

Relocation and Public Ownership of Firms

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Abstract

This paper studies how the structure of markets in advanced countries is affected by the relocation of domestic firms to countries where wage costs are lower. We consider that private firms compete in the product market with firms partly owned by the government (semipublic firms). Assuming a mixed duopoly, we obtain the counterintuitive result that, for a certain range of values of the parameters of the model, in equilibrium, only the semipublic firm relocates. Moreover, if only one firm changes its location, social welfare is greater if it is the semipublic firm that relocates.

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1. Introduction

The relocation of firms, which affects market structure in advanced countries, is a matter of current interest given the liberalization currently under way in world trade. This issue has been analyzed considering firms as privately owned. The objective of private firms is to maximize profits and, thus, a private firm decides to change its location if its profit can be increased by doing so. However, in many advanced countries private firms compete with firms which are partly owned by the government. These firms, referred to as semipublic, maximize the weighted average of the social welfare and their own profits (weighted welfare). Therefore, a semipublic firm relocates only if weighted welfare is thereby increased; thus, when such a firm decides whether to move it takes into account not only its own profit but also the consumer surplus, the producer surplus and the income obtained by workers. The weight of social welfare in the objective function of the semipublic firm depends on the percentage of its shares owned by the government. As a result, that percentage is a crucial factor when deciding whether to relocate. The objective of this paper is to analyze the relocation decision of domestic firms and how it affects social welfare in advanced countries when private firms compete in the product market with semipublic firms.

Although there are various factors that lead firms to move their plants, this paper focuses on relocations that seek to reduce labour costs since there is currently more and more empirical evidence that shows that firms are deciding to move to countries where wage costs are lower.¹ In advanced countries, the labour market is characterized by high levels of unionization, whereas in less advanced countries there is little or no trade union presence or wage bargaining, so labour costs are lower.

¹ For example, the European textile sector is closing factories in Europe to relocate in countries with lower wages due to the total liberalization of the textile trade that took place in 2005.

An example that illustrates the problem analyzed here is given by the automobile firm Volkswagen (VW). This firm is partly owned by the government of Lower Saxony, which holds approximately a 20 percent stake (Esser, 1998). This firm owns nine plants in Germany and one each in Belgium, Portugal and Spain. VW also owns several plants in Eastern Europe.² Reports have suggested that VW is considering closing its Brussels plant. This scaling down of the carmaker's Western European plants, followed by relocation in countries with lower labour costs, is vital to VW's future survival. It is largely inevitable that more factories in Western Europe, be they in Germany, Belgium or elsewhere, will be closed to make way for increased production in low wage countries. Such closures are vital to the survival of large European carmakers (Automotive Business Review, 7/13/2005).³

The literature studying the location decisions of firms has mainly analyzed the different factors that influence such decisions, e. g. reducing wage costs, entering foreign markets and establishing cooperation agreements between firms (see Feenstra, 1999; Mucchielli and Saucier, 1997), and how governments can influence them when all firms are privately owned (see, for example, Blomstöm and Kokko, 2003; Fumagalli 2003; Bárcena-Ruiz and Garzón, 2003*a*). These studies have been extended to analyze whether the relocation of companies is harmful to the countries out of which they move because of the resulting loss of employment when the labour force is unionized (see Lommerud et al., 2003; Leahy and Montagna, 2000). However, these papers do not analyze how firms' location decisions are affected by the existence of a semipublic firm that competes with private firms in the product market.

Most of the literature on mixed oligopoly usually considers only one country and one public firm (see for instance De Fraja and Delbono, 1989, 1990; Corneo and Jeanne, 1994; White, 1996; Willner, 2001). This literature has been extended to analyze, among other issues, how market structure is affected by the existence of a semipublic firm (see Matsumura, 1998; Bárcena-Ruiz and Garzón, 2003*b*), by the existence of international trade assuming that a

² http://www.volkswagen-environment.de/buster/buster.asp?i=_content/aktuelles_114.asp

publicly-owned firm competes with both domestic and foreign firms (see for instance Fjell and Pal, 1996; Pal and White, 1998) and by the fact that there may be several publicly-owned firms located in different countries competing with private firms (Bárcena-Ruiz and Garzón, 2005*a*, 2005*b*). However, these papers do not analyze whether firms located in advanced countries want to relocate their plants.

To fill this gap in the literature, we study how the structure of markets in advanced countries is affected by the relocation of firms and how it affects social welfare when private firms compete in the product market with firms that are jointly owned by the private and public sectors. In order to analyze this question we consider an economy made up of two firms: a private firm and a semipublic firm. Both firms have the same technology, which exhibits constant returns to scale, and they produce a homogeneous good. Labour is the only factor used in the production process, all workers are unionized and there is a separate, independent union at each firm. In order to determine the wage set at each firm we consider the monopoly-union model, which assumes that the unions set the wage while the firms choose the employment level once the wage is set by unions (see Booth, 1995). Firms are able to close their plants located in an advanced country to relocate in a country with lower wages, paying a fixed cost. In the latter country the wage costs are lower because workers are not unionized.

We obtain that when the fixed cost of relocating the firm is low (high) enough both (neither) of them relocate(s). When the fixed cost takes an intermediate value and the government owns a low enough percentage of the shares in the semipublic firm only one firm moves and there are two equilibria: in one of them the semipublic firm relocates and in the other the private firm. Finally, for the remaining parameters values only the semipublic firm changes its location. This last result is counterintuitive since it does so in spite of the fact that it cares about the utility of

³ http://www.automotive-business-review.com/article_feature.asp?guid=8F99CB05-C9B8-4FCE-9AAE-31619EAF7C11

domestic workers.⁴ The explanation of this result is the following. When a firm relocates, it reduces its production cost and increases its output level; as a result, market competition increases. If the private firm does not relocate the semipublic firm does, because the increases in consumer surplus and in its own profit (due to the increase in its output) offset the lower utility of domestic workers, the lower profit of the private firm and the cost of relocation. On the other hand, if the semipublic firm moves, the private firm does not, because market competition would be excessively high, which harms its profit.

We also obtain that if only one firm relocates, social welfare is greater if that firm is the semipublic firm. In that case, the greater consumer and producer surpluses offset the lower union utility compared with the case in which only the private firm relocates. Finally, at least as many firms relocate when the relocation decision is taken by firms themselves as when it is taken by an agent whose objective is social welfare. This is because the private firm does not take into account the utility of the workers and the profit of the firm that remains in the country when it decides whether to relocate. Moreover, the semipublic firm maximizes weighted welfare rather than social welfare.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 studies the decision by firms as to whether or not to relocate. Section 4 analyzes whether the decision taken by firms reduces social welfare. Conclusions are drawn in Section 5.

2. The model

⁴ A possible extension of the paper is to consider that there are two countries and two multiproduct firms: one firm is private and the other one is semipublic. Each multiproduct firm owns two plants, one located in each country, that produce substitute goods. Each firm is owned by investors from one of the countries. The firms can relocate their plants to a third country where wage costs are lower. In this context the semipublic firm prefers to relocate the plant located in the foreign country rather than the one located in its own country.

We consider an economy made up of two firms producing a homogeneous good: one firm is jointly owned by the public and private sectors, and the other firm is private. They are denoted by 0 and 1, respectively.⁵ Inverse demand function is given by:

$$p = a - q_0 - q_1,$$

where p is the price of the good and q_i is the amount of the good produced by firm i , $i=0, 1$.

We assume that labour is the only factor used in the production process. Firm i hires L_i workers with a uniform wage rate w_i . Both firms have the same technology and exhibit constant returns to scale such that $q_i = L_i$. All workers in each firm are unionized and there is a separate independent union at each firm. Unions and firms are both risk neutral. In order to determine the wage set at each firm, we consider the monopoly-union model, which assumes that the unions set the wage while the firms choose the employment level once the wage is set by unions (see Booth, 1995). The utility function of the union at firm i is its wage bill: $U_i(w_i, L_i) = w_i L_i$, $i=0, 1$.

We assume that when a firm relocates it closes its production plant and sets up a new one in a country where wage costs are lower because since its workers are not unionized. In order to simplify the analysis, and with no loss of generality, we assume that the wage paid in that country is normalized to zero. The firm has to pay a fixed cost F to relocate its production plant. Thus, given that labour is the only factor used by each firm, the profit of firm i is given by:

⁵ Bös (1986, p. 231) points out that when publicly-owned and private firms exist in an economy, “Partial analysis must be centred on duopolistic or oligopolistic structures where one of the participants is a public enterprise. The great advantage of such an analysis is that it reveals the whole range of possible outcomes as depending on the different possible reactions of the economic agents considered”.

$$p_i = (a - q_i - q_j - w_i) q_i - F_i, \quad i = 1, j = 0, 1, \quad (2)$$

where $F_i = F$ and $w_i = 0$ if firm i relocates and, $F_i = 0$ and w_i is positive if firm i remains in its present country.

As usual, social welfare comprises the consumer surplus, CS , the producer surplus, PS , and the rents obtained by the workers, U . Specifically, we assume the following social welfare function:

$$W = CS + PS + U, \quad (3)$$

where $CS = (q_0 + q_1)^2/2$, $PS = p_0 + p_1$ and $U = U_0 + U_1$. Union rents are included as that part of the producer surplus which is absorbed by the unions.⁶ We assume that the semipublic firm is jointly owned by the public sector and private domestic shareholders. The private firm is owned by domestic shareholders. Thus, even if the private and the semipublic firms relocate, their profits are included as a part of the social welfare of this economy.

The private firm chooses the output level, q_1 , that maximizes its profit given by (2) for $i=1$ and $j=0$. We assume that the government owns a percent of the shares in the semipublic firm, where $a \in (0, 1)$. Following Matsumura (1998) we consider that a semipublic firm maximizes the weighted average of the payoff of the government and its own profit (denoted as weighted welfare). Therefore, the semipublic firm chooses the output level q_0 that maximizes:

$$V = a W + (1 - a) p_0, \quad (4)$$

where p_0 is given by (2), for $i = 0$ and $j = 1$, and W is given by (3).

⁶ This is usual in literature. See, for example, Brander and Spencer (1988), Mezzetti and Dinopoulos (1991), Bughin and Vanini (1995), Ulph (1996) and Naylor (1998).

The objective of this paper is to study the firms' decision as to whether to relocate when a private firm competes with a semipublic firm in the product market. To that end we propose a three stage game with the following timing. In the first stage, firms decide simultaneously whether or not to relocate. In the second stage, unions set wages simultaneously. Finally, in the third stage, firms simultaneously choose their output and employment levels. We solve the game by backward induction from the last stage of the game to obtain a subgame perfect Nash Equilibrium.

3. Results

Given that we have a private firm and a semipublic firm that can relocate their productive plants, there are four subgames to be analyzed: neither firm relocates (denoted by NN), only the semipublic firm relocates (denoted by RN), only the private firm relocates (denoted by NR), and both firms relocate (denoted by RR). Next, we solve the second and third stages of the game when neither firm relocates.

3.1. Neither firm relocates

In the third stage, the private firm chooses the value of q_1 that maximizes its profit given by (2), for $i=1, j=0$ and $F_1 = 0$. The semipublic firm chooses the value of q_0 that maximizes weighted welfare given by (4) where $F_0 = 0$. From the first order conditions of these maximization problems we obtain the output and employment levels as a function of wage rates:

$$q_0(w_0, w_1) = L_0(w_0, w_1) = \frac{a + w_1 - 2w_0(1-a)}{3-2a},$$

$$q_1(w_0, w_1) = L_1(w_0, w_1) = \frac{(a + w_0)(1-a) - w_1(2-a)}{3-2a}.$$
(5)

It is easy to see that the output and employment of the semipublic (private) firm increase (decrease) with \mathbf{a} . This is because as \mathbf{a} increases, the weight of social welfare (and, thus, the consumer surplus) in the objective function of the semipublic firm becomes greater.

In the second stage, given (5), the union at firm i sets the wage, w_i , that maximizes union rents, $U_i(w_i, w_j) = w_i L_i(w_i, w_j)$, $i \neq j$, $i, j = 0, 1$. Solving these problems we obtain the following result.

Lemma 1. *When neither firm relocates, the wage, output and employment levels, the profit of each firm, the utility of workers, the consumer surplus, social welfare and weighted welfare are:*

$$\begin{aligned}
w_0^{NN} &= \frac{a(5-3\mathbf{a})}{(15-8\mathbf{a})(1-\mathbf{a})}, \quad w_1^{NN} = \frac{a(5-4\mathbf{a})}{15-8\mathbf{a}}, \quad q_0^{NN} = L_0^{NN} = \frac{2a(5-3\mathbf{a})}{(3-2\mathbf{a})(15-8\mathbf{a})}, \\
q_1^{NN} = L_1^{NN} &= \frac{a(2-\mathbf{a})(5-4\mathbf{a})}{(3-2\mathbf{a})(15-8\mathbf{a})}, \quad p_0^{NN} = \frac{2a^2(5-3\mathbf{a})^2(2-\mathbf{a}(7-4\mathbf{a}))}{(3-2\mathbf{a})^2(15-8\mathbf{a})^2(1-\mathbf{a})}, \\
p_1^{NN} &= \frac{a^2(5-4\mathbf{a})^2(2-\mathbf{a})^2}{(3-2\mathbf{a})^2(15-8\mathbf{a})^2}, \quad U_0^{NN} = \frac{2a^2(5-3\mathbf{a})^2}{(3-2\mathbf{a})(15-8\mathbf{a})^2(1-\mathbf{a})}, \\
U_1^{NN} &= \frac{a^2(5-4\mathbf{a})^2(2-\mathbf{a})}{(3-2\mathbf{a})(15-8\mathbf{a})^2}, \quad CS^{NN} = \frac{a^2(20-\mathbf{a}(19-4\mathbf{a}))^2}{2(3-2\mathbf{a})^2(15-8\mathbf{a})^2}, \\
W^{NN} &= \frac{a^2(7-4\mathbf{a})(10-7\mathbf{a})(20-\mathbf{a}(19-4\mathbf{a}))}{2(3-2\mathbf{a})^2(15-8\mathbf{a})^2}, \\
V^{NN} &= \frac{a^2(2-\mathbf{a})(100+\mathbf{a}(280-\mathbf{a}(759-8\mathbf{a}(65-14\mathbf{a}))))}{2(3-2\mathbf{a})^2(15-8\mathbf{a})^2}.
\end{aligned}$$

It can be shown that the output levels and the wages paid at both firms are positive since $\hat{\mathbf{I}} \in (0, 1)$. On the other hand, as only the semipublic firm takes the consumer surplus into account it produces more and hires more labour than the private firm ($L_0^{NN} > L_1^{NN}$). This permits the union at the semipublic firm to set a higher wage ($w_0^{NN} > w_1^{NN}$) and obtain a greater utility ($U_0^{NN} > U_1^{NN}$).

Next, we solve the second and third stages of the game when only the private firm relocates.

3.2. Only the private firm relocates

In the third stage of the game the semipublic firm chooses the value of q_0 that maximizes weighted welfare given by (4) and the private firm chooses the value of q_1 that maximizes its profit given by (2), for $i=1$ and $j=0$, where $w_1=0$, $F_0 = 0$ and $F_1 = F$. From the first order conditions of these maximization problems we obtain that the output and employment levels as a function of wage rates are given by (5), where $w_1=0$.

In the second stage, given the output and employment levels as a function of wage rates, the union at the semipublic firm sets the wage, w_0 , that maximizes union rents, U_0 . Solving this problem we obtain the following result.

Lemma 2. *When only the private firm relocates, the wage, output and employment levels, the profit of each firm, the utility of workers, the consumer surplus, social welfare and weighted welfare are:*

$$w_0^{NR} = \frac{a}{4(1-a)}, w_1^{NR} = 0, q_0^{NR} = L_0^{NR} = \frac{a}{2(3-2a)}, q_1^{NR} = \frac{a(5-4a)}{4(3-2a)},$$

$$p_0^{NR} = \frac{a^2(2-a(7-4a))}{8(3-2a)^2(1-a)}, p_1^{NR} = \frac{a^2(5-4a)^2}{16(3-2a)^2} - F, U_0^{NR} = \frac{a^2}{8(3-2a)(1-a)},$$

$$U_1^{NR} = 0, CS^{NR} = \frac{a^2(7-4a)^2}{32(3-2a)^2}, W^{NR} = \frac{a^2(7-4a)(17-12a)}{32(3-2a)^2} - F,$$

$$V^{NR} = \frac{a^2(8+a(7-4a)(13-12a))}{32(3-2a)^2} - aF.$$

Next, we solve the second and third stages of the game when only the semipublic firm relocates.

3.3 Only the semipublic firm relocates

In the third stage of the game the semipublic firm chooses the value of q_0 that maximizes weighted welfare given by (4) and the private firm chooses the value of q_1 that maximizes its profit given by (2), for $i=1$ and $j=0$, where $w_0=0$, $F_0 = F$ and $F_1 = 0$. From the first order conditions of this maximization problem we obtain that the output and employment levels as a function of wage rates are given by (5), where $w_0=0$.

In the second stage, given the output and employment levels as a function of wage rates, the union at the private firm sets the wage, w_1 , that maximizes union rents, U_1 . Solving this problem we obtain the following result.

Lemma 3. *When only the semipublic firm relocates, the wage, output and employment levels, the profit of each firm, the utility of workers, the consumer surplus, social welfare and weighted welfare are:*

$$w_0^{RN} = 0, w_1^{RN} = \frac{a(1-a)}{2(2-a)}, q_0^{RN} = \frac{a(5-3a)}{2(3-2a)(2-a)}, q_1^{RN} = L_1^{RN} = \frac{a(1-a)}{2(3-2a)},$$

$$p_0^{RN} = \frac{a^2(5-3a)^2(1-a)}{4(3-2a)^2(2-a)^2} - F, p_1^{RN} = \frac{a^2(1-a)^2}{4(3-2a)^2}, U_0^{RN} = 0, U_1^{RN} = \frac{a^2(1-a)^2}{4(2-a)(3-2a)},$$

$$CS^{RN} = \frac{a^2(7-a(6-a))^2}{8(3-2a)^2(2-a)^2}, W^{RN} = \frac{a^2(7-a(6-a))(17-a(22-7a))}{8(3-2a)^2(2-a)^2} - F,$$

$$V^{RN} = \frac{a^2(25-a(8+a(38-a(32-7a))))}{8(3-2a)^2(2-a)} - F.$$

Next, we solve the second and third stages of the game when both firms relocate.

3.4 Both firms relocate

In the third stage of the game the semipublic firm chooses the value of q_0 that maximizes weighted welfare given by (4) and the private firm chooses the value of q_1 that maximizes its profit given by (2), for $i=1$ and $j=0$, where $w_0=0$, $w_1=0$, $F_0=F$ and $F_1=F$.⁷ From the first order conditions of these maximization problems we obtain the following result.

Lemma 4. *When the private and the semipublic firms relocate, the wage, output and employment levels, the profit of each firm, the utility of workers, the consumer surplus, social welfare and weighted welfare are:*

$$w_0^{RR} = w_1^{RR} = 0, q_0^{RR} = \frac{a}{3-2a}, q_1^{RR} = \frac{a(1-a)}{3-2a}, p_0^{RR} = p_1^{RR} = \frac{a^2(1-a)^2}{(3-2a)^2} - F,$$

$$U_0^{RR} = U_1^{RR} = 0, CS^{RR} = \frac{a^2(2-a)^2}{2(3-2a)^2}, W^{RR} = \frac{a^2(2-a)(4-3a)}{2(3-2a)^2} - 2F,$$

$$V^{RR} = \frac{a^2(2+a(2-a)(2-3a))}{2(3-2a)^2} - (1+a)F.$$

Once the second and third stages of the game have been analyzed in all four subgames, it remains to solve the first stage of the game.

3.5 Firms' decisions as to whether or not to relocate

In this section we study whether firms want to relocate their plants to a country where wage costs are lower. Taking into account lemmas 1 to 4 the following result is obtained. F_1 denotes the value of F such that $p_1^{RN} = p_1^{RR}$, F_2 denotes the value of F such that $p_1^{NR} = p_1^{NN}$, F_3 denotes the value of F such that $V^{NR} = V^{RR}$ and, finally, F_4 denotes the value of F such that $V^{RN} = V^{NN}$. It can be shown that $F_2 = F_3$ if and only if $a = a^*$. The values of F_i ($i=1, 2, 3, 4$) and a^* are relegated to Appendix 1.

⁷ In the second stage of this subgame there is no wage bargaining since both firms move to a country where wage costs are lower and, thus, $w_0=w_1=0$.

Proposition 1. *Both firms relocate if $F \leq F_1$. Neither firm relocates if $F \geq F_4$. There are two equilibria if $F_2 \leq F \leq F_3$: in one of them only the semipublic firm relocates, and in the other, only the private firm. For the remaining values of parameter F , only the semipublic firm relocates.*

Proof. See Appendix 1.

The result shown in Proposition 1 is illustrated in Figure 1. When \mathbf{a} increases, market competition is greater and the private firm finds relocation less attractive. Therefore, the private firm moves for lower values of parameter F , which means that F_1 and F_2 decrease with \mathbf{a} . Moreover, if \mathbf{a} rises, weighted welfare V is greater if the semipublic firm relocates than if it does not, because of the greater weight of the consumer surplus. Therefore, if \mathbf{a} increases the semipublic firm finds relocation more attractive and moves for greater values of parameter F . As a result, F_3 and F_4 increase with \mathbf{a} .

[INSERT FIGURE 1 AROUND HERE]

If relocation of the private firm to a country with lower wages does not require any investment (i.e. if $F=0$), then $\mathbf{p}_1^{RR} > \mathbf{p}_1^{RN}$ and $\mathbf{p}_1^{NR} > \mathbf{p}_1^{NN}$. This means that the private firm relocates regardless of what the semipublic firm decides. The relocation of the private firm reduces the wages that it pays, and consequently its production costs, and increases its market share, which in turn increases its profits. On the other hand, if $F=0$, then $V^{RR} > V^{NR}$ and $V^{RN} > V^{NN}$, which means that the semipublic firm relocates regardless of whether or not the private firm does so. When the semipublic firm relocates the output of industry and, thus, the consumer surplus rises ($CS^{RR} > CS^{NR}$ and $CS^{RN} > CS^{NN}$). The utility obtained by domestic workers decreases ($U^{RR} < U^{NR}$ and $U^{RN} < U^{NN}$) since domestic employment and wages are lower. Moreover, $\mathbf{p}_1^{Ri} < \mathbf{p}_1^{Ni}$, and $\mathbf{p}_0^{Ri} > \mathbf{p}_0^{Ni}$, $i=N, R$. As the increases in the consumer

surplus and the profit of the semipublic firm offset the reductions in the utility of domestic workers and the profit of the private firm, weighted welfare is greater if the semipublic firm relocates. Therefore, if relocating a firm does not entail any costs, both firms have a positive incentive to relocate. By contrast, the fixed cost F is a negative incentive to relocation.

When the fixed cost, F , is low enough ($F \leq F_1$) the positive incentive to relocate is stronger than the negative one in both firms and, thus, they both relocate. When F is high enough ($F \geq F_4$) neither firm relocates since the negative incentive to relocate is stronger than the positive one in both firms.

When F takes an intermediate value and \mathbf{a} is low enough ($F_2 \leq F \leq F_3$), only one firm relocates and there are two equilibria: in one the semipublic firm relocates, and in the other the private firm (see Figure 1). In this case, as F takes an intermediate value, the positive effect outweighs the negative one only in one of the firms. Therefore, if one firm relocates, the other firm does not find it profitable to follow suit. This happens only if \mathbf{a} is low enough ($\mathbf{a} < \mathbf{a}^*$). As \mathbf{a} increases the weight of social welfare in the objective function of the semipublic firm rises, and its production and market competition are thus greater. As a result, the private firm finds relocation less attractive and the critical level of F for which the private firm wants to relocate is lower. On the other hand, as \mathbf{a} increases, the weight of the consumer surplus in the objective function of the semipublic firm is greater and, thus, weighted welfare increases more if the semipublic firm relocates than if it does not. This means that the semipublic firm finds relocation more attractive and relocates for greater values of F . As a result, as \mathbf{a} increases, the range of values of parameters for which there are two equilibria decreases, and the two equilibria only exist if $\mathbf{a} < \mathbf{a}^*$.

For the remainder of the values of F only the semipublic firm relocates (see Figure 1). In this case, if the semipublic firm relocates, the private firm does not follow suit since competition in the product market would be excessively high, which harms its profit. As a result, the private firm does not find it profitable to pay the relocation cost. If the private firm does not relocate

the semipublic firm does, since the increases in consumer surplus and in its own profit offset the lower utility of domestic workers, the lower profit of the private firm and the cost of relocation. As a result, only the semipublic firm relocates. It should be noted that as α increases the range of parameter values for which only the semipublic firm relocates increases since the weight of the consumer surplus in the objective function of the semipublic firm becomes greater.

4. Does the relocation of firms reduce social welfare?

Next we analyze whether the relocation of the firms reduces social welfare. We compare first the social welfare obtained if only the private firm moves with that obtained if only the semipublic firm does.

Proposition 2. *When only one firm changes its location, social welfare is greater if it is the semipublic firm that relocates.*

This proposition shows that when only one firm relocates, the government prefers it to be the semipublic firm rather than the private firm ($W^{RN} > W^{NR}$). Given that only the semipublic firm takes the consumer surplus into account, the increase in the output of industry is greater if this firm is the one that moves. As the consumer surplus increases with the output of industry CS^{RN} is greater than CS^{NR} . The producer surplus is greater if it is the semipublic firm that relocates ($PS^{RN} > PS^{NR}$) since the greater output produced by the semipublic firm with lower costs generates a greater producer surplus. On the other hand, the utility of domestic workers is greater if it is the private firm that relocates ($U^{NR} > U^{RN}$) since in this case the production of the firm that remains in the country is greater and it pays more wages. The greater consumer and producer surpluses obtained when only the semipublic firm relocates offset the lower union utility compared with the case in which only the private firm relocates, which means that social welfare is greater in the first case ($W^{RN} > W^{NR}$). Therefore, when only one firm moves, the government prefers it to be the semipublic firm.

Given that social welfare is not maximized when the private firm relocates, we next compare social welfare in the remaining cases. This comparison gives rise to the following result. Let F_{w1} and F_{w2} denote the values of F such that $W^{RN} = W^{RR}$ and $W^{NN} = W^{RN}$, respectively. The values of F_{wi} ($i=1, 2$) are relegated to Appendix 2.

Proposition 3. *Social welfare is maximised when both firms relocate if $F \leq F_{w1}$, when neither firm relocates if $F \geq F_{w2}$ and when the semipublic firm relocates if $F_{w2} > F > F_{w1}$.*

Proof. See Appendix 2.

Proposition 3 is illustrated in Figure 2. In this figure, we denote the preference of the government by the superscript W .

[INSERT FIGURE 2 AROUND HERE]

This proposition shows that for a given \mathbf{a} the government prefers neither firm to relocate if parameter F is great enough ($F \geq F_{w2}$) since the cost of moving the firms is high enough. If parameter F decreases (when $F_{w2} > F > F_{w1}$), it is worthwhile for one firm to relocate from a social welfare point of view. We have seen in proposition 2 that when only one firm relocates, social welfare is greater if it is the semipublic firm. On the other hand, in this zone $CS^{RN} > CS^{NN}$, $PS^{RN} > PS^{NN}$ and $U^{RN} < U^{NN}$, and it can be shown that the greater consumer and producer surpluses offset the lower utility of unions. Therefore, if the semipublic firm relocates social welfare is greater than if neither firm relocates. Finally, if parameter F is low enough ($F \leq F_{w1}$) the greatest social welfare is obtained when both firms relocate.

Next we compare firms' decision whether to relocate as shown in proposition 1 with that taken from a social welfare point of view, shown in proposition 3. From this comparison we obtain the following result.

Proposition 4 *At least as many firms relocate when the decision is taken by firms as when it is taken considering social welfare.*

Proof. See Appendix 3.

This proposition is illustrated in figure 3. Proposition 4 states that at least as many firms relocate to a country with lower wage costs if the decision is taken by an agent whose objective is social welfare as if it is taken by the firms themselves.

[INSERT FIGURE 3 AROUND HERE]

When $F \leq F_{w1}$, both firms relocate and this maximizes social welfare. When $F_4 \leq F$, neither firm relocates and this maximizes social welfare. When $F_1 \leq F \leq F_{w2}$, only the semipublic firm relocates and this maximizes social welfare. In these three cases, the decision taken by firms is driven by efficiency reasons and, thus, coincides with that preferred by the government.

When $F_{w2} \leq F \leq F_1$, both firms relocate when it is socially optimal for neither firm to do so. When $F_{w1} < F < \text{Min}\{F_{w2}, F_1\}$, both firms relocate when it is socially optimal for only the semipublic firm to do so. When $F_3 \leq F \leq F_2$, only one firm relocates when it is socially optimal for neither firm to do so. Finally, for the remaining values of parameter F , only the semipublic firm relocates when it is socially optimal for neither firm to do so. These results are due to the fact that the utility of the workers and the profit of the firm that remains in the original country (if any) has greater weight in social welfare than in the objective function of the semipublic firm and decreases in case of relocation. On the other hand, the private firm only considers its profit when it decides whether to relocate.

5. Conclusions

The literature studying firms' decisions as to whether to relocate does not analyze how those decisions are affected by the existence of a semipublic firm that competes with private firms in the product market. On the other hand, the literature on mixed oligopoly does not analyze whether firms located in advanced countries want to relocate their plants. To fill this gap, we analyze how the structure of markets in advanced countries and social welfare is affected by the relocation of domestic firms when there is a firm partially owned by the government that competes with a private firm.

The objective of private firms is to maximize profits and, thus, a private firm decides to relocate if its profit is increased thereby. The objective function of a semipublic firm is the weighted average of the social welfare and its own profit since the government owns a percentage of its shares. Therefore, a semipublic firm decides to relocate only if the weighted welfare increases. Unlike the private firms, when a semipublic firm decides whether to relocate it takes into account not only its profit but also the consumer and producer surpluses and the utility of workers. The weight of social welfare in the objective function of the semipublic firm depends on the percentage owned by the government, so it is a crucial factor when such a firm has to decide whether to relocate.

We obtain that when the fixed cost of relocating is low (high) enough both (neither) of the firms relocate(s). When the fixed cost takes an intermediate value and the government owns a low enough percentage of the shares in the semipublic firm only one firm relocates and there are two equilibria: in one the semipublic firm relocates, and in the other the private firm. Finally, for the remaining parameter values only the semipublic firm relocates. We also obtain that for the range of parameter values such that only one firm relocates, social welfare is greater if it is the semipublic firm. Moreover, at least as many firms relocate when the decision is taken by firms themselves as when it is taken considering social welfare.

One possible extension of the paper is to consider two countries and one firm located in each country. These firms produce a homogeneous good and consumers in both countries can buy the product independently of the location of the firms. Each firm is owned by the investors of the country in which it is located and decides whether to relocate its production plant to a country with lower wages, paying a fixed cost. In this context, the main results of the paper hold.

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Appendix 1

From lemmas 1 to 4, the following results are obtained:

i) $\mathbf{p}_1^{RR} > \mathbf{p}_1^{RN}$ if and only if $F < F_1$ and $\mathbf{p}_1^{NR} > \mathbf{p}_1^{NN}$ if and only if $F < F_2$, $F_1 < F_2$, where

$$F_1 = \frac{3a^2(1-a)^2}{4(3-2a)^2} \text{ and } F_2 = \frac{a^2(5-4a)^2(7-4a)(23-12a)}{16(15-8a)^2(3-2a)^2}.$$

ii) $V^{RR} > V^{NR}$ if and only if $F < F_3$ and $V^{RN} > V^{NN}$ if and only if $F < F_4$, $F_3 < F_4$, where

$$F_3 = \frac{a^2(24-27a+8a^2)}{32(3-2a)^2} \text{ and } F_4 = \frac{a^2(5-3a)^2(161-234a+109a^2-16a^3)}{8(2-a)(15-8a)^2(3-2a)^2}.$$

From (i) and (ii), the result shown in Proposition 1 and illustrated in Figure 1 is obtained. In order to plot Figure 1, it is necessary to show that F_1 and F_2 decrease with \mathbf{a} , while F_3 and F_4 increase with \mathbf{a} (note that $0 < \mathbf{a} < 1$):

$$\frac{\partial F_1}{\partial \mathbf{a}} = -\frac{3a^2(1-a)}{2(3-2a)^3} < 0, \quad \frac{\partial F_2}{\partial \mathbf{a}} = -\frac{a^2(5-4a)(2655-4400a+2432a^2-448a^3)}{4(3-2a)^3(15-8a)^3} < 0,$$

$$\frac{\partial F_3}{\partial \mathbf{a}} = \frac{3a^2(5-2\mathbf{a})}{32(3-2\mathbf{a})^3} > 0,$$

$$\frac{\partial F_4}{\partial \mathbf{a}} = \frac{a^2(5-3\mathbf{a})(17865-50435\mathbf{a}+57233\mathbf{a}^2-32621\mathbf{a}^3+9334\mathbf{a}^4-1072\mathbf{a}^5)}{8(2-\mathbf{a})^2(3-2\mathbf{a})^3(15-8\mathbf{a})^3} < 0.$$

On the other hand, it can be shown that $F_4 > F_2$ for all $\mathbf{a} > 0$ and $F_4 = F_2$ for $\mathbf{a} = 0$, $F_3 > F_1$ for all $\mathbf{a} > 0$ and $F_3 = F_1$ for $\mathbf{a} = 0$. Finally, $F_3 < F_2$ if and only if $\mathbf{a} < \mathbf{a}^*$, where \mathbf{a}^* is the value of parameter \mathbf{a} , such that: $2650 - 9845\mathbf{a} + 11816\mathbf{a}^2 - 5824\mathbf{a}^3 + 1024\mathbf{a}^4 = 0$. It is easy to prove that $(2650 - 9845\mathbf{a} + 11816\mathbf{a}^2 - 5824\mathbf{a}^3 + 1024\mathbf{a}^4)$ is strictly convex in \mathbf{a} , takes value 2650 when $\mathbf{a} = 0$, and tends to -179 when \mathbf{a} tends to 1. Therefore, there exists a unique value of $\mathbf{a} \in (0, 1)$, denoted as \mathbf{a}^* , such that the above expression is equal to 0. It can be shown that $\mathbf{a}^* \approx 0.5095$.

Appendix 2

From lemmas 1 to 4, the following results are obtained:

$$i) W^{RN} - W^{RR} = \frac{-a^2(1-\mathbf{a})^3(9-5\mathbf{a})}{8(3-2\mathbf{a})^2(2-\mathbf{a})^2} + F > 0 \text{ if and only if } F > F_{w1}.$$

$$ii) W^{NN} - W^{RN} = \frac{-a^2(5-3\mathbf{a})^3(35-49\mathbf{a}+16\mathbf{a}^2)}{8(15-8\mathbf{a})^2(3-2\mathbf{a})^2(2-\mathbf{a})^2} + F > 0 \text{ if and only if } F > F_{w2}.$$

$$iii) W^{NN} - W^{RR} = \frac{-2a^2(5-6\mathbf{a}+2\mathbf{a}^2)(20-29\mathbf{a}+10\mathbf{a}^2)}{(15-8\mathbf{a})^2(3-2\mathbf{a})^2} + 2F > 0 \text{ if and only if } F > F_{w3}.$$

$$iv) W^{NR} - W^{RR} = \frac{-a^2(9-8\mathbf{a})}{32(3-2\mathbf{a})^2} + F > 0 \text{ if and only if } F > F_{w4}.$$

$$v) W^{NN} - W^{NR} = \frac{-5a^2(7-4\mathbf{a})(5-4\mathbf{a})^3}{32(15-8\mathbf{a})^2(3-2\mathbf{a})^2} + F > 0 \text{ if and only if } F > F_{w5}.$$

$$vi) W^{NR} - W^{RN} = \frac{-a^2\mathbf{a}(20-29\mathbf{a}+10\mathbf{a}^2)}{32(2-\mathbf{a})^2(3-2\mathbf{a})} < 0.$$

$$\text{Where: } F_{w1} = \frac{a^2(1-a)^3(9-5a)}{8(3-2a)^2(2-a)^2}, \quad F_{w2} = \frac{a^2(5-3a)^3(35-49a+16a^2)}{8(15-8a)^2(3-2a)^2(2-a)^2}, \quad F_{w3} = \frac{a^2(5-6a+2a^2)(20-29a+10a^2)}{(15-8a)^2(3-2a)^2},$$

$$F_{w4} = \frac{a^2(9-8a)}{32(3-2a)^2}, \quad F_{w5} = \frac{5a^2(7-4a)(5-4a)^3}{32(15-8a)^2(3-2a)^2}.$$

Comparing the values of F_{wi} , we obtain that: (i) $F_{w2} > \max\{F_{w5}, F_{w3}, F_{w4}\} > F_{w1}$; (ii) if $a < a^{***}$, then $F_{w5} > F_{w3} > F_{w4}$; if $a > a^{***}$, then $F_{w4} > F_{w3} > F_{w5}$; if $a = a^{***}$, then $F_{w5} = F_{w3} = F_{w4}$. Where a^{***} is the value of parameter a , such that: $1175 - 4520a + 5952a^2 - 3264a^3 + 640a^4 = 0$. It is easy to prove that $(1175 - 4520a + 5952a^2 - 3264a^3 + 640a^4)$ is strictly convex in a , and that it takes value 1175 when $a=0$, and tends to -17 when a tends to 1. Therefore, there exists a unique value of $a \in (0, 1)$, denoted as a^{***} , such that the above expression is equal to 0. It can be shown that $a^{***} \sim 0.5601$.

Comparing the social welfare obtained in the different cases the following is obtained: (i) if $F > F_{w2}$, then $W^{NN} > W^{RN} > W^{NR} > W^{RR}$; (ii) if $F_{w2} > F > \max\{F_{w5}, F_{w4}\}$, then $W^{RN} > W^{NN} > W^{NR} > W^{RR}$; (iii) if $F_{w5} > F > F_{w3}$, then $W^{RN} > W^{NR} > W^{NN} > W^{RR}$; (iv) if $F_{w3} > F > F_{w4}$, then $W^{RN} > W^{NR} > W^{RR} > W^{NN}$; (v) if $F_{w4} > F > F_{w3}$, then $W^{RN} > W^{NN} > W^{RR} > W^{NR}$; (vi) if $F_{w3} > F > F_{w5}$, then $W^{RN} > W^{RR} > W^{NN} > W^{NR}$; (vii) if $\min\{F_{w5}, F_{w4}\} > F > F_{w1}$, then $W^{RN} > W^{RR} > W^{NR} > W^{NN}$; (viii) if $F < F_{w1}$, then $W^{RR} > W^{RN} > W^{NR} > W^{NN}$.

Appendix 3

It can be shown that $F_1 > F_{w1}$, $F_{w2} < \min\{F_2, F_3\}$, and that $F_1 > F_{w2}$ if and only if and $a < a^{**} \in (0, 1)$, $a^{**} < a^*$, where a^{**} is the value of parameter a , such that: $1025 + a(-7960 + a(18616 + 3a(-6756 + a(3833 + 16a(-69 + 8a)))) = 0$. It can be shown that $a^{**} \sim 0.2132$.

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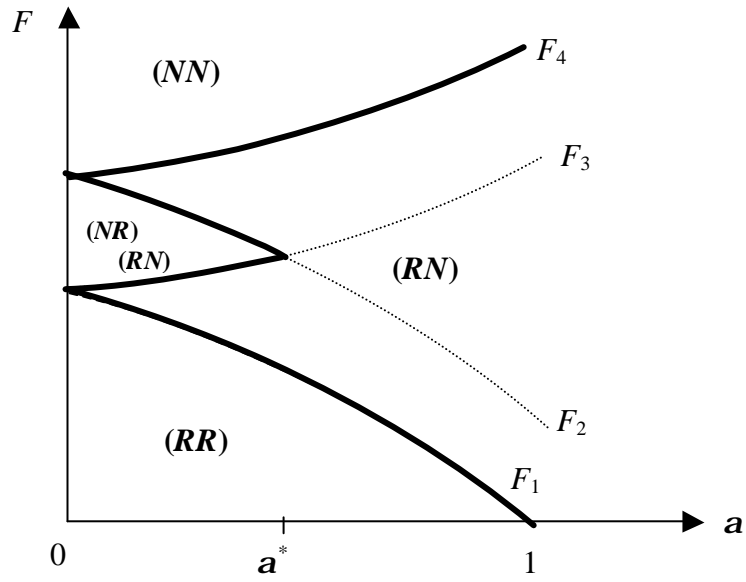


Figure 1. Illustration of Proposition 1

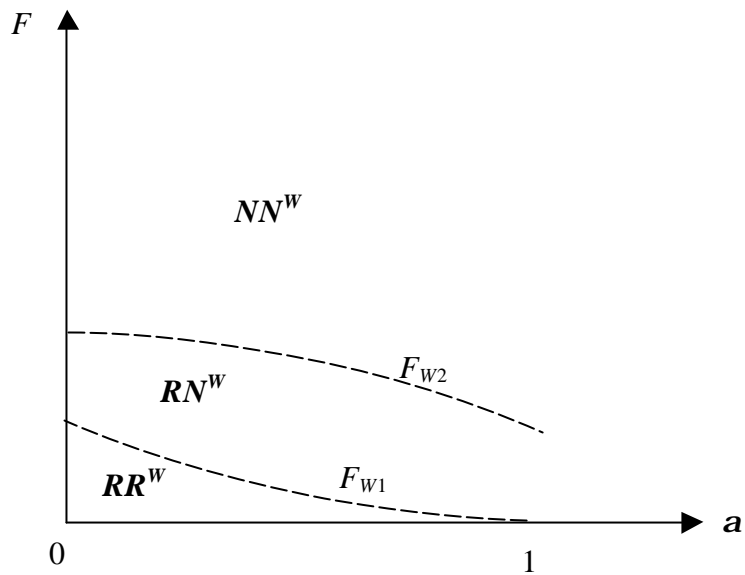


Figure 2. Illustration of Proposition 3

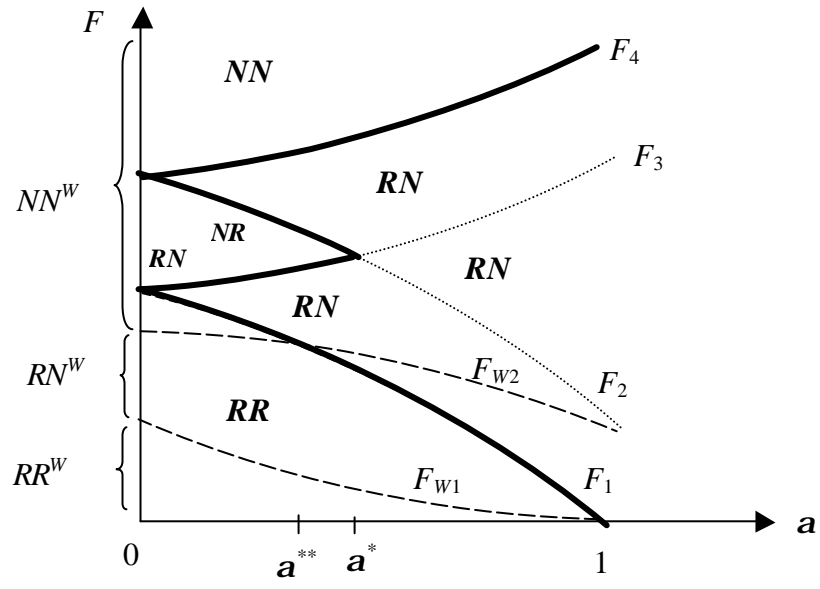


Figure 3. Illustration of Proposition 4