1/2$ there will be positive unemployment in the presence of a union. Consequently, the government must set the wage tax rate so as to finance the redistribution. A balanced-budget policy would result in

$$\begin{aligned}\tau_n(\alpha) &= \frac{\gamma[1 - 2q(\gamma)]}{\gamma[1 - 2q(\gamma)] + 2\omega(\gamma)q(\gamma)} \\ &= \frac{2\alpha}{4 + 3\alpha(2 - \alpha)}\end{aligned}\tag{24}$$

Observe that the tax rate is increasing in the union power because unemployment rises with α at a higher rate than taxable income, $\omega(\alpha)q(\alpha)$. Therefore, in order to satisfy the budget constraint the tax rate must rise with α to accommodate the higher number of recipients of unemployment benefits. Moreover, the tax rate is convex in α which is a feature that is linked to the degree of tax shifting. Remember that a stronger union is associated with a lower degree of tax shifting. Knowing that the effect of a marginal increase in the tax rate on labour input costs is weakening in α , the government finds it optimal to increase $\tau_n(\alpha)$ more than proportionally when α rises in order to finance the increased demand for welfare transfers resulting from higher unemployment.

The level of the net unemployment benefit is given by

$$\begin{aligned}b_n(\alpha) &= \gamma_n [1 - \tau_n(\alpha)] \\ &= \frac{1}{2} \left[\frac{4 + \alpha(4 - 3\alpha)}{4 + 3\alpha(2 - \alpha)} \right]\end{aligned}\tag{25}$$

Accordingly, a rise in the negotiating strength of the union implies that less will be paid to each unemployed worker.

6.1.2 Relocation regime

We now turn to consider how the ‘pro-business’ government chooses its policy instruments when firm 2 produces abroad. The Lagrangean becomes

$$\Gamma(\tau, \gamma, \sigma, \delta_1, \delta_2) = W_r(\gamma) + \sigma B_r(\tau, \gamma) + \delta_1(\gamma - \gamma_r) + \delta_2(\bar{\gamma} - \gamma)$$

where the budget constraint reads

$$B_r(\tau, \gamma) = \tau\omega_1(\gamma)q_1(\gamma) - \gamma(1 - \tau)[1 - q_1(\gamma)]\tag{26}$$

Like in the previous case, the objective function reaches its maximum when γ is lowest, i.e. $\gamma = \gamma_r(\alpha, \omega_2, K)$ where the proof is analogous to that in the previous section.¹⁵ This implies that the equilibrium wage and output levels are

$$\omega_1(\alpha, \omega_2, K) = \frac{1}{8} [(8 + \alpha)\omega_2 - 2\alpha + \Delta^{-1}(\alpha, \omega_2)K]\tag{27}$$

¹⁵Suppose that $\gamma - \gamma_r > 0$. The complementary slackness conditions then imply that $\delta_1 = 0$. Hence, the first order condition on γ becomes $(dW_r)/(d\gamma) = \delta_2$. Note however that $\frac{dW_r}{d\gamma} = [q_1(\gamma) + q_2(\gamma)] \left(\frac{\partial(q_1 + q_2)}{\partial\gamma} \right) + 2q_1(\gamma) \frac{\partial q_1}{\partial\gamma} < 0$. Therefore, in equilibrium we have that $\gamma = \gamma_r$.

and

$$\begin{aligned} q_1(\alpha, \omega_2, K) &= \frac{1}{12} [(2 - \omega_2)(4 + \alpha) - \Delta^{-1}(\alpha, \omega_2)K] \\ q_2(\alpha, \omega_2, K) &= \frac{1}{24} [(2 - \omega_2)(8 - \alpha) + \Delta^{-1}(\alpha, \omega_2)K] \end{aligned} \quad (28)$$

It follows that $q_1(\alpha, \omega_2, K) + q_2(\alpha, \omega_2, K) = \frac{1}{24} [(2 - \omega_2)(16 + \alpha) - \Delta^{-1}(\alpha, \omega_2)K]$. A balanced-budget fiscal policy would result in the following wage tax rate and net unemployment benefit

$$\begin{aligned} \tau_r(\alpha, \omega_2, K) &= \frac{\gamma_r[1 - q_1(\gamma_r)]}{\gamma_r[1 - q_1(\gamma_r)] + \omega_1(\gamma_r)q_1(\gamma_r)} \\ b_r(\alpha, \omega_2, K) &= \gamma_r(1 - \tau_r) \end{aligned} \quad (29)$$

It is easy to check that $K < \bar{K}$ implies that the impact of α on the wage rate and on output is inverted with respect to the regime without relocation.

Lemma 3: *Assume $\beta = 1$. In the relocation regime the domestic wage is decreasing in α and, correspondingly, the employment and output levels of the domestic firm are increasing in α .*

This seemingly paradoxical effect captures an important feature of the interaction between the union, the mobile firm, and the ‘pro-business’ government. Firms anticipate that higher values of α imply tougher wage negotiations and therefore are willing to relocate for lower values of γ . At the same time, the government will set the lowest possible γ consistent with relocation. The final effect on workers is that the union will end up settling for a lower wage. To see this, it is useful to rewrite the wage function explicitly as $\omega_1(\alpha, \gamma_r(\alpha, \omega_2, K), \omega_2)$. Taking the total derivative of the domestic wage rate with respect to α in equation (11), evaluated at the optimum, we obtain $\frac{\partial \omega_1}{\partial \alpha} + \frac{\partial \omega_1}{\partial \gamma_r} \frac{\partial \gamma_r}{\partial \alpha} < 0$. Put differently, a rise in α compels the government to set a lower γ , which is captured by the second term on the right-hand side, and thus worsens the fall-back payoff of workers. This last effect is responsible for the negative impact of α on the domestic wage rate.

As to the effect of ω_2 on domestic output, it, too, is inverted. An increase in the foreign wage renders the option of relocating less attractive for firm 2. This implies that the government will set a higher γ which exerts a positive impact on domestic wages and thus decreases domestic output. Specifically, from equation (12) we obtain $\frac{\partial q_1}{\partial \omega_2} + \frac{\partial q_1}{\partial \gamma_r} \frac{\partial \gamma_r}{\partial \omega_2} < 0$ where $\frac{\partial q_1}{\partial \omega_2} > 0$.

6.1.3 The welfare impact of offshoring

Having derived the equilibrium levels of output with and without relocation, we are now in a position to ask whether, from the perspective of the ‘pro-business’ government, it is optimal to avoid or induce offshoring. Recalling

that this type of government attaches positive weight only to the surplus of the domestic producer and consumers, we first explore how the former is affected by a relocation of the MNE. Then, we do the same exercise regarding the impact on consumers. Finally, we consider the welfare effects on workers.

For an assessment of the gains or losses in domestic *profits* it suffices to compare the respective output levels given by (9) and (12) in the optimum. We find that

$$q_1(\alpha, \gamma_r, \omega_2) \gtrless q(\alpha, \gamma_n) \Leftrightarrow 2\gamma_r - \gamma_n \lesseqgtr \omega_2 \quad (30)$$

Surprisingly, the domestic firm may benefit from the relocation of the competitor. In particular, offshoring benefits (harms) the domestic producer if the difference between the chosen domestic tax/transfer package with and without relocation is not too large (small) with respect to the foreign labour costs. In other words, given $\gamma_n = 1/2$, the domestic firm will enjoy higher profits in the offshoring regime if domestic labour is not too costly with regard to foreign labour. As the wage rate in firm 1 is increasing in γ_r , which in turn is increasing in K , condition (30) holds if

$$K \lesseqgtr K^\circ(\alpha, \omega_2) := [5\alpha + 2 - (4 + \alpha)\omega_2] \Delta(\alpha, \omega_2) \quad (31)$$

where $\underline{K} < K^\circ < \bar{K}$.

Proposition 1: *Assume $\beta = 1$. If relocation costs are sufficiently low relative to the union's negotiation power and to foreign wages, $\underline{K} < K < K^\circ(\alpha, \omega_2)$, the domestic producer benefits from an outward relocation of the MNE.*

As mentioned in lemma 1, the option of relocating abroad becomes more attractive for the foreign firm when the costs associated with such a move decrease. As a result, the relocation threshold, γ_r , falls. Since the ‘pro-business’ government optimally sets $\gamma = \gamma_r$, lower relocation costs dampen domestic wages and push up domestic output. In other words, the domestic firm benefits all the more from import competition, the less costly the relocation is, since the government optimally reacts by mitigating the distortion in the domestic labour market setting a lower gross benefit level. The stronger are the incentives for the mobile firm to move production abroad, the more likely it is that the domestic producer is better off if the foreign firm produces abroad rather than at home.¹⁶

It is important to emphasise the fact that proposition 1 is independent of the domestic firm's market share. Recall, from lemma 2, that relocation costs $K > K^*(\alpha, \omega_2)$ result in equilibria where the domestic firm faces higher labour costs than the firm producing abroad. It thus seems natural to ask whether it is possible that the domestic firm benefits from a relocation of its competitor even though domestic labour costs turn out to exceed foreign labour costs and

¹⁶It can be shown that a rise in the negotiation power of the domestic union decreases the likelihood that the domestic firm benefits from the competitor's outward relocation as $\frac{\partial(K^\circ - K)}{\partial\alpha} = -(2\omega_2 - 1)\Delta(\alpha, \omega_2) + (2\omega_2 - 1)(2 - \alpha)\frac{\partial\Delta}{\partial\alpha} < 0$.

therefore the domestic firm's market share is reduced as a result of relocation. This could happen if $K^* < K^\circ$ and $K \in [K^*, K^\circ]$. It turns out that such equilibria exist if the measure of union negotiation strength is sufficiently high with respect to the foreign labour costs, namely,

$$\alpha > \underline{\alpha}(\omega_2) := \frac{2(2\omega_2 - 1)}{3}$$

On the other hand, at this point it is convenient to note that $\underline{K} < K^*$ requires

$$\alpha < \bar{\alpha}(\omega_2) := \frac{2(2\omega_2 - 1)}{\omega_2 + 1}$$

and that $\underline{\alpha}(\omega_2) < \bar{\alpha}(\omega_2)$.

The previous observations allow us to put forward the following propositions.

Proposition 2: *Assume $\beta = 1$ and $\alpha > \bar{\alpha}(\omega_2)$, then $K^* < \underline{K}$ and for $K \in [\underline{K}, K^\circ]$ we have that $q_1(\gamma_r) > q(\gamma_n)$ and $q_1(\gamma_r) < q_2(\gamma_r)$.*

Proposition 2 builds upon lemma 2 and exploits the fact that $\alpha > \bar{\alpha}$ implies that all admissible values of K give rise to equilibria where the domestic wage rate exceeds the foreign wage rate as $K^* < \underline{K}$. Therefore, if the domestic labour union is sufficiently strong and costs are below K° , an outward relocation of the MNE benefits the domestic firm even though the latter faces higher labour costs than its relocated competitor. That is, for the domestic firm the relocation of the MNE is profitable, yet, it comes at the cost of a lower domestic market share.

Proposition 3: *Assume $\beta = 1$ and $\alpha < \underline{\alpha}(\omega_2)$, then $K^\circ < K^*$ and for $K \in [\underline{K}, K^\circ]$ we have that $q_1(\gamma_r) > q(\gamma_n)$ and $q_1(\gamma_r) > q_2(\gamma_r)$.*

This proposition is related to lemma 1. If the domestic labour union is sufficiently weak and if moving offshore is not too costly ($K < K^\circ$), the outward relocation of the MNE benefits the domestic firm and, furthermore, results in domestic wages being lower than foreign wages. It thus entails an increase in the domestic firm's market share. As stated previously, however, this outcome might be empirically less relevant.

Proposition 4: *Assume $\beta = 1$. If the labour union is moderately strong, $\underline{\alpha}(\omega_2) < \alpha < \bar{\alpha}(\omega_2)$, and*
(i) costs are such that $\underline{K} < K < K^$, then the same conclusion as in proposition 3 prevails;*
(ii) costs are as high as $K^ < K < K^\circ$, then we obtain the same conclusion as in proposition 2.*

Proposition 4 sets out conditions on α and ω_2 under which $\underline{K} < K^* < K^\circ < \bar{K}$. Thus the range of relocation costs under which the domestic firm is affected positively when the MNE moves its plant offshore can be split into two

intervals: one that gives rise to a labour input cost advantage on the part of the domestic firm (*i*), and one that results in a labour cost disadvantage (*ii*). To see what the relocation cost constraints entail graphically, figure 3 plots the various cost thresholds and the respective inequalities assuming a moderately strong domestic labour union as in proposition 4.

Regarding the domestic *consumer surplus*, we can perform a similar exercise.

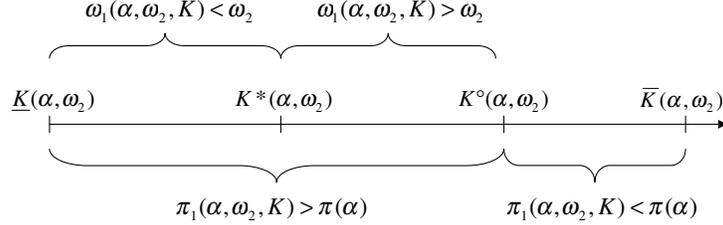


Figure 3: Offshoring assuming a moderately strong union as in proposition 4.

The comparison of consumer surplus with and without relocation yields:

$$q_1(\alpha, \gamma_r, \omega_2) + q_2(\alpha, \gamma_r, \omega_2) > 2q(\alpha, \gamma_n)$$

$$\text{if } \gamma_r - 2\gamma_n < \frac{6\alpha - (4 + \alpha)\omega_2}{2(2 - \alpha)} \quad (32)$$

Put differently, consumers benefit from offshoring if and only if total output increases. Condition (32) is fulfilled if

$$K < K^{\circ\circ}(\alpha, \omega_2) := [2(7\alpha + 4) - (16 + \alpha)\omega_2]\Delta(\alpha, \omega_2) \quad (33)$$

where $\underline{K} < K^{\circ\circ}$. Remark that $K^{\circ\circ} < \bar{K}$ if $\omega_2 > \alpha$. Only if the latter inequality holds, does condition (33) impose any restrictions. It is also noteworthy that $K^{\circ\circ} \geq K^\circ$ if $\alpha \geq \underline{\alpha}$, which leads to the following statements:

Proposition 5: Assume $\beta = 1$.

(i) If $K < \min\{K^\circ, K^{\circ\circ}\}$, the transition from the symmetric equilibrium without relocation to the equilibrium with import competition benefits both the domestic consumers and the domestic firm. In this case, the government optimally sets γ so as to encourage offshoring, i.e. $\gamma = \gamma_r(\alpha, \omega_2, K)$.

(ii) If $K > \max\{K^\circ, K^{\circ\circ}\}$, offshoring harms consumers and the domestic firm. Thus, the government will set γ so as to discourage offshoring, i.e. $\gamma = 1/2$.

Remark 1: Assume $\beta = 1$. If $\min\{K^\circ, K^{\circ\circ}\} < K < \max\{K^\circ, K^{\circ\circ}\}$, offshoring harms one of these groups (respectively consumers or the domestic firm) but proves to be beneficial from the point-of-view of the other. Thus, the conditions in propositions 1 to 3 that guarantee that a relocation is profitable are not tight. In particular, from a ‘pro-business’ perspective, the relocation might be profitable in more cases than the ones identified in those propositions.

Welfare effects on workers Concerning the effects of a relocation on domestic *workers*, we arrive at the following conclusions. As in our framework there is no complementarity in production among the goods produced in each firm, it is not surprising that offshoring results in a lower level of total domestic employment. Evaluating equations (9) and (12) in the optimum, we obtain $2q(\alpha, \gamma_n) > q_1(\alpha, \gamma_r, \omega_2)$.¹⁷ As to the role of the labour union regarding the extent of relocation-related job losses we remark the following.

Remark 2: *Assume $\beta = 1$. The stronger the domestic union, the fewer jobs are lost due to relocation.*

To see this, consider how α affects the change in domestic employment following a relocation. Partial differentiation yields

$$\frac{\partial [2q(\alpha) - q_1(\alpha, \omega_2, K)]}{\partial \alpha} = -\frac{1}{2} - \frac{1}{12} \left[(2 - \omega_2) + \frac{K \frac{\partial \Delta}{\partial \alpha}}{\Delta^2} \right] \quad (34)$$

Since $\frac{\partial \Delta}{\partial \alpha} < 0$, expression (34) is increasing with K . Substituting K by its upper bound, \bar{K} , we obtain $-\frac{1}{2} - \frac{(2-\omega_2)(2-\alpha)}{6(8-\alpha)} < 0$. It follows that expression (34) is negative for all admissible values of K . Intuitively, this follows directly from lemma 3. Generally, a stronger union affects employment negatively. In the relocation regime, however, two things contribute to reduce the negative effects on employment. First, the government will attempt to counteract the negative effects on employment associated with higher wages by reducing the level of γ as the union strength increases. On the other hand, a strong union will be more concerned about the destruction of jobs following relocation and thus will moderate its wage claims accordingly. As a result, starting from a situation where both firms are located in the domestic country and α is relatively high, an outward relocation of firm 2 is associated with fewer relocation-related job losses than if α were relatively lower.

Lastly, it can be shown that in most cases both the domestic *net* wage and the *net* unemployment benefit are affected negatively when the foreign firm relocates abroad. In particular, considering the condition set out in proposition 2, i.e. $\alpha > \bar{\alpha}(\omega_2)$ and $K < K^\circ$, we obtain that $\omega_1(1 - \tau_r) < \omega(1 - \tau_n)$ and $b_r < b_n$.

6.2 The ‘pro-labour’ government: $\beta = 0$

Consider now a government that attaches full weight to the sum of net rents of employed and unemployed workers.

The government’s objective function in the respective regime becomes

$$W(\gamma, \tau) = \begin{cases} \widetilde{W}_n(\tau, \gamma) = R_n(\gamma) - B_n(\tau, \gamma) & \text{if } 1/2 \leq \gamma \leq \gamma_r \\ \widetilde{W}_r(\gamma, \tau) = R_r(\gamma) - B_r(\tau, \gamma) & \text{if } \gamma_r \leq \gamma \leq \bar{\gamma}(\omega_2) \end{cases} \quad (35)$$

¹⁷From equations (9) and (12) we obtain that $\gamma_r - \gamma_n > \frac{\omega_2 - 2}{2}$ since $\omega_2 < 2$ and $\gamma_n < \gamma_r$.

where $R_n(\gamma) = 2\omega(\gamma)q(\gamma)$ and $R_r(\gamma) = \omega_1(\gamma)q_1(\gamma)$ denote the gross rents of domestic workers in the regime without and with offshoring, respectively.¹⁸ Notice that these rents are concave in γ which means that they increase for sufficiently low γ as higher labour taxes and benefits exert upward pressure on wage claims up to a point where the negative impact of γ on employment dominates the former effect.¹⁹ In what follows we apply the same procedure as in the previous section and derive the optimum levels of τ and b in both regimes.

6.2.1 No relocation regime

We start by considering the Lagrangean function

$$\Psi(\tau, \gamma, \nu, \rho_1, \rho_2) = R_n(\gamma) + (\nu - 1)B_n(\tau, \gamma) + \rho_1\left(\gamma - \frac{1}{2}\right) + \rho_2(\gamma_r - \gamma)$$

In this case, $\frac{\partial B_n}{\partial \tau} > 0$ implies that $\nu = 1$ and thus the first-order condition with respect to γ reduces to

$$\frac{dR_n}{d\gamma} + \rho_1 - \rho_2 = 0$$

Solving for γ , we obtain

$$\tilde{\gamma}_n(\alpha) = \frac{2(1 - \alpha)}{2 - \alpha}$$

Note that $1/2 \leq \tilde{\gamma}_n(\alpha) \leq \gamma_r(\alpha, \omega_2, K)$ is guaranteed if $\alpha < 2/3$ and $K > \tilde{K}(\alpha, \omega_2) := [2(4 - \alpha) - (8 - \alpha)\omega_2] \Delta(\alpha, \omega_2)$ where $\underline{K} < \tilde{K} < \overline{K}$. Observe that $\tilde{\gamma}_n(\alpha)$ is decreasing in α . Hence, contrary to the ‘pro-business’ government, when both firms produce domestically, the ‘pro-labour’ government counterbalances a rise in the union bargaining strength by setting a respectively lower γ . At an interior solution, it turns out that the equilibrium wage and output do not depend on α :

$$\tilde{\omega}_n = 1 \qquad \tilde{q}_n = \frac{1}{3}$$

Being concerned with the total income of workers and unemployed, the government sets γ in such a way that any change in the wage rate arising from a change in α is neutralized. Totally differentiating the wage rate given by equation (8) with respect to α , evaluated at the interior solution, we have that $\frac{\partial \omega}{\partial \alpha} + \frac{\partial \omega}{\partial \tilde{\gamma}_n} \frac{\partial \tilde{\gamma}_n}{\partial \alpha} = 0$.

Using expression (19) we obtain that a balanced-budget policy would result in the optimum domestic wage tax rate and benefit level

$$\tilde{\tau}_n(\alpha) = \frac{1 - \alpha}{3 - 2\alpha} \qquad \tilde{b}_n(\alpha) = 2\tilde{\tau}_n(\alpha)$$

¹⁸One way of interpreting the objective function involves expressing it in terms of the union rent, Θ . Namely, in the regime without relocation, $R_n(\gamma) - B_n(\tau, \gamma) = \omega(1 - \tau)2q + b(1 - 2q) = (\omega - \gamma)(1 - \tau)2q + b = \Theta + b$. In words, the entire labour force, which is normalised to 1, receives an amount corresponding to the net unemployment insurance whereas the excess over the benefit accrues to employed workers only. Analogous expressions can be found for the case where the MNE moves offshore.

¹⁹ $\frac{d^2 R_n(\gamma)}{d\gamma^2} = 4 \frac{\partial \omega}{\partial \gamma} \frac{\partial q}{\partial \gamma} < 0$ and $\frac{d^2 R_r(\gamma)}{d\gamma^2} = 2 \frac{\partial \omega_1}{\partial \gamma} \frac{\partial q_1}{\partial \gamma} < 0$

6.2.2 Relocation regime

The Lagrangean in this case is given by

$$\Upsilon(\tau, \gamma, \psi, \varrho_1, \varrho_2) = R_r(\gamma) + (\psi - 1)B_r(\tau, \gamma) + \varrho_1(\gamma - \gamma_r) + \varrho_2(\bar{\gamma} - \gamma)$$

Interestingly, in this case the ‘pro-labour’ government chooses the same equilibrium level of γ as the ‘pro-business’ government. To see this, note that in equilibrium $\psi = 1$, and suppose that $\gamma > \gamma_r(\alpha, \omega_2, K)$; complementary slackness then implies $\varrho_1 = 0$ and the first-order-condition with respect to γ yields

$$\frac{dR_r}{d\gamma} = \varrho_2$$

Now,

$$\frac{dR_r}{d\gamma} = \frac{\partial \omega_1}{\partial \gamma} \left[q_1(\alpha, \gamma, \omega_2) - \frac{2}{3}\omega_1(\alpha, \gamma, \omega_2) \right]$$

where $\frac{\partial \omega_1}{\partial \gamma} > 0$ and the term in brackets is negative if $\gamma > \gamma^*(\alpha, \omega_2) := \frac{(1-\alpha)(2+\omega_2)}{2(2-\alpha)}$. It turns out that if $K > \tilde{K}$, which is required for an interior solution in the no-relocation case, we obtain $\gamma_r(\alpha, \omega_2, K) > \gamma^*(\alpha, \omega_2)$ and thus $\frac{dR_r}{d\gamma} < 0$ for all $\gamma \geq \gamma_r$ which contradicts nonnegativity of ϱ_2 . Consequently, in equilibrium, $\gamma = \gamma_r(\alpha, \omega_2, K)$ and the wage and output levels are given by equations (27) and (28).

6.2.3 The welfare impact of offshoring

Recall that the ‘pro-labour’ government places full weight on the rents of employed and unemployed workers. In anticipation of how fiscal policy is going to affect wage bargaining and the competition in the product market, the government chooses γ so as to maximise workers’ rents. The resulting equilibrium welfare levels under a balanced-budget policy, without and with import competition, respectively, are given by

$$\tilde{W}_n(\tilde{\gamma}_n) = 2\tilde{\omega}_n\tilde{q}_n \quad \tilde{W}_r(\gamma_r) = \omega_1(\alpha, \gamma_r, \omega_2)q_1(\alpha, \gamma_r, \omega_2)$$

Proposition 6: *Assume $\beta = 0$. The government will optimally set its policy so as to discourage relocation because the sum of net wages and benefits is larger when both firms produce in the domestic country.*

Proof. Using expressions (8), (9), (11) and (12), the difference between the welfare levels is given by

$$\begin{aligned} \tilde{W}_n(\tilde{\gamma}_n) - \tilde{W}_r(\gamma_r) = \\ 4(2 - \alpha)(\gamma_r^2 - \tilde{\gamma}_n^2) + 4(1 - \alpha)[4\tilde{\gamma}_n - (2 + \omega_2)\gamma_r] + \alpha[16 - (2 + \omega_2)^2] \end{aligned}$$

Note that the last term in square brackets is nonnegative since $\omega_2 \leq 2$. We proceed by showing that the addition of the first two terms is positive; in particular, it is enough to show that:

$$(2 - \alpha)(\gamma_r^2 - \tilde{\gamma}_n^2) \geq (1 - \alpha)[(2 + \omega_2)\gamma_r - 4\tilde{\gamma}_n]$$

which can be rewritten as

$$\gamma_r [(2 - \alpha)\gamma_r - (1 - \alpha)(2 + \omega_2)] \geq \tilde{\gamma}_n [(2 - \alpha)\tilde{\gamma}_n - 4(1 - \alpha)]$$

Exploiting the fact that $\gamma_r \geq \tilde{\gamma}_n$, by construction, we focus on the terms in square brackets to show that

$$(2 - \alpha)(\gamma_r - \tilde{\gamma}_n) \geq (1 - \alpha)(\omega_2 - 2)$$

which is always fulfilled because the last term on the right-hand side is non-positive for $\omega_2 \leq 2$.

Welfare effects on the domestic producer and consumers Although the ‘pro-labour’ government does not attach any weight to producers’ and consumers’ welfare, it is interesting to see how its policy affects these groups. Recall that if $\alpha < 2/3$ and $K > \tilde{K}(\alpha, \omega_2)$, we obtain an interior solution in the regime without offshoring, namely, $\gamma = \tilde{\gamma}_n(\alpha)$. Using expressions (30) and (32), evaluated at the interior solution, we find that offshoring increases the domestic producer’s profit if

$$K < \tilde{K}^\circ(\alpha, \omega_2) := [2(2 + \alpha) - (4 + \alpha)\omega_2] \Delta(\alpha, \omega_2)$$

and leads to a rise in the consumer surplus if

$$K < \tilde{K}^{\circ\circ}(\alpha, \omega_2) := [2(8 + \alpha) - (16 + \alpha)\omega_2] \Delta(\alpha, \omega_2)$$

where $\underline{K} < \tilde{K}^\circ < \bar{K}$. Note that if $\omega_2 > 1$, we obtain that $\tilde{K}^{\circ\circ} < \tilde{K} < \tilde{K}^\circ$. If $\omega_2 < 1$ and

$$\alpha < \tilde{\alpha}(\omega_2) := \frac{2(1 - \omega_2)}{2 - \omega_2}$$

we have that $\tilde{K}^\circ < \tilde{K} < \tilde{K}^{\circ\circ}$ whereas if $\omega_2 < 1$ and $\alpha > \tilde{\alpha}(\omega_2)$, we obtain that $\tilde{K} < \tilde{K}^\circ < \tilde{K}^{\circ\circ}$.

We can summarise our findings in the following proposition.

Proposition 7: *Assume $\beta = 0$. If $\alpha < 2/3$ and $K > \tilde{K}$, the government sets $\gamma = \tilde{\gamma}_n(\alpha)$, where $1/2 < \tilde{\gamma}_n(\alpha) < \gamma_r(\alpha, \omega_2, K)$.*

(i) If $\omega_2 > 1$, the outward relocation of the MNE always harms consumers but benefits the domestic producer if $K \in]\tilde{K}, \tilde{K}^\circ[$.

(ii) If $\omega_2 < 1$ and $\alpha < \tilde{\alpha}(\omega_2)$, offshoring benefits consumers if $K \in]\tilde{K}, \tilde{K}^{\circ\circ}[$ whereas the domestic producer always becomes worse off.

(iii) If $\omega_2 \leq 1$ and $\alpha > \tilde{\alpha}(\omega_2)$, offshoring benefits both the domestic producer

and consumers if $K \in]\tilde{K}, \tilde{K}^\circ[$ where $\tilde{K}^\circ \leq \tilde{K}^{\circ\circ}$.

Proposition 7 shows that, in the interior solution, for every combination of α and ω_2 there exists a range of relocation costs where either the consumers or the domestic producer or both are better off when the MNE produces abroad. Particularly, a strong domestic labour union, low foreign wages, and low relocation costs as in (iii) work so as to reduce domestic wages to the extent that total *and* domestic output increase due to the relocation.

We now turn to consider the cases where either $\alpha \geq 2/3$ or $K \leq \tilde{K}$ which represent conditions under which corner solutions emerge to the problem in section 6.2.1.

Remark 3: Assume $\beta = 0$ and $\alpha \geq 2/3$. Then the ‘pro-labour’ government sets the optimum γ equal to $1/2$ in the regime without relocation. This corresponds to the policy of the ‘pro-business’ government. Although the ‘pro-labour’ government always discourages offshoring, there would be potential gains from relocation for domestic consumers and producers as given in propositions 1 to 5. A technical restriction must be taken into account; depending on the value of ω_2 , the thresholds $\underline{\alpha}$ and $\bar{\alpha}$ can be smaller or larger than $2/3$ and thus only some of the results in propositions 2 to 4 may be relevant. In particular, for $\omega_2 < 4/5$ we have $\bar{\alpha} < 2/3$ and only proposition 2 may hold for $\alpha \geq 2/3$. Analogously, for $4/5 < \omega_2 < 1$, we have $\underline{\alpha} < 2/3 < \bar{\alpha}$ and propositions 2 and 4 may hold; finally, for $\omega_2 > 1$, we have $2/3 < \underline{\alpha}$ and all the parameter constellations in propositions 2, 3, and 4 are possible.

Note, however, that the ‘pro-business’ and the ‘pro-labour’ governments would implement the same low tax/transfer policy ($\gamma = 1/2$) if relocation costs were sufficiently high, i.e. $K > \max\{K^\circ, K^{\circ\circ}\}$ as in proposition 5 (ii).

Remark 4: Assume $\beta = 0$, $\alpha < 2/3$ and $K \leq \tilde{K}$. Then the ‘pro-labour’ government does not change its policy conditional upon the location of the MNE and sets $\gamma = \gamma_r(\alpha, \omega_2, K)$ in both regimes. This corresponds to the ‘pro-business’ government’s choice with relocation. To see how domestic consumers’ and producer’s welfare is affected by the outward relocation of the MNE, we can check the conditions given by expressions (30) and (32) when $\gamma_n = \gamma_r$. We obtain that both groups would favour offshoring if $|K| < \hat{K}(\alpha, \omega_2) := 3\alpha(2 - \omega_2)\Delta(\alpha, \omega_2)$. Since $\hat{K} < \underline{K}$, for all admissible values of K only consumers benefit from offshoring.

Looking at expressions (9) and (12), we observe that the negative impact of the policy variable γ on the domestic firm’s output and employment is stronger when the MNE is producing in the foreign country and that this effect is reinforced for lower α . Therefore, for low values of α the domestic producer can only benefit from the MNE’s relocation if γ is sufficiently low. For $\gamma = \gamma_r(\alpha, \omega_2, K)$ this translates into sufficiently low relocation costs, namely, $K < \hat{K}$. On the other hand, notice that if the MNE produces abroad, its output is increasing in γ . Thus, for total domestic output and consumers’ surplus to rise after relocation,

γ and thus K must be sufficiently high to offset the negative impact on the domestic firm's output, i.e. $K > -\widehat{K}$.

6.3 Equal weights

The previous sections have shown that the value of β , along with the other parameters α , ω_2 , and K , determine whether the government does or does not favour offshoring. In order to better understand the mechanism through which labour taxes and unemployment insurance benefits affect the equilibrium, we have so far restricted the analysis to polar weights, i.e. $\beta = 1$ and $\beta = 0$. The question arises as to which policy a more egalitarian government, that would to some extent reconcile efficiency and equity goals, would endorse. For this purpose, let $\Lambda_n^\beta(\gamma, \tau)$ and $\Lambda_r^\beta(\gamma, \tau)$ denote welfare without and with offshoring, respectively, for a given value of β where

$$\Lambda_n^\beta(\gamma, \tau) = \beta W_n(\gamma) + (1 - \beta)\widetilde{W}_n(\gamma, \tau)$$

and

$$\Lambda_r^\beta(\gamma, \tau) = \beta W_r(\gamma) + (1 - \beta)\widetilde{W}_r(\gamma, \tau).$$

Recall from expressions (18) and (35) that W_n and W_r correspond to the sum of domestic consumer and producer surplus and that \widetilde{W}_n and \widetilde{W}_r correspond to employed and unemployed workers' rents without and with relocation, respectively.

In order to simplify the analysis, suppose that $\beta = 1 - \beta = 1/2$. We show in the appendix that in this case the optimum levels of γ with and without offshoring are identical to the levels chosen by the 'pro-business' government. Moreover, we also show that the welfare function in the relocation regime evaluated at the optimum, $\Lambda_r(\gamma_r)$, is increasing in α and decreasing in K . To understand the forces at work, recall on the one hand from lemma 3 that in the relocation regime the government reacts to an increase in the degree of union bargaining power by setting a lower tax/transfer package which results in lower domestic wages. Consequently, not only domestic and total output but also workers' rents are increasing in α because the positive effect on employment outweighs the negative effect on employed and unemployed workers' payoffs. On the other hand, higher relocation costs strengthen the bargaining position of domestic workers to the extent that the negative effect on total and domestic firms' output dominates the positive effect on wages.

In order to assess the welfare implications of offshoring, we adopt the following strategy. We choose a set of parameter values that constitute the most favourable conditions for relocation to improve welfare and show that even under these circumstances welfare deteriorates due to relocation. Thus, we set $\alpha = 1$ and $K = \underline{K}(\alpha, \omega_2)$.²⁰ It follows that $\underline{K}(\omega_2) = (8 - 7\omega_2)\Delta$, $q_1(\omega_2) = \frac{1}{6}(1 + \omega_2)$, $q_2(\omega_2) = \frac{1}{12}(11 - 7\omega_2)$, $\omega_1(\omega_2) = \frac{1}{4}(3 + \omega_2)$, $\omega = 5/4$, $q = 1/4$. Substituting these expressions into the welfare functions, we obtain $\Lambda_r(\gamma_r) < \Lambda_n(1/2)$. Hence, the

²⁰These parameter values require that $\omega_2 \leq 11/7$ for an interior solution in equation (12).

following proposition holds.

Proposition 8: *If $\beta = 1/2$, the government optimally chooses a low tax/transfer package, $\gamma = 1/2$, so as to discourage relocation.*

In general, one can check that for β sufficiently high, the government optimally sets the lowest possible tax/transfer package in the regimes without and with offshoring, i.e. it sets $\gamma_n = 1/2$ and $\gamma_r(\alpha, \omega_2, K)$ in the respective case. Proposition 8 would also apply to that case. Indeed, offshoring improves welfare if and only if

$$\Lambda_r^\beta(\gamma_r) > \Lambda_n^\beta(1/2) \quad \text{which requires that} \\ \beta > \beta^* := \frac{1}{1 + \Pi} \quad (36)$$

where

$$\Pi := \frac{W_r(\gamma_r) - W_n(1/2)}{\widetilde{W}_n(1/2) - \widetilde{W}_r(\gamma_r)}$$

Recall from section 6.2.3 that in equilibrium $\widetilde{W}_n(1/2) > \widetilde{W}_r(\gamma_r)$. Since condition (36) can only be satisfied if $\beta^* < 1$, welfare can only increase due to offshoring if $W_r(\gamma_r) > W_n(1/2)$, that is, if the sum of domestic consumer and producer surplus rises. In fact, it follows from proposition 8 that $\beta^* > 1/2$. Thus, if sufficient weight is attached to the welfare of domestic consumers and producers, offshoring could be favoured by the government. In particular, the weight must be higher than $1/2$.

7 Concluding remarks

This paper takes a political economy approach in analysing labour taxation and redistributive policy with non-competitive labour and goods markets, assuming that firms are partly mobile. In particular, the focus of attention lies in the interaction between a foreign-owned MNE, an immobile domestic firm, a domestic labour union, and a government. We show that it may be optimal for the government to strategically induce an outward relocation of the foreign-owned firm if two conditions are fulfilled, namely, if a) the government's objective is predominantly inclined towards maximising the rents of domestic consumers and producers rather than the rents going to the labour force in the form of net wage and transfer incomes (the so-called 'pro-business' government), and if b) the MNE's incentives to relocate, as measured by the sunk offshoring costs, the domestic labour union's bargaining strength, and the foreign labour costs are sufficiently strong. Otherwise, it is optimal for the government to discourage a relocation of industrial activity by setting an accordingly lower labour tax/transfer package.

In a way, we complement Leahy and Montagna's (2000) finding that *inward* FDI may not be welfare improving when the government is limited to using

lump-sum policies, by finding circumstances under which it may be desirable to encourage *outward* FDI through labour taxation policies. In both cases the reason is to be found in the negative (positive) effect on domestic firms' profits when a competing MNE locates its plant in the domestic (foreign) country, provided that domestic labour is unionised.

From the perspective of workers, offshoring is shown to be disfavourable as workers are assumed to have no other income than wage income and the gains from offshoring are assumed to accrue to firm owners only. At first glance, it seems as if union bargaining could be a mechanism by which profits could flow to workers. However, we show that this is not attained because the union distorts competition thereby putting the domestic firm in a labour cost disadvantage. Alternatively, one could assume that the firm is at least partly owned by workers. To the extent that workers are share owners, the loss in wage income could be partly offset by the gain in capital income.

Our analysis offers a potential explanation why high labour income taxes are sustainable even if they are detrimental for the labour market as a whole: high labour taxes stimulate mobile firms to relocate to lower wage countries from which they compete in the domestic market, thereby putting pressure on the domestic labour union. As a result, domestic producers and consumers benefit.

A Appendix

A.1 Equal weights: $\beta = 1 - \beta = 1/2$

If the MNE does not offshore and the government attaches equal weights to the sum of consumer and producer surplus, on the one hand, and to the rents of workers, on the other hand, the Lagrangean function becomes

$$\begin{aligned} \Pi(\tau, \gamma, \xi, \varpi_1, \varpi_2) = & \\ & \frac{1}{2}W_n(\gamma) + \frac{1}{2}\widetilde{W}_n(\tau, \gamma) + \xi B_n(\tau, \gamma) + \varpi_1(\gamma - \frac{1}{2}) + \varpi_2(\gamma_r - \gamma) = \\ & \frac{1}{2} [3q^2(\gamma) + R_n(\gamma)] + (\xi - \frac{1}{2})B_n(\tau, \gamma) + \varpi_1(\gamma - \frac{1}{2}) + \varpi_2(\gamma_r - \gamma) \end{aligned}$$

Since the budget is increasing in τ , in equilibrium $\xi = 1/2$. As in section 6.1, it is easy to show that the equilibrium level of γ cannot exceed $1/2$. To this end, we take the first-order condition with respect to γ and suppose that $\gamma > 1/2$ so that

$$3q(\gamma)\frac{\partial q}{\partial \gamma} + \frac{1}{2}\frac{\partial R_n}{\partial \gamma} = \varpi_2 \quad (37)$$

We can rewrite this expression by substituting $\frac{\partial R_n}{\partial \gamma} = 2\frac{\partial q}{\partial \gamma}(\omega - 3q)$ which reduces the left-hand side of expression (37) to $w\frac{\partial q}{\partial \gamma} < 0$ and yet again contradicts the nonnegativity constraint on the multiplier. Thus, in equilibrium $\gamma = 1/2$.

In the regime with relocation the Lagrangean is given by

$$\begin{aligned}\Sigma(\tau, \gamma, \varsigma, o_1, o_2) = & \\ & \frac{1}{2}W_r(\gamma) + \frac{1}{2}\widetilde{W}_r(\tau, \gamma) + \varsigma B_r(\tau, \gamma) + o_1\left(\gamma - \frac{1}{2}\right) + o_2(\gamma_r - \gamma) = \\ & \frac{1}{2}\left[\frac{1}{2}[q_1(\gamma) + q_2(\gamma)]^2 + q_1^2(\gamma) + R_r(\gamma)\right] + \left(\varsigma - \frac{1}{2}\right)B_r(\tau, \gamma) \\ & + o_1\left(\gamma - \frac{1}{2}\right) + o_2(\gamma_r - \gamma)\end{aligned}$$

Again, the first-order condition with respect to τ yields $\varsigma = 1/2$. If we suppose that $\gamma > \gamma_r$, partial differentiation with respect to γ yields

$$\frac{1}{2}\left[(q_1 + q_2)\frac{\partial(q_1 + q_2)}{\partial\gamma} + 2q_1\frac{\partial q_1}{\partial\gamma} + \frac{\partial R_r}{\partial\gamma}\right] = o_2 \quad (38)$$

Notice that $\frac{\partial(q_1+q_2)}{\partial\gamma} < 0$. If we substitute $\frac{\partial R_r}{\partial\gamma} = \frac{\partial q_1}{\partial\gamma}(\omega_1 - \frac{3}{2}q_1)$ the left-hand side of equation (38) becomes negative so that in the relocation equilibrium we have that $\gamma = \gamma_r$.

A.2 Welfare impact of α and K when $\beta = 1/2$

$$\frac{\partial\Lambda_r}{\partial\alpha} = (q_1 + q_2)\frac{\partial(q_1 + q_2)}{\partial\alpha} + 2q_1\frac{\partial q_1}{\partial\alpha} + \frac{\partial q_1}{\partial\alpha}\left(\omega_1 - \frac{2}{3}q_1\right)$$

where

$$\frac{\partial q_1}{\partial\alpha} = \frac{(2 - \omega_2)}{12}\left[1 - \frac{K\Delta^{-1}}{(8 - \alpha)(2 - \omega_2)}\right] > 0$$

for $K \leq \bar{K}(\alpha, \omega_2)$ and

$$\frac{\partial(q_1 + q_2)}{\partial\alpha} = \frac{1}{2}\frac{\partial q_1}{\partial\alpha} > 0$$

Since, moreover, $\omega_1(\alpha, \omega_2, K) - \frac{2}{3}q_1(\alpha, \omega_2, K) > 0$, we have that the welfare function with relocation is increasing in α . Analogously, it can be shown that $\Lambda_r(\gamma_r)$ is decreasing in relocation costs, since

$$\frac{\partial\Lambda_r}{\partial K} = (q_1 + q_2)\frac{\partial(q_1 + q_2)}{\partial K} + \frac{\partial q_1}{\partial K}\left(2q_1 + \omega_1 - \frac{3}{2}q_1\right) < 0$$

On the other hand,

$$\frac{\partial\Lambda_n}{\partial\alpha} = \frac{\partial q}{\partial\alpha}[6q + 2(\omega - 3q)] < 0$$

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