

## Mergers between local public firms \*

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### Abstract

We consider a country made up of two regions, where each region owns a local public firm and a domestic private one. A national authority decides whether or not to merge the two local public firms. The result depends on whether the goods produced by the firms are homogeneous, substitutes or complements. We find that if the two local public firms produce the same good, the national authority is indifferent as to whether to merge or not. When local public firms produce different goods two cases arise. First, if the firms in each region produce homogeneous goods the national authority merges the two local public firms when the goods are complements, independent in demand and weak substitutes. Second, if the firms in each region produce heterogeneous goods the national authority merges the two local public firms only when the goods are close complements. Therefore, there is greater scope for mergers in the former case than in the later.

*Keywords:* merger, state corporation, multiproduct firms, mixed oligopoly.

*JEL classification:* G34, L32, L22.

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## 1. Introduction

There is ample evidence of mergers between public and private firms, and in those mergers public firms play an important role. Maksimovic et al. (2013) use plant-level data on a sample of approximately 40,000 firms over the 1977 to 2004 period and find that public firms purchase and sell assets at a higher intensity than private firms. They point out that the merger waves observed are driven by higher participation of public firms.<sup>1</sup> The analysis of mergers between public firms is the main objective of this paper.

One example that helps to motivate the paper is that of mergers between public banks. Spanish savings banks are controlled by politicians and public entities. Hence, savings banks are similar in many ways to public banks in other countries. The social function of these banks requires that part of their profits be allocated to activities that improve the well-being of the region where they are based. By law, they must pursue a wide set of goals, not just profit maximization or cost minimization (García-Cestona and Surroca, 2008). Savings banks in Spain were typically established by local or regional governments, churches, welfare societies and trade unions to promote savings by middle- and working- class people and to provide loans to small businesses and individuals in the same city or region. Regional governments have decisive power in the renewal of the governing bodies and the establishment of the strategies of savings banks. The Spanish government undertook a reform of savings banks in Spain in 2010 to strengthen them with a view to adapting them to the needs and challenges of the current financial situation (García-Meca and Sánchez-Ballesta 2014, p. 536). The main objective of the reform was to promote consolidation of the Spanish saving banks sector through mergers or other integration processes. The resulting mergers and acquisitions has reduced the number of Spanish savings banks from 45 to 9 (International Monetary Fund 2012, p. 19).<sup>2</sup>

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<sup>1</sup> An alternative to mergers and acquisitions is the privatizing of public firms (see Cai and Li, 2011). Thus our study is related to the literature on privatization of public firms (see De Fraja and Delbono 1989, 1990; Matsumura, 1998; Matsumura and Shimizu, 2010; Wang et al. 2014; Wang and Tomaru, 2015; Xu et al. 2017; Haraguchi and Matsumura, 2017; Bárcena-Ruiz and Garzón, 2018).

<sup>2</sup> There is also evidence of mergers that affect public banks in other countries. The International Monetary Fund (2012) points out that the number of savings banks has been reduced through mergers, acquisitions, and interventions. Kaur and Kaur (2010) argue that public sector banks dominate commercial banks in India, with a market share of around 70 percent. In the Indian banking sector, policy makers introduced reform measures in 1990s. One objective of that reform was to consolidate the banking industry through

The literature on mixed markets has analyzed the decision to merge by private and public firms.<sup>3</sup> Bárcena-Ruiz and Garzón (2003) analyze mergers between a public firm and a private firm that produce heterogeneous products in a mixed duopoly. They show that the decision to merge crucially depends on the degree to which goods are substitutes and on the percentage of shares owned by the government in the merged firm. Nakamura and Inoue (2007) extend the above paper by considering productivity improving merger activities between the public firm and a private firm in a mixed oligopoly. Andree (2013) analyzes the incentives to merge in a mixed duopoly if firms compete on prices or quantities. Gelves and Heywood (2013) consider two cases: a merger between an inefficient public leader and an efficient private follower, and the unilateral privatization of the public leader (both options make the leader efficient). They assume that after the merger, the resulting plant has mixed ownership and thus behaves as a semipublic firm. They find that partial privatization by merger may increase both social welfare and private profits. Moreover, they show that partial privatization by merger often dominates unilateral privatization in spite of the loss of a competitor.

The literature on mixed oligopolies has also considered mergers between private firms when they compete with a public firm. Méndez-Naya (2008) analyzes the incentive to merge for both, private and public firms, when non-merging firms change their strategies as a consequence of the merger. Kamijo and Nakamura (2009) examine endogenous merger formations in a mixed oligopoly. Artz et al. (2009) examine the set of surplus maximizing mergers in a model of mixed oligopoly. They consider mergers between two private firms and between the public firm and one private firm, including privatization through merger. Méndez-Naya (2011) addresses the issue of endogenous timing in the analysis of mergers in mixed oligopoly models. Heywood and McGinty (2011) consider the acquisition of a foreign private firm by a domestic private firm in a mixed oligopoly. Ouattara (2015) analyzes mergers incentives in an asymmetric mixed

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mergers and acquisitions. Koetter (2008) analyzes the wave of mergers in German savings and cooperative banks. He points out that around 80% of all banks are non-publicly traded cooperative and savings banks. Levine and Woodard (2006) point out that the Chinese government sees mergers and acquisitions as key drivers of its process of privatizing state-owned firms.

<sup>3</sup> Mergers between private firms have received a great deal of attention in the relevant literature. See Mukherjee et al. (2004) for a survey on this issue.

oligopoly. Finally, Chao et al. (2018) study the effect of a merger of public firms on wage gap, employment, and social welfare in a general equilibrium setting.

The papers cited above consider that each country has only one public firm. However, each country may usually have more than one public firm, located in different regions, which compete one with another. The literature on regional mixed oligopoly has analyzed this issue. Tomaru and Nakamura (2012) consider that a state-owned public firm owned by a central government competes with a local public firm owned by a local government. They find that when the two governments independently decide whether to privatize their respective public firms, only the state-owned public firm is privatized. Inoue et al. (2009) use a spatial model with price competition to analyze an interregional mixed duopoly in which a local public firm competes against a private firm. Bárcena-Ruiz and Casado-Izaga (2018) study the optimal size of the residential area assuming two mixed duopolies in a single region.

Our paper is related to two branches of the literature on mixed oligopoly: First, to the literature on regional mixed oligopoly; and second to the literature that analyzes mergers between public and private firms. Neither of these two branches of the literature studies mergers between local public firms located in different regions of a country. The purpose of this paper is to fill that gap in the literature.<sup>4</sup>

We consider a country made up of two regions. Each region has a local public firm and a domestic private firm. There are two differentiated goods that may be substitutes or complements. Firms sell their products in the two regions.<sup>5</sup> There is a national authority in the country that has to decide whether or not to merge the two local public firms, thus setting up a state corporation that has two production plants, one in each region. State corporations are usually multiproduct, multiplant firms that produce different products,

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<sup>4</sup> An specific example that illustrates the analysis is the following. Kutxabank is a public bank based in the Basque Country (Spain) that was founded on 2012. Kutxabank arised as a result of the merger of three public Basque saving banks operating on their respective provinces. This merger is due to the reform undertaken by the Spanish Government to promote consolidation of the Spanish saving banks sector.

<sup>5</sup> Pérez-Díaz and Rodríguez (2012, p. 40) point out that at the beginning of the 80's savings bank were allowed to extend to other province in their respective regional autonomous communities. The 1988 reform allowed savings bank to expand outside their own autonomous communities.

which may be substitutes or complements.<sup>6</sup> Governments may have different goals when they set up state holding corporations (see Kumar, 1992). First, they may seek to introduce market forces into public firms, with strong emphasis on financial independence and a binding budget constraint. Second, they may seek to make the holding institution responsible for the possible transfer of its firms to private ownership.

There are several papers that study the behavior of state holding corporation located in a single region. Bárcena-Ruiz and Garzón (2017) consider a state holding corporation with two plants that may produce complement or substitute goods. They study whether the government wants to privatize that corporation, and if so whether the two plants are sold to different private investors or to a single investor. Dong *et al.* (2018) extend the above paper by assuming that the government can partially privatize each plant of the state holding corporation. We differ from these papers in that we consider two local public firms located in different regions; in the event of a merger the state holding corporation will have one plant in each region.

In each region the public firm and the private firm may produce the same good or different goods, so there are three possible cases.<sup>7</sup> In Case 1 the firms in each region produce the same good, which may be a substitute or complement of the good produced by the firms in the other region. In Case 2 the local public firm in one region and the private firm in the other region produce the same good, which may be a substitute or complement of the homogeneous good produced by the other firms. Finally, in Case 3 the two local public firms produce the same good, which may be a substitute or complement of the homogeneous good produced by the two private firms. Table 1 summarizes the types of good produced by the firms in the different cases, where goods  $i$  and  $j$  may be substitutes or complements.

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<sup>6</sup> In Europe governments have created holdings that comprise domestic public firms such as, for example, the *Sociedad Estatal de Participaciones Industriales* -SEPI- in Spain (see [www.sepi.es](http://www.sepi.es)), the Istituto per la Ricostruzione Industriale -IRI- in Italy (see Cafferata, 2010), and the Agence des Participations de l'État -APE- in France ([www.economie.gouv.fr](http://www.economie.gouv.fr)).

<sup>7</sup> Private Banks and Savings Bank may specialize in different products, such as consumer loans and government and mortgage loans, consumer credit, services, etc. (Martín-Oliver *et al.* 2017, p. 7). They may therefore be differentiated in terms of their sources of revenue, so we consider that firms may produce differentiated goods. Empirical evidence shows that most real world markets are characterized by product differentiation. Cremer *et al.* (1991) argue that introducing heterogeneous products is a significant step towards achieving a better understanding of actual mixed oligopolies.

	Case 1	Case 2	Case 3
Region I	The local public firm and the private firm produce good $i$ .	The local public firm produces good $i$ and the private firm produces good $j$ .	The local public firm produces good $i$ and the private firm produces good $j$ .
Region II	The local public firm and the private firm produce good $j$ .	The local public firm produces good $j$ and the private firm produces good $i$ .	The local public firm produces good $i$ and the private firm produces good $j$ .

**Table 1.** Types of good produced by the firms in the different cases

We find in the paper that because the two local public firms produce the same good, in Case 3 the national authority is indifferent as to whether merge them or not. This is because the two regions are identical, so maximizing the joint welfare of the two regions is the same as maximizing local welfare. This result does not hold when the two local public firms produce heterogeneous goods, so the decision to merge can take place only when the two local public firms produce differentiated goods. In this last case the decision to merge depends on whether the firms in each region produce homogeneous or heterogeneous goods.

In Cases 1 and 2 the national authority may merge the local public firms since they produce heterogeneous goods. In Case 1 the firms in each region produce the same good and the national authority merges the two local public firms if the goods produced in the two regions are complements, independent in demand, and weak substitutes. In Case 2 the firms in each region produce heterogeneous goods. In that case the national authority merges the two local public firms only if the goods are close complements. Finally, a comparison of the results obtained in these two cases reveals that there is greater scope for merger in Case 1 than in Case 2.

We analyze the robustness of our results by considering three extensions of the main model: We first consider that the two regions have different market sizes. We find that as one region increases its consumer population compared to the other there is greater scope for a merger between the two local public firms. Second, we assume that there are two private firms in one region and only one in the other. We find that there is greater scope for a merger than in the symmetric model if goods are close substitutes in Case 1, if goods

are substitutes and weak complements in Case 2, and if goods are substitutes and complements in Case 3.<sup>8</sup> Finally, we consider that firms have constant marginal costs of production and that local private firms are more inefficient than private firms. We find that if the inefficiency of the public firms is low enough, the main results obtained in the paper hold.

The paper is organized as follows. Section 2 presents the model. Sections 3, 4 and 5 analyze Cases 1, 2 and 3 respectively. Section 6 compares the results obtained in the different cases. Section 7 analyzes the robustness of the results and Section 8 concludes.

## 2. The Model

We consider a country made of by two regions, denoted by  $I$  and  $II$ . Region  $k$  has a local public firm and a domestic private firm denoted by  $kA$  and  $kB$ , respectively,  $k = I, II$ . There is a national authority in the country that has to decide whether or not to merge the two local public firms. If they are merged the national authority sets up a state corporation organized as a multiplant firm with two production plants, one in each region. As the two regions and the two local public firms are identical we assume that in the case of a merger each region owns half of the shares in the state corporation.

There are two differentiated goods, denoted by 1 and 2, that may be substitutes or complements. Firms sell their products in the two regions. In each region the public firm and the private firm may produce the same good or different goods, so there are three possible cases. In Case 1 the firms in each region produce the same good, which may be a substitute or a complement of the good produced by the firms in the other region. In Case

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<sup>8</sup> The results obtained in the paper help to partially explain the example of the merger between the three Basque public savings banks cited in footnote 4. We find in the paper sever factors that encourage local public firms to merge. In Cases 1 and 2 we find that there is a merger with complement goods. In this regard, although all three Basque public savings banks sell some products that are close substitute they also sell others that are complements. Moreover, the regions where the Basque saving banks are active have different sizes, and we find that this is a factor in favor of a merger. Finally, we also find that the asymmetry in the number of private firms in each region may be a factor in favor of a merger.

2 the local public firm in one region and the private firm in the other region produce the same good, which may be a substitute or a complement of the homogeneous good produced by the other firms. Finally, in Case 3 the two local public firms produce the same good, which may be a substitute or a complement of the homogeneous good produced by the two private firms.

On the consumption side, there is a continuum of consumers of the same type. The representative consumer maximizes  $U(q_1, q_2) - p_1q_1 - p_2q_2$ , where  $p_i$  is the price of good  $i$  and  $q_i$  is the amount of good  $i$ ,  $i = 1, 2$ . The function  $U(q_1, q_2)$  is assumed to be quadratic, strictly concave and symmetric in  $q_1$  and  $q_2$ :

$$U(q_1, q_2) = a(q_1 + q_2) - ((q_1)^2 + 2bq_1q_2 + (q_2)^2)/2, -1 < b < 1.$$

Thus, industry inverse demand functions are:

$$p_i = a - q_i - bq_j, i \neq j; i, j = 1, 2, \quad (1)$$

where if  $b > 0$  goods 1 and 2 are substitutes, if  $b < 0$  they are complements, and if  $b = 0$  the demands for the goods are independent.

Following De Fraja and Delbono (1989) and Bárcena-Ruiz and Garzón (2005), we assume that firms have the same technology represented by the following quadratic cost function:  $C(q_i^{kl}) = c(q_i^{kl})^2$ ,  $i = 1, 2; k = I, II; l = A, B$ . Therefore, the profit function of firm or plant  $kl$ , which produces good  $i$ , is:

$$\pi_i^{kl} = p_i q_i^{kl} - c(q_i^{kl})^2, i = 1, 2; k = I, II; l = A, B. \quad (2)$$

The producer surplus in region  $k$ , denoted by  $PS^k$  ( $k = I, II$ ), is the following: The profit of the domestic private firm plus the profit of the local public firm if there is no merger, and the profit of the domestic private firm plus half the profit of the state corporation in case of a merger. Total producer surplus in the country is  $PS = PS^I + PS^{II}$ . As products 1 and 2 are heterogeneous, the consumer surplus is given by  $CS = (q_1)^2/2 + bq_1q_2 + (q_2)^2/2$ . We assume globally homogeneous consumers and that each region has half of the consumer population. Therefore, the consumer surplus in region  $k$ ,  $k = I, II$ , is:  $CS^k = CS/2$  (see Duval and Hamilton, 2002; Bárcena-Ruiz and Garzón, 2014). The social welfare function considered by region  $k$  comprises the consumer surplus of domestic consumers,



$CS^k$ , and the producer surplus of domestic firms,  $PS^k$ . Specifically, the social welfare function considered by region  $k$  can be expressed as:

$$W^k = CS^k + PS^k, k = I, II. \quad (3)$$

If there is a local public firm in region  $k$  its objective function is domestic welfare, given by (3), as it is not integrated into a state corporation. If there is a state corporation with two plants half of the shares in which belong to each local government, its objective function is the weighted sum of the welfare of the two regions, where the weight is 1/2. Specifically, its objective function is the following:

$$W^I/2 + W^{II}/2. \quad (4)$$

The two regions belong to the same country so social welfare in that country is given by:

$$W = CS + PS. \quad (5)$$

To analyze the national authority's decision on whether or not to merge the two local public firms and set up a state corporation, we propose a two-stage game. In the first stage, the national authority decides whether to merge the two local public firms or not. In the second stage, firms make production decisions simultaneously. The equilibrium concept used is the subgame perfect equilibrium solved by backward induction. To simplify the presentation of results we assume that  $c=1$ .<sup>9</sup>

In the first stage the national authority decides whether to set up a state corporation or not, so there are two subgames to be analyzed. In the first one, the national authority does not set up a state corporation (denoted by subscript  $N$ ) and in the second it merges the two local public firms into a state corporation (denoted by subscript  $M$ ).

To explain the findings in the paper three effects must be considered. The first effect, denoted as the "output effect", arises because only public firms take the consumer surplus into account when taking production decisions, which leads public firms to produce more than private firms. This effect is stronger if there is a state corporation than if there are local public firms, because the state corporation takes into account consumers in both regions while local public firms consider only local consumers.

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<sup>9</sup> It can be shown that the main results of the paper hold for values of  $c$  other than 1.

The second effect is denoted as the “internalization effect”. If there is no merger, this effect arises because the objective function of a local public firm comprises the profits of the firms in the region, so it takes into account how its output affects the production of the private firm of its region. If there is a merger this effect arises because the objective function of the state corporation comprises the profits of the all firms. Thus, when each plant in the state corporation takes its production decision it takes into account how its output affects the output of the other plant and that of the two private firms.

The third effect is denoted as the “competition effect”. This effect arises because the output of each firm is affected by the output of the other firms. When firms produce substitute goods they compete in the product market, which leads them to reduce their outputs. When firms produce complementary goods the output of each firm increases with that of the others (they cooperate).

Under a merger, the output decisions taken by the state corporation can be explained by the above effects but in that case the second effect includes the third. This is because each plant in the state corporation takes into account how its output affects the output of the other plant and that of the two private firms. Thus, each plant takes into account that its product is a substitute or complement of those produced by the other plant and the private firms.

### 3. Case 1: the firms in each region produce the same good

In this case the firms in one region produce good  $i$  and the firms in the other region produce good  $j$ , so  $q_i = q_i^{IA} + q_i^{IB}$  and  $q_j = q_j^{IIA} + q_j^{IIB}$ ,  $i \neq j$ ;  $i, j = 1, 2$ . Thus, from (1), industry inverse demand functions are:

$$p_i = a - (q_i^{IA} + q_i^{IB}) - b(q_j^{IIA} + q_j^{IIB}), i \neq j; i, j = 1, 2. \quad (6)$$

Next we analyze the first subgame.

#### 3.1. Merger

In this case, the two local public firms merge, so the national authority sets up a state corporation. It is a public multiplant firm with two plants, one of which produces good 1 and

the other good 2. There are also two private firms, one in each region, that produce different goods. In the second stage of the game, private firm  $kB$  sets the output level  $q_i^{kB}$  that maximizes its profit function, given by expression (2),  $i=1, 2, k= I, II$ . The state corporation chooses the output levels  $q_i^{IA}$  and  $q_j^{IIA}$  that maximize its objective function, given by expression (4), which is equivalent to maximizing the joint welfare of the two regions. Solving these problems, we obtain the following result.

**Lemma 1.** *When the two local public firms merge, in equilibrium:*

$$p_{iM} = \frac{6a}{11+5b}, q_{iM}^{kA} = \frac{3a}{11+5b}, q_{iM}^{kB} = \frac{2a}{11+5b}, CS_M = \frac{25a^2(1+b)}{(11+5b)^2}, \pi_{iM}^{kA} = \frac{9a^2}{(11+5b)^2},$$

$$\pi_{iM}^{kB} = \frac{8a^2}{(11+5b)^2}, PS_M = \frac{34a^2}{(11+5b)^2}, W_M^k = \frac{a^2(59+25b)}{2(11+5b)^2}, i=1, 2; k= I, II.$$

The state corporation maximizes the joint welfare of the two regions, so we obtain the usual result that its plants produce an output level such that the price equals the marginal cost ( $p_{iM} = 2q_{iM}^{kA}, i=1, 2$ ).

In this case local public firms merge, so the competition effect is included in the internalization effect. Due to the output and internalization effects, the output level of each plant in the state corporation is greater than that of each private firm ( $q_{iM}^{kA} > q_{iM}^{kB}$ ). The explanation of this result is the following.

We first consider that goods 1 and 2 are substitutes. In this case, the internalization effect (which includes the competition effect) encourages the state corporation to reduce its production. This is because the good produced by each plant in the state corporation is a perfect substitute of that produced by the private firm in its region and an imperfect substitute of the good produced by the firms in the other region. The output effect makes the plants in the state corporation produce more than private firms. These effects go in opposite directions but the output effect dominates. As a result, each plant in the state corporation produces more than each private firm.

Next we consider that goods 1 and 2 are complements. Given that the internalization effect includes the competition effect in this case it influences the production in each plant in the state corporation in two ways. First, the production of each plant decreases with that of the private firm in its region since they produce perfect substitute goods. Second, given that goods 1 and 2 are complements the production in each plant in the state

corporation increases with that of the firms in the other region. On the other hand, the output effect makes the plants in the state corporation produce more than private firms. As a result of these effects, each plant in the state corporation produces more than each private firm.

Finally, each plant in the state corporation obtains more profit than each private firm independently of whether goods 1 and 2 are substitutes or complements ( $\pi_{iM}^{kA} > \pi_{iM}^{kB}$ ). Their greater output implies greater total production costs, but their greater market share means more profits.

### 3.2. Non merger

In this case the market comprises four uniplant firms: two of them are private and the other two are public. In region  $k$  there is one local public firm,  $kA$ , and one domestic private firm  $kB$ ,  $k=I, II$ . In the second stage of the game, private firm  $kB$  sets the output level  $q_i^{kB}$  that maximizes its profit, given by expression (2),  $k=I, II$ ;  $i = 1, 2$ . Local public firm  $kA$  sets the output level  $q_i^{kA}$  that maximizes the social welfare of region  $k$ , given by expression (3),  $k=I, II$ ;  $i = 1, 2$ . Solving these problems, we obtain the following result.

**Lemma 2.** *When the local public firms do not merge, in equilibrium:*

$$p_{iN} = \frac{3a(5-b)}{25+7b}, q_{iN}^{kA} = \frac{a(5+b)}{25+7b}, q_{iN}^{kB} = \frac{a(5-b)}{25+7b}, CS_N = \frac{100a^2(1+b)}{(25+7b)^2}, \pi_{iN}^{kA} = \frac{2a^2(5+b)(5-2b)}{(25+7b)^2},$$

$$\pi_{iN}^{kB} = \frac{2a^2(5-b)^2}{(25+7b)^2}, PS_N = \frac{4a^2(50-b(15+b))}{(25+7b)^2}, W_N^k = \frac{2a^2(75+10b-b^2)}{(25+7b)^2}, i = 1, 2; k = I, II.$$

The local public firm in each region maximizes local welfare, but it produces an output level such that the price is greater than the marginal cost ( $p_{iN} > 2q_{iN}^{kA}$ ,  $i = 1, 2$ ). This is because the local public firms do not maximize the joint welfare of the two regions.

From Lemma 2 it emerges that when the local public firms do not merge, the output level of each local public firm is greater than that of each private firm when goods are substitutes ( $q_{iN}^{kA} > q_{iN}^{kB}$  if  $b>0$ ), but lower when goods are complements ( $q_{iN}^{kA} < q_{iN}^{kB}$  if  $b<0$ ). We explain this result below.

We consider first that goods 1 and 2 are substitutes. In this case, the internalization effect encourages local public firms to produce less since firms produce perfect substitute goods in each region. The competition effect also encourages local public firms to produce less since the good produced by each local public firm is an imperfect substitute of the good produced by the firms in the other region. The output effect makes local public firms produce more than private firms. This last effect dominates the other two effects so local public firms produce more than private firms.

We next consider that goods 1 and 2 are complements. The internalization effect encourages local public firms to produce less since firms produce perfect substitute goods in each region. The competition effect encourages the two local public firms to produce more since, given that goods 1 and 2 are complements, the output of each local public firm increases with that of the firms in the other region. Finally, the output effect makes local public firms produce more than private firms. As a result, the internalization effect dominates the other effects, so local public firms produce less than private firms.

Local public firms obtain more (less) profit than private firms when goods 1 and 2 are substitutes (complements). The firms that produce more have greater total production costs but they also have greater market shares, so they make more profits.

The decision by the national authority as to whether or not to merge local public firms remains to be analyzed. This decision, taken in stage one, depends on the degree to which products 1 and 2 are substitutes or complements.

### *3.3. Decision on whether to merge local public firms*

A comparison of the joint welfare obtained by the regions in Lemmas 1 and 2 gives the following result.

**Proposition 1.** *In Case 1, in equilibrium, the national authority merges the two local public firms into a state corporation, if  $b < 0.4299$ ; otherwise there is no merger.*<sup>10</sup>

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<sup>10</sup> It can be shown that when there is a multiplant private firm with one plant in each region (rather than a uniplant private firm in each region), the national authority sets up a state corporation if and only if  $b < 0.1077$ . This means that there is less scope for merging local public firms when there is a multiplant private firm than when private firms are uniplant.

**Proof.** See Appendix.

This proposition shows that the national authority merges local public firms if goods 1 and 2 are complements ( $b < 0$ ), independent in demand ( $b = 0$ ), and weak substitutes ( $0 < b < 0.4299$ ). If goods 1 and 2 are close substitutes ( $b \geq 0.4299$ ) then local public firms remain independent. Next, we compare the consumer and producer surpluses with and without a merger. After that, we analyze whether the national authority merges the two local public firms.

Each plant in the state corporation produces more than each local public firm ( $q_{iM}^{kA} > q_{iN}^{kA}$ ), for all values of parameter  $b$ . This is because the output effect is stronger with a state corporation given that it takes into account the consumer surplus of both regions while each local public firm considers only the consumer surplus of its region. This leads private firms to produce less when they compete with a state corporation ( $q_{iM}^{kB} < q_{iN}^{kB}$ ) since the public firm and the private firm produce perfect substitute goods in each region. The total output of the public firms has a stronger effect so the consumer surplus is greater in the case of a merger ( $CS_M > CS_N$ ).

It is easy to see that  $PS_M < PS_N$  if and only if  $b > -0.6564$ . Next we explain this result. When goods 1 and 2 are substitutes or independent in demand the state corporation produces more than local public firms but it obtains lower profits, because costs are quadratic. Private firms produce less when competing with a state corporation, and although costs are quadratic their lower market share means lower profits. As a result, when goods 1 and 2 are substitutes or independent in demand the producer surplus is lower in the case of a merger.

When goods 1 and 2 are complements, the firms in the same region compete with each other but those from different regions cooperate. Private firms produce more without a merger and even though costs are quadratic they obtain more profits ( $\pi_{iM}^{kB} < \pi_{iN}^{kB}$ ). However, each plant in the state corporation obtains higher profits than each local public firm if goods 1 and 2 are close complements ( $\pi_{iM}^{kA} > \pi_{iN}^{kA}$  if and only if  $b < -0.3216$ ). This is because as seen above, if goods are independent in demand ( $b = 0$ ) it emerges that  $\pi_{iM}^{kA} < \pi_{iN}^{kA}$ . As goods become closer complements (which means a lower  $b$ ), firms or plants producing goods 1 and 2 cooperate in the product market, so they produce more

and obtain higher profits. However, the profit of each plant in the state corporation increases by more than that of each local public firm because the internalization effect is stronger for the state corporation. This is because each local public firm internalizes the fact that firms in its region produce perfect substitute goods while the state corporation also internalizes the fact that goods 1 and 2 produced in both regions are complements. As a result, if  $b < -0.3216$  it is obtained that  $\pi_{iM}^{kA} > \pi_{iN}^{kA}$ .

If  $0 > b > -0.3216$  both the public and private firms obtain higher profits without a merger, so the producer surplus is greater in that case. If  $-0.3216 > b > -0.6564$ , the public (private) firms obtain higher profits with (without) a merger. In this case, the profit of the private firms has a greater influence since goods are weak complements so  $PS_M < PS_N$ . Finally, if  $b < -0.6564$ , given that goods 1 and 2 are close complements the greater profit of the state corporation has a greater influence so  $PS_M > PS_N$ .

Next we analyze whether the national authority merges the two local public firms. If goods 1 and 2 are close substitutes ( $b > 0.4299$ ) the national authority does not merge them. The explanation is that the state corporation and each local public firm internalize the fact that the goods produced in each region are perfect substitutes, which reduces total output. Moreover, the state corporation also internalizes the fact that goods 1 and 2 are close substitutes, which further reduces total output. Thus, the internalization effect is stronger in the case of a merger than without one, which leads to lower total output in the former case. On the other hand, the output effect leads to higher total output in the case of a merger. When goods 1 and 2 are close substitutes, total output and the consumer surplus with a merger are higher than without one due to the output effect ( $CS_M - CS_N > 0$ ). However, the difference between the consumer surplus with and without a merger is small since the internalization effect in the case of a merger is greater. As a result,  $PS_N - PS_M > CS_M - CS_N$  so the national authority does not merge the two local public firms.

If goods are complements, independent in demand and weak substitutes ( $b < 0.4299$ ), the national authority merges the two local public firms. The explanation is that as parameter  $b$  decreases, goods 1 and 2 become weaker substitutes and the internalization effect in the case of a merger becomes weaker, which increases total output. Moreover, as parameter  $b$  decreases, total output without a merger does not change due to the internalization effect. Thus, when goods 1 and 2 are weak substitutes, the difference  $CS_M - CS_N$  is greater than

when they are close substitutes. As a result, it now emerges that  $CS_M - CS_N > PS_N - PS_M$  so the national authority merges the two local public firms. If goods 1 and 2 are complements, the output of each firm increases with that of the other firms so the internalization effect in the case of a merger reinforces the output effect. As a result,  $CS_M - CS_N > PS_N - PS_M$ , so the national authority merges the two local public firms.

#### 4. Case 2: the public firm in one region and the private firm in the other produce perfect substitute goods

In this case the public firm in one region and the private firm in the other region produce good  $i$  and the other firms produce good  $j$ , so  $q_i = q_i^{IA} + q_i^{IIB}$  and  $q_j = q_j^{IIA} + q_j^{IIB}$ ,  $i \neq j$ ;  $i, j = 1, 2$ . Thus, from (1), industry inverse demand functions are:

$$p_i = a - (q_i^{IA} + q_i^{IIB}) - b(q_j^{IIA} + q_j^{IIB}), i \neq j; i, j = 1, 2. \quad (3)$$

Next we analyze first the subgame in which the national authority sets up a state corporation.

##### 4.1. Merger

In the case of a merger the state corporation chooses the output levels  $q_i^{IA}$  and  $q_j^{IIA}$  that maximize its objective function, given by expression (4). Private firm  $kB$  sets the output level  $q_i^{kB}$  that maximizes its profit function, given by expression (2),  $i=1, 2, k= I, II$ . Solving these problems, we obtain the same result as in Lemma 1. This is because the situation is the same as in Subsection 3.1: the government of each region owns half the shares in the state corporation and the good of each plant in the state corporation is a perfect substitute of the good of one private firm and an imperfect substitute or complement of that of the other private firm.

##### 4.2. Non merger



When the national authority does not set up a state corporation, local public firm  $kA$  sets the output level  $q_i^{kA}$  that maximizes the social welfare of region  $k$ , given by expression (3),  $k=I, II$ ;  $i = 1, 2$ . Private firm  $kB$  sets the output level  $q_i^{kB}$  that maximizes its profit function, given by expression (2),  $i=1, 2$ . Solving these problems, we obtain the following result.

**Lemma 3.** *When the two local public firms do not merge, in equilibrium:*

$$p_{iN} = \frac{3a(5-b)}{27+7b-2b^2}, q_{iN}^{kA} = \frac{a(7-b)}{27+7b-2b^2}, q_{iN}^{kB} = \frac{a(5-b)}{27+7b-2b^2}, CS_N = \frac{4a^2(6-b)^2(1+b)}{(27+7b-2b^2)^2},$$

$$\pi_{iN}^{kA} = \frac{2a^2(7-b)(4-b)}{(27+7b-2b^2)^2}, \pi_{iN}^{kB} = \frac{2a^2(5-b)^2}{(27+7b-2b^2)^2}, PS_N = \frac{4a^2(53-b(21-2b))}{(27+7b-2b^2)^2},$$

$$W_N^k = \frac{2a^2(89+3b-9b^2+b^3)}{(27+7b-2b^2)^2}, i = 1, 2; k = I, II.$$

The local public firm of each region does not maximize the joint welfare of the two regions, so it produces an output level such that the price is greater than the marginal cost ( $p_{iN} > 2q_{iN}^{kA}$ ,  $i = 1, 2$ ).

From Lemma 3 it emerges that without a merger the output level of each local public firm is greater than that of each private firm independently of whether goods 1 and 2 are substitutes, complements or independent in demand ( $q_{iN}^{kA} > q_{iN}^{kB}$ ).

We consider first that goods 1 and 2 are substitutes. In this case, both the internalization effect and the competition effect encourage local public firms to produce less since firms produce substitute goods. These effects are dominated by the output effect, which makes local public firms produce more than private firms.

When goods 1 and 2 are complements local public firms produce more than private firms. The internalization effect encourages local public firms to produce more since firms produce goods which are complements in each region. The competition effect influences the output of the local public firms in two ways. First, the output of each local public firm decreases with that of the private firm in the other region since they produce perfect substitute goods. Second, the output of each local public firm increases with that of the private firm of its own region and with that of the other local public firm since goods 1 and 2 are complements. Finally, the output effect makes local public firms

produce more than private firms. As a result of these effects local public firms produce more than private firms.

Local public firms make more profit than private firms, independently of whether goods 1 and 2 are substitutes, complements or independent in demand ( $\pi_{iM}^{kA} > \pi_{iM}^{kB}$ ). Local public firms produce more than private firms and, although costs are quadratic their greater market share means greater profits.

The decision by the national authority as to whether or not to set up a state corporation remains to be analyzed. This decision, taken in stage one, depends on the degree to which products 1 and 2 are substitutes or complements.

#### 4.3. Decision on whether to merge local public firms

A comparison of the welfare obtained by the regions in Lemmas 1 and 3 leads to the following result.

**Proposition 2.** *In Case 2, in equilibrium, the national authority merges the two local public firms if  $b < -0.5173$ ; otherwise there is no merger.*<sup>11</sup>

**Proof.** See Appendix.

This proposition shows that the national authority merges local public firms if goods are close complements ( $b < -0.5173$ ). If goods are weak complements ( $0 > b > -0.5173$ ), independent in demand ( $b = 0$ ) or substitutes ( $b > 0$ ) local public firms remain as independent firms.

In each region, each plant in the state corporation produces more than each local public firm ( $q_{iM}^{kA} > q_{iN}^{kA}$ ) for all  $b$ . This is because the output effect is stronger with a state corporation since it takes into account the consumer surplus of both regions. This leads private firms to produce less when there is a state corporation ( $q_{iM}^{kB} < q_{iN}^{kB}$ ) since the public firm of one region and the private firm in the other region produce perfect substitute

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<sup>11</sup> When there is a multiplant private firm with one plant in each region, the national authority sets up a state corporation if and only if  $b < 0.1077$ . This means that there is greater scope to merge local public firms when there is a multiplant private firm than when private firms are uniplant.

goods. The total output of the public firms has a stronger effect so the consumer surplus is greater in the case of a merger ( $CS_M > CS_N$ ).

It can be shown that  $PS_M < PS_N$  if and only if  $b > -0.9393$ . Next we explain this result. When goods 1 and 2 are substitutes or independent in demand the state corporation produces more than local public firms and obtains lower profits, because costs are quadratic. Private firms produce less when competing with a state corporation and, although costs are quadratic, their lower market share means lower profits. As a result, when goods 1 and 2 are substitutes or independent in demand the producer surplus is lower in the case of a merger.

When goods 1 and 2 are complements, private firms produce more without a merger so they obtain more profits ( $\pi_{iM}^{kB} < \pi_{iN}^{kB}$ ). However, the state corporation obtains higher profits than local public firms only if goods 1 and 2 are close complements ( $\pi_{iM}^{kA} > \pi_{iN}^{kA}$  if and only if  $b < -0.8825$ ). This is because as seen above, if goods are independent in demand ( $b=0$ ) it emerges that  $\pi_{iM}^{kA} < \pi_{iN}^{kA}$ . As goods become complements (which means a lower  $b$ ), producers of goods 1 and 2 cooperate in the product market, so they produce more and obtain higher profits. However, as the internalization effect is stronger for the state corporation its profit increases more than that of local public firms. As a result, if  $b < -0.8825$  it is obtained that  $\pi_{iM}^{kA} > \pi_{iN}^{kA}$ .

If  $0 > b > -0.8825$  both public and private firms obtain higher profits without a merger, so the producer surplus is greater in that case. If  $-0.8825 > b > -0.9393$ , the public (private) firms obtain higher profits with (without) a merger. As goods 1 and 2 become closer complements, the profit of each firm or plant increases but the profit of each plant in the state corporation increases more due to the internalization effect. However, in this case, this increase is not enough so the profit of the private firm has a greater influence on the producer surplus, which means that  $PS_M < PS_N$ . Finally, if  $b < -0.9393$ , given that goods 1 and 2 are close complements the greater profit of the state corporation has a greater influence so  $PS_M > PS_N$ .

Next we analyze the decision whether to merge taken by the national authority. If goods 1 and 2 are substitutes or independent in demand the national authority does not merge the two local public firms. The explanation is the following. The state corporation

and each local public firm internalize the fact that the goods produced in each region are imperfect substitutes, which reduces total output. Moreover, the state corporation also internalizes that the fact that the good produced by each plant is a perfect substitute of the good produced by the private firm in the other region, which further reduces total output. Thus, the internalization effect with a merger is stronger than without one, which leads to lower total output in the case of a merger. On the other hand, the output effect leads to higher total output in the case of a merger. When goods 1 and 2 are substitutes, total output in the case of a merger is higher than without one due to the output effect, which means that  $CS_M - CS_N > 0$ . However, the difference between the consumer surplus with and without a merger is small since the internalization effect in the case of a merger is greater. As a result,  $PS_N - PS_M > CS_M - CS_N$  so the national authority does not merge local public firms.

If goods are close complements ( $b < -0.5173$ ), the national authority merges the two local public firms. The explanation is the following. The state corporation internalizes the fact that the good produced by each plant is a perfect substitute of the good produced by the private firm in the other region, which reduces total output. Moreover, the state corporation and each local public firm internalize the fact that the goods produced in each region are complements, which increases total output. On the other hand, the output effect leads to higher total output in the case of a merger. If goods 1 and 2 are weak complements ( $-0.5173 < b < 0$ ) the internalization effect means that  $PS_N - PS_M > CS_M - CS_N$  so the national authority does not merge the two local public firms. If goods 1 and 2 are close complements ( $b < -0.5173$ ) the internalization effect is stronger than in the above case, and is stronger with a merger than without one. This means that now  $CS_M - CS_N > PS_N - PS_M$  so the national authority merges the two local public firms.

### 5. Case 3: the two public firms produce the same good

In this case the two local public firms or the two plants in the state corporation produce good  $i$  and the two private firms produce good  $j$ , so  $q_i = q_i^{IA} + q_i^{IIA}$  and  $q_j = q_j^{IB} + q_j^{IIB}$ ,  $i \neq j$ ;  $i, j = 1, 2$ . Thus, from (1), industry inverse demand functions are:

$$p_i = a - (q_i^{IA} + q_i^{IIA}) - b(q_j^{IB} + q_j^{IIB}), i \neq j; i, j = 1, 2. \quad (7)$$

Next we analyze first the subgame in which the national authority sets up a state corporation.

### 5.1. Merger

When the national authority merges the two local public firms, it sets up a state corporation that chooses the output levels  $q_i^{IA}$  and  $q_i^{IIA}$  that maximize its objective function, given by expression (4). Private firm  $kB$  sets the output level  $q_j^{kB}$  that maximizes its profit function, given by expression (2),  $i=1, 2, k = I, II$ . Solving these problems, we obtain the following results.

**Lemma 4.** *When the two local public firms merge, in equilibrium:*

$$q_{iM}^{kA} = \frac{a(5-2b)}{4(5-b^2)}, q_{iM}^{kB} = \frac{a(2-b)}{2(5-b^2)}, CS_M = \frac{a^2(41+4b-28b^2+8b^3)}{8(5-b^2)^2}, \pi_{iM}^{kA} = \frac{a^2(5-2b)^2}{16(5-b^2)^2},$$

$$\pi_{iM}^{kB} = \frac{a^2(2-b)^2}{2(5-b^2)^2}, PS_M = \frac{a^2(57-52b+12b^2)}{8(5-b^2)^2}, W_M^k = \frac{a^2(49-24b-8b^2+4b^3)}{8(5-b^2)^2}, i = 1, 2; k = I, II.$$

As the state corporation maximizes the joint welfare of the two regions, the usual result emerges that its plants produce an output level such that the price equals the marginal cost ( $p_{iM} = 2q_{iM}^{kA}, i = 1, 2$ ).

Given that in this case local public firms merge the competition effect is included in the internalization effect. Due to the output and internalization effects, the output level of each plant in the state corporation is greater than that of each private firm ( $q_{iM}^{kA} > q_{iM}^{kB}$ ).

We first consider that goods 1 and 2 are substitutes. In this case, the internalization effect (which includes the competition effect) encourages the state corporation to produce less. This is because the good produced by one plant in the state corporation is a perfect substitute of that produced by the other plant and an imperfect substitute of the good produced by the private firms. The output effect makes the state corporation produce more than private firms. These effects go in opposite directions but the output effect dominates so each plant in the state corporation produces more than each private firm.

Next we consider that goods 1 and 2 are complements. In this case the internalization effect includes the competition effect, so it influences the production of each plant in the

state corporation in two ways. First, the production of each plant decreases with that of the other plant since they produce perfect substitute goods. Second, as goods 1 and 2 are complements the production of each plant in the state corporation increases with that of the private firms. On the other hand, the output effect makes the state corporation produce more than private firms. As a result of these effects, each plant in the state corporation produces more than each private firm.

Finally, each plant in the state corporation obtains a greater profit than each private firm if goods are close substitutes ( $\pi_{iM}^{kA} > \pi_{iM}^{kB}$  if and only if  $b > 0.7928$ ). In the above sections, the state corporation obtain greater profits than the private firms for all  $b$  because the two plants of the state corporation produce heterogeneous goods. The difference between these results is due to the fact that now the two plants in the state corporation produce perfect substitute goods.

Next, we analyze the subgame in which the national authority does not merge the two local public firms.

## 5.2. *Non merger*

When the national authority does not set up a state corporation, local public firm  $kA$  sets the output level  $q_i^{kA}$  that maximizes the social welfare of region  $k$ , given by expression (3),  $k=I, II$ ;  $i = 1, 2$ . Private firm  $kB$  sets the output level  $q_i^{kB}$  that maximizes its profit function, given by expression (2),  $i=1, 2$ . Solving these problems, we obtain the same result as in Lemma 4.

The decision by the national authority as to whether or not to merge local public firms remains to be analyzed.

## 5.3. *Decision on whether to merge local public firms*

From the results obtained in this section the following can be concluded.

**Proposition 3.** *In Case 3, in equilibrium, the national authority is indifferent between merging the two local public firms and not doing so.*<sup>12</sup>

The result obtained in Proposition 3 is because the two regions are identical. Thus maximizing the joint welfare of the two regions is the same as maximizing local welfare.

## 6. Comparison of results

In this section we compare the results obtained in the three cases considered in the paper. In Case 3 the two local public firms produce the same good. This good can be a substitute or a complement of the homogeneous good produced by the private firms. This means that the two regions are equal so, as seen in Proposition 3, the national authority is indifferent between merging the two local public firms and not doing so.

Next we compare Cases 1 and 2 analyzed in the paper. A comparison of Propositions 1 and 2 reveals that there is greater scope for a merger in Case 1 than in Case 2. Next, we provide an intuition of this result.

In Case 1, the two firms in each region produce perfect substitute goods, and the goods produced in the two regions can be substitutes or complements. In Case 2, the good produced by the public firm of one region is a perfect substitute of the good produced by the private firm in the other region and that good is a substitute or a complement of the good produced by the other firms. In Cases 1 and 2 the effects that arise when the two public firms merge are the same. Thus, there is greater scope for a merger in Case 1 than in Case 2 because the effects that arise with no merger are different in these two cases. The output effect is the same in both cases since each local public firm takes into account the consumer surplus of its own region and the two regions are identical. Therefore the result is due to the internalization effect. When goods 1 and 2 are substitutes, the internalization effect leads to less being produced in Case 1 than in Case 2. This is because in Case 1 the firms in each region produce perfect substitute goods while in Case 2 they produce imperfect substitute goods. When goods 1 and 2 are complements, the

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<sup>12</sup> When there is a multiplant private firm with one plant in each region, the national authority is indifferent between merging the two local public firms and not doing so.

internalization effect leads to less being produced in Case 1 than in Case 2. As a result, consumer surplus in Case 2 is greater than in Case 1 so the difference between the consumer surplus with and without a merger is greater in Case 1 than in Case 2. As seen in Propositions 1 and 2, the difference between the consumer surplus with and without a merger is a key factor in explaining mergers between local public firms. As this difference is greater in Case 1 than in Case 2 there is greater scope for a merger in Case 1.

## 7. Extensions of the model

In this section we check the robustness of the results obtained in the paper by considering three extensions of the model: First, the two regions have different market sizes; second, the two regions have different numbers of private firms; and finally firms have constant marginal costs of production when local public firms are more inefficient than private firms.

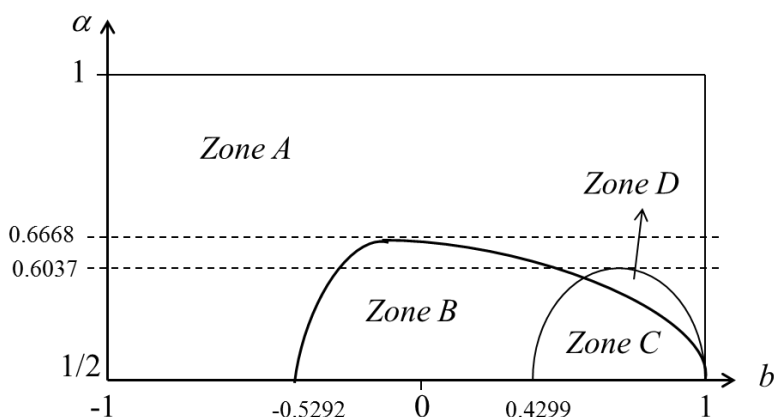
### 7.1. The two regions have different market sizes

We now assume that Region I has  $\alpha\%$  of the consumer population so it owns  $\alpha\%$  of the total consumer surplus, and Region II has  $(1-\alpha)\%$  of the total consumer surplus; therefore,  $CS^I = \alpha CS$  and  $CS^{II} = (1-\alpha)CS$ . With no loss of generality we assume that  $1/2 < \alpha < 1$ , so Region I is larger than Region II. If the national authority merges the two local public firms the government of Region I (Region II) owns  $\beta\%$  ( $(1-\beta)\%$ ) of the shares in the merged firm. The objective function of the merged firm is the weighted sum of the welfare of the two regions  $\beta W^I + (1-\beta)W^{II}$ , where  $\beta$  is the ratio of the profit of the local public firm in Region I without merger to the joint profit of the two local public firms with no merger; thus, the value of  $\beta$  is given by  $\pi_{iN}^{IA} / (\pi_{iN}^{IA} + \pi_{iN}^{IIA})$ . The percentage of the merged firm that each local government owns is the ratio of the profit of the local public



firm in its region when there is no merger to the total profit of the two local public firms with no merger.<sup>13</sup>

The results obtained in Cases 1 and 2 are illustrated in Figure 1.<sup>14</sup> We find in Case 1 (Case 2) that the two local public firms do not merge in zones C and D (B and C), but do merge in zones A and B (A and D). In both cases, the values of parameter  $b$  such that there is no merger become smaller as  $\alpha$  increases. Moreover, if  $\alpha$  is sufficiently large ( $\alpha > 0.6037$  in Case 1, and  $\alpha > 0.6668$  in Case 2) local public firms merge for all values of parameter  $b$ . This is because when the two local public firms do not merge they seek to obtain profits at the expense of the firms from the other country. The asymmetry in size encourages this behavior, so with no merger, the joint welfare of the two regions decreases with parameter  $\alpha$ . If the two local public firms merge, this behavior is mitigated since the merged firm maximizes the weighted welfare of the two regions.



**Figure 1.** Results obtained in Cases 1 and 2 with different market sizes.

In Case 3 the two local public firms merge if  $\alpha > 1/2$ , so there is greater scope for a merger than in Cases 1 and 2. If  $\alpha = 1/2$  the joint welfare obtained with and without a

<sup>13</sup> There is empirical evidence supporting this assumption. For example, the percentage of shares in Kutxabank allocated to each of the three Basque public savings banks was determined by taking into account the consolidated total assets, solvency in terms of consolidated net equity, and profitability in terms of net profit attributed to the group and social work (see <http://www.elmundo.es/mundodinero/2008/10/30/economia/1225366739.html>).

<sup>14</sup> Given the complexity of the expressions obtained in these cases, we cannot solve explicitly, so we compare the joint welfare obtained in the three cases by performing simulations (see Appendix).

merger in Case 3 is the same since the two regions are of the same size. If the two local public firms do not merge the joint welfare decreases with  $\alpha$ , so they merge for  $\alpha > 1/2$ .

## 7.2. The two regions have different numbers of private firms

In this section we assume that there are two private firms in Region I and only one in Region II. To compare with the main model we consider that the two regions are of the same size. In a merger, the government of Region I (II) owns  $\beta\%$  ( $(1-\beta)\%$ ) of the shares in the merged firm. The objective function of the merged firm is  $\beta W^I + (1-\beta)W^{II}$ , where  $\beta$  is given by  $\pi_{iN}^{IA}/(\pi_{iN}^{IA} + \pi_{iN}^{IIA})$ . Next we analyze the results obtained in the three cases (see Appendix).

In Case 1 we assume that Region I has one local public firm and two private firms that produce the same good; Region II has one local public firm and one private firm that produce the same good. We find that the local public firms do not merge if  $b < -0.5268$  or if  $0.1503 < b < 0.9158$ . Proposition 1 shows that the local public firms merge for  $b < 0.4029$ . Therefore, the scope for a merger is the same as or smaller than in Proposition 1 when goods are weak substitutes and complements (i.e. if  $b < 0.9158$ ), and greater when goods are close substitutes (i.e. if  $b > 0.9158$ ). In Case 2 the new private firm in Region I produces the same good as the other private firm there, and as the local public firm in Region II. We find that the two local public firms merge for  $b > -0.8810$ . Proposition 2 shows that the local public firms merge for  $b < -0.5173$ . This means that the scope for a merger is the same as or smaller than in Proposition 2 when goods are close complements ( $b < -0.5173$ ), and greater when goods are substitutes and weak complements ( $b > -0.5173$ ). An intuition that explains the above results is the following: When the local public firms do not merge, they behave strategically to increase profits at the expense of the firms in the other region, which reduces the joint welfare of the two regions. When the local public firms merge, this behavior is mitigated since the merged firm maximizes the weighted welfare of the two regions. The difference between Case 1 and Case 2 is that in Case 1 the firms in each region produce the same good, while in case 2 the public firm in each region produces the same good as the private firms in the other region. This permits the local public firms

to be more aggressive in Case 2 than in Case 1 so, and the national authority encourages a merger more in Case 2 to mitigate this aggressive behavior.

In Case 3 all private firms produce the same good. We find that the joint welfare is greater with a merger if the goods are substitutes and complements, while merger and non-merger give the same joint welfare when goods are independent in demand ( $b=0$ ). In this case the two local public firms produce the same good, so competition between them is strong. With a merger the strategic behavior of local public firms is mitigated. This leads to greater joint welfare with a merger when goods are substitutes and complements. If  $b=0$  the strategic behavior of the local public firms has no effect on social welfare, so the national authority is indifferent between merging and not merging the two local public firms.

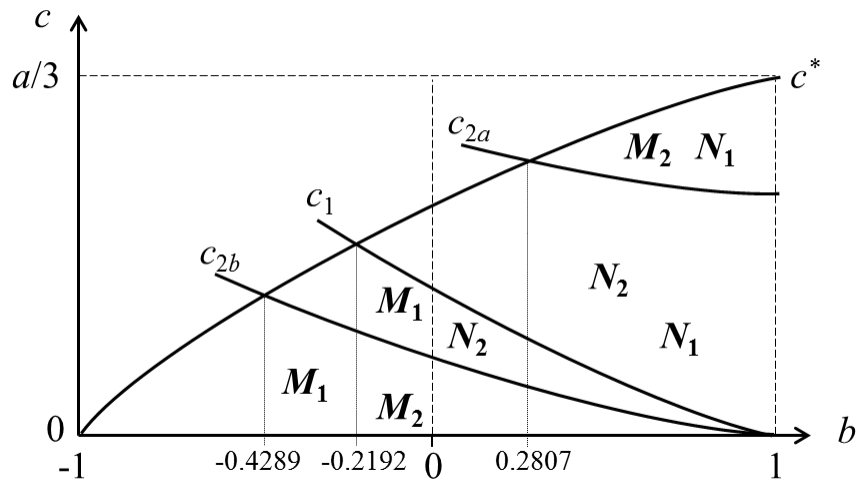
### 7.3. Constant marginal cost of production

In this section we assume that private firms have a constant marginal cost of production which is normalized to zero. The marginal cost of production of the local public firms is constant at  $c$ , where  $0 < c < c^*$ .<sup>15</sup> We denote by subscript  $Nl$  ( $Ml$ ) that the two local public firms do not merge (merge) in Case  $l$ ,  $l = 1, 2, 3$ .

Next we analyze the results obtained in each of the three cases. The expressions for the joint social welfare obtained in the different cases are relegated to the Appendix. In Case 1, we find that  $W_{M1} > W_{N1}$  if and only if  $c < c_1$ , so the national authority merges the two local public firms only in those circumstances. In Case 2 we find that  $W_{N2} > W_{M2}$  if  $c_{2b} < c < c_{2a}$ , so there is no merger only in that case. These results are shown in Figure 2.

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<sup>15</sup> This assumption is usually employed in mixed oligopoly literature to avoid a trivial solution. If the public firm is at least as efficient as the private firms the public firm will produce a quantity such that the market price equals its marginal cost, resulting in a local public monopoly (see Pal, 1998; Estrin and de Meza, 1995). The value of  $c^*$  and other critical values of parameter  $c$  are relegated to the Appendix. The assumption  $c < c^*$  ensures that the output of all firms is positive in all the cases considered.



**Figure 2.** Results obtained in Cases 1 and 2 with constant marginal costs.

In Case 3 the two local public firms produce the same good which may be a substitute or complement of the good produced by the private firms. Thus, the two regions are equal and the national authority is indifferent between merging the two local public firms and not doing so, independently of the functional form of the cost function of the firms. Next we compare Cases 1 and 2.

A comparison of the results for Cases 1 and 2 reveals that when the marginal production cost is constant and the local public firms are less efficient than the private firms, the main results of the model hold. This is because in that case the same effects arise as when production costs are quadratic. Note that if the inefficiency of the local public firms is high enough (i.e. when  $c_1 < c < c_{2a}$ ) there is no merger in Cases 1 and 2. In both cases, each plant of the state corporation produces more than each local public firm since the output effect is stronger with a merger. If the inefficiency of the local public firms is high enough there is no merger due to the output effect.

Only when the inefficiency of the local public firms is high enough is there more scope for a merger in Case 2. In this Case, when goods are substitutes the state corporation and the local public firms internalize the fact that the two regions produce imperfect substitute goods, which reduces the total output. The state corporation also internalizes the fact that the good produced by each plant is a perfect substitute of the good produced by the private firm in the other region, which further reduces the total output. Thus, the internalization

effect is stronger with a merger than without one, which leads to lower total output in case of a merger. If the marginal cost of the local public firms is high enough (i.e. when  $c > c_{2a}$ ), the two local public firms merge in Case 2 since the internalization effect dominates the output effect. In Case 1, the internalization effect is weaker than in Case 2 so the output effect dominates; as a result, the national authority does not merge the two local public firms when  $c > c_{2a}$ .

## 8. Conclusions

There is widespread evidence of mergers between public and private firms, and in such mergers public firms may play an important role. This is, for example, the case of mergers between public banks. The literature on mixed markets has analyzed the decision to merge by private and public firms, and by private firms that compete with a public firm. However, it has not studied mergers between local public firms that belong to the same country. We seek to fill this gap in the literature with the analysis in this paper.

We consider two regions, each of which has a local public firm and a domestic private firm. There is a national authority that decides whether or not to merge the two local public firms and set up a state corporation. The goods produced by the firms may be homogeneous, substitutes or complements. Thus, given that there are two regions, there are three cases. In Cases 1 and 2, the local public firms produce the same good. However, in Case 1 firms in each region produce a homogeneous good, while in Case 2 they produce heterogeneous goods. In Case 3 the two local public firms produce the same good.

We find in Case 3 that given that the two local public firms produce the same good, the national authority is indifferent between merging them and not doing so. This result does not hold when the two local public firms produce heterogeneous goods. In Case 1 the firms in each region produce the same good, and the national authority merges the two local public firms if the goods produced in the two regions are complements, independent in demand and weak substitutes. In Case 2, the firms in each region produce heterogeneous goods and the national authority merges the two local public firms only if goods are close complements. Therefore, we find that there is greater scope for mergers in Case 1 than in Case 2.

We consider three extensions of the main model to check the robustness of the results. First, we find that the scope for a merger between the two local public firms becomes greater as one region increases its size in comparison to the other. Second, if one region has two private firms and the other just one, we find that there is greater scope for a merger if goods are close substitutes in Case 1, if goods are substitutes and weak complements in Case 2, and if goods are substitutes and complements in Case 3. Finally, we consider that firms have constant marginal costs of production when local private firms are more inefficient than private firms. We find that if the inefficiency of the public firms is low enough the main results of the paper hold.

This analysis of the robustness of results points to some possible extensions of the paper. For example, it would be interesting to consider a larger number of private firms in the two regions, to analyze how this affects the merger between local public firms. It would also be interesting to analyze whether the results of the model hold when different types of market competition, e.g. price and spatial competition, are considered. These extensions of the paper make computations cumbersome, so a simplification of the main model is needed. We leave this for future research.

## Appendix

### *Proof of Proposition 1*

$$W_M - W_N = \frac{5a^2(1-b)(198b+153b^2+20b^3-115)}{(11+5b)^2(25+7b)^2} > 0 \text{ if and only if } b < 0.4299,$$

$$CS_M - CS_N = \frac{75a^2(1-b)(1+b)(47+17b)}{(11+5b)^2(25+7b)^2} > 0 \text{ for all } b,$$

$$PS_M - PS_N = -\frac{10a^2(1-b)(295+579b+204b^2+10b^3)}{(11+5b)^2(25+7b)^2} > 0 \text{ if and only if } b < -0.6564,$$

$$\pi_{iM}^{kA} - \pi_{iN}^{kA} = -\frac{5a^2 20b^3}{(11+5b)^2(25+7b)^2} > 0 \text{ if and only if } b < -0.3217.$$

### *Proof of Proposition 2*

$$W_M - W_N = -\frac{a^2(1-b)(651-b150b1-b45b^2-4b^3)}{(11+5b)^2(27+7b-2b^2)^2} > 0 \text{ if and only if } b < -0.5173,$$

$$CS_M - CS_N = \frac{3a^2(1-b)(1+b)(267+73b-20b^2)}{(11+5b)^2(27+7b-2b^2)^2} > 0 \text{ for all } b,$$

$$PS_M - PS_N = -\frac{2a^2(1-b)(433+585b+102b^2-32b^3)}{(11+5b)^2(27+7b-2b^2)^2} > 0 \text{ if and only if } b < -0.9393,$$

$$\pi_{iM}^{kA} - \pi_{iN}^{kA} = -\frac{a^2(1-b)(215+311b+64b^2-14b^3)}{(11+5b)^2(27+7b-2b^2)^2} > 0 \text{ if and only if } b < -0.8825.$$

*The two regions have different market sizes*

We denote by subscript *Nl* (*MI*) that the two local public firms do not merge (merge) in Case *l*, *l* = 1, 2, 3. As the two regions have different sizes computations are cumbersome, so we have to compare the joint welfare obtained in the different cases by performing simulations.

Solving Case 1 we obtain the following result:

$$W_{N1} = (a^2(22333 + 4436a - 4508a^2 + 144a^3 - 72a^4 + 120b^3(5 - 6a + 6a^2) - 10b(1063 - 252a + 252a^2) - 4b^4(25 - 80a + 98a^2 - 36a^3 + 18a^4) + b^2(505 - 2956a + 3100a^2 - 288a^3 + 144a^4)))/(2(154 + 9a - 9a^2 + b^2(-10 - 9a + 9a^2))^2),$$

$$W_{M1} = -(a^2(72a^4(1 - 2\beta)^4 + 6a^3(1 - 2\beta)^3(-31 + 48\beta) + a^2(1 - 2\beta)^2(109 - 4892\beta + 4766\beta^2) - (1 - \beta)^2(47 - 8196\beta + 30482\beta^2) + \alpha(52 - 3790\beta + 2050\beta^2 + 19600\beta^3 - 17912\beta^4) + 4b^4(1 - 2\beta)^2(18a^4(1 - 2\beta)^2 + 10\alpha(3 - 11\beta)\beta + 25\beta^2 - 6a^3(1 - 14\beta + 24\beta^2) + a^2(13 - 92\beta + 182\beta^2)) + 10b^3(45a^3(-1 + 2\beta)^3 - 5\beta^2(12 - 30\beta + 37\beta^2) - 3a^2(1 - 2\beta)^2(14 - 2\beta + 47\beta^2) + \alpha(-8 - 34\beta + 213\beta^2 - 508\beta^3 + 564\beta^4)) - 10b(44 + 128\beta - 1717\beta^2 + 2902\beta^3 - 1357\beta^4 + 45a^3(-1 + 2\beta)^3 - 3a^2(1 - 2\beta)^2(44 - 62\beta + 107\beta^2) + \alpha(133 - 1084\beta + 2697\beta^2 - 2764\beta^3 + 1284\beta^4)) + b^2(-144a^4(1 - 2\beta)^4 + 6a^3(-1 + 2\beta)^3(-35 + 96\beta) - a^2(1 - 2\beta)^2(-127 - 3460\beta + 3694\beta^2) - 5(-20 - 2\beta + 329\beta^2 - 968\beta^3 + 446\beta^4) + 2\alpha(391 - 2299\beta + 7823\beta^2 - 12696\beta^3 + 6236\beta^4)))/(2(33 + 9(-1 + b^2)\alpha^2(1 - 2\beta)^2 + 10(-22 + b^2)\beta + (187 + 5b^2)\beta^2 - 6\alpha(-1 + 2\beta)(-4 - 3\beta + b^2(1 + 3\beta))))^2), \text{ where } \beta = (5b(2 - 3\alpha) - 22 - 17\alpha - 3a^2 + b^2\alpha(2 + 3\alpha))(77 - 23\alpha - 12a^2 + 4b^2\alpha(2 + 3\alpha) - 5b(7 + 3\alpha))/(72a^4 - 3458 - 1883\alpha + 1811a^2 - 144a^3 - 35b^3(10 - 27\alpha + 27a^2) + 5b(686 - 369\alpha + 369a^2) + b^2(1231\alpha - 730 - 1375a^2 + 288a^3 - 144a^4) + 4b^4(25 - 80\alpha + 98a^2 - 36a^3 + 18a^4)).$$

The two local public firms merge if  $W_{N1} < W_{M1}$ . In that case, although one region may worsen it may receive payments from the other so that both may improve their welfare.

In Case 2 we obtain the following:

$$W_{N2} = (a^2(2b^7 + b^3(3166 + 228\alpha - 228\alpha^2) - b^6(6 - 8\alpha + 8\alpha^2) - 2b^5(53 + 87\alpha - 87\alpha^2) + b^4(71 + 920\alpha - 992\alpha^2 + 144\alpha^3 - 72\alpha^4) - 18b(898 - 97\alpha + 97\alpha^2) + 36(857 + 177\alpha - 179\alpha^2 + 4\alpha^3 - 2\alpha^4) - b^2(5107 + 5500\alpha - 5644\alpha^2 + 288\alpha^3 - 144\alpha^4))/ (2(b^4 + 9(20 + \alpha - \alpha^2) - b^2(37 + 9\alpha - 9\alpha^2))^2),$$

$$W_{M2} = (a^2(1808 + 2b^7(1 - 2\beta)^4 - 72\alpha^4(1 - 2\beta)^4 - 2b^6(3 - 4\alpha + 4\alpha^2)(1 - 2\beta)^4 - 23416\beta + 92497\beta^2 - 126304\beta^3 + 55298\beta^4 + 6\alpha^3(-1 + 2\beta)^3(-31 + 48\beta) - \alpha^2(1 - 2\beta)^2(1183 - 9188\beta + 9062\beta^2) + 2\alpha(-428 + 3233\beta + 595\beta^2 - 19472\beta^3 + 17548\beta^4) + 2b^5(1 - 2\beta)^2(-17 + 67\alpha^2(1 - 2\beta)^2 + 86\beta - 54\beta^2 + \alpha(-35 + 204\beta - 268\beta^2)) - b^4(1 - 2\beta)^2(-45 + 72\alpha^4(1 - 2\beta)^2 + 214\beta + 4\beta^2 - 24\alpha^3(1 - 14\beta + 24\beta^2) + 10\alpha^2(45 - 196\beta + 232\beta^2) - 4\alpha(70 - 369\beta + 508\beta^2)) + b^2(-676 + 144\alpha^4(1 - 2\beta)^4 + 7494\beta - 24663\beta^2 + 28776\beta^3 - 10586\beta^4 - 6\alpha^3(-1 + 2\beta)^3(-35 + 96\beta) + \alpha^2(1 - 2\beta)^2(1353 - 9380\beta + 9614\beta^2) + \alpha(-266 + 4462\beta - 27214\beta^2 + 56784\beta^3 - 36152\beta^4)) - 2b^3(-232 + 2358\beta - 7806\beta^2 + 9902\beta^3 - 4357\beta^4 + 225\alpha^3(-1 + 2\beta)^3 + \alpha^2(1 - 2\beta)^2(74 - 1106\beta + 431\beta^2) + \alpha(248 - 1330\beta + 1113\beta^2 + 1972\beta^3 - 1724\beta^4)) + 2b(-608 + 6836\beta - 25777\beta^2 + 35422\beta^3 - 16161\beta^4 + 225\alpha^3(-1 + 2\beta)^3 - \alpha^2(1 - 2\beta)^2(443 - 62\beta + 737\beta^2) + \alpha(988 - 6924\beta + 14757\beta^2 - 11196\beta^3 + 2948\beta^4)))/ (2(48 + b^4(1 - 2\beta)^2 - 280\beta + 247\beta^2 - 9\alpha^2(1 - 2\beta)^2 - 6\alpha(4 - 5\beta - 6\beta^2) + b^2(9\alpha^2(1 - 2\beta)^2 - 16 + 74\beta - 59\beta^2 + 6\alpha(1 + \beta - 6\beta^2)))^2), where  $\beta = ((b^3\alpha - 2b(13 - 7\alpha) + b^2(2 - 6\alpha - 3\alpha^2) + 3(12 + 7\alpha + \alpha^2))(11b(2 + \alpha) + b^3(-3 + 4\alpha) + b^2(11 - 15\alpha - 12\alpha^2) + 6(-12 + 5\alpha + 2\alpha^2)))/(b^3(-359 + 381\alpha - 381\alpha^2) + b^5(-29 + 132\alpha - 132\alpha^2) + b^6(1 - 8\alpha + 8\alpha^2) + 9b(556 - 157\alpha + 157\alpha^2) + b^2(-1466 + 2665\alpha - 2809\alpha^2 + 288\alpha^3 - 144\alpha^4) + 18(-244 - 159\alpha + 163\alpha^2 - 8\alpha^3 + 4\alpha^4) + b^4(233 - 695\alpha + 767\alpha^2 - 144\alpha^3 + 72\alpha^4))$ .$$

The two local public firms merge if  $W_{N2} < W_{M2}$ .

In Case 3 we obtain the following:

$$W_{N3} = \frac{a^2(857 - 4b^4(1 - 2\alpha)^2 + 100\alpha - 100\alpha^2 - b(452 - 80\alpha + 80\alpha^2) - 64b^2(2 + \alpha - \alpha^2) + 16b^3(5 - 2\alpha + 2\alpha^2))}{72(5 - b^2)^2},$$

$$W_{M3} = \frac{a^2(49 - 24b - 8b^2 + 4b^3)}{4(5 - b^2)^2}, \text{ and } W_{M3} - W_{N3} = \frac{a^2(5 + 2b - 2b^2)^2(1 - 2\alpha)^2}{72(5 - b^2)^2} > 0 \text{ since } \alpha > 1/2.$$

*The two regions have a different number of private firms*



In Case 1 we obtain the following:

$$W_{N1} = \frac{8a^2(34675-16120b-1148b^2+1092b^3-67b^4)}{(725-77b^2)^2},$$

$$W_{M1} = 2a^2(4b^4(1-2\beta)^2(-39+30\beta-28\beta^2) - 2(600+9905\beta-105377\beta^2+194020\beta^3-99272\beta^4) + b^3(1575-5786\beta+12054\beta^2-11256\beta^3+5184\beta^4) - 2b^2(2130-8409\beta+15409\beta^2-12212\beta^3+5128\beta^4) + b(5625-20190\beta-37846\beta^2+119352\beta^3-62272\beta^4))/((75-884\beta+896\beta^2+b^2(21+44\beta-32\beta^2))^2), \text{ where } \beta = \frac{5(55-38b+7b^2)(50+5b-7b^2)}{34775-27410b+2136b^2+2506b^3-487b^4}.$$

$W_{N1} = W_{M1}$  if  $b=-0.5268$ , if  $b=0.1503$  and if  $b=0.9158$ ,  $W_{N1} > W_{M1}$  if  $0.1503 < b < 0.9158$  and if  $b < -0.5268$ , and  $W_{N1} < W_{M1}$  for the rest of values of  $b$ .

In Case 2 we obtain the following:

$$W_{N2} = \frac{8a^2(53208-28227b-14986b^2+8047b^3+869b^4-472b^5-15b^6+8b^7)}{(891-251b^2+8b^4)^2},$$

$$W_{M2} = 2a^2(7242-60b^6(1-2\beta)^4+32b^7(1-2\beta)^4-110896\beta+535726\beta^2-861200\beta^3+438592\beta^4-8b^5(1-2\beta)^2(63-391\beta+390\beta^2)+2b^4(1-2\beta)^2(472-2911\beta+2886\beta^2)+b(-3873+58850\beta-284110\beta^2+457176\beta^3-233216\beta^4)-2b^2(2359-30035\beta+121433\beta^2-182780\beta^3+91512\beta^4)+b^3(2521-32018\beta+129662\beta^2-195640\beta^3+98240\beta^4))/((165+8b^4(1-2\beta)^2-1256\beta+1280\beta^2-7b^2(11-64\beta+64\beta^2))^2), \text{ where } \beta = \frac{(132-65b-11b^2+4b^3)(231-134b-5b^2+4b^3)}{50904-51630b+9026b^2+4330b^3-1062b^4-68b^5+20b^6}.$$

$W_{N2} = W_{M2}$  if  $b=-0.8810$ ,  $W_{N2} > W_{M2}$  if  $b < -0.8810$ , and  $W_{N2} < W_{M2}$  for the rest of values of  $b$ .

In Case 3 we obtain the following:

$$W_{N3} = \frac{a^2(351+162b-b^2)}{162(2+b)^2}, W_{M3} = \frac{a^2(13+6b)}{6(2+b)^2} \text{ since } \beta = \frac{1}{2}; W_{N3} - W_{M3} = -\frac{a^2b^2}{162(2+b)^2} > 0 \text{ if } b \neq 0.$$

### *Constant marginal cost of production*

The expressions for the joint social welfare obtained in the different cases are the following.

$$W_{N1} = \frac{2(4a^2 - a(5+2b+b^2)c + 2(5+4b+b^2)c^2)}{(3+b)^2}, W_{M1} = \frac{a^2 - 2ac + (3+2b)c^2}{1+b}.$$

$$W_{M1} - W_{N1} = \frac{(1-b)(a-c)(a(1-b) - (7+7b+2b^2)c)}{(1+b)(3+b)^2} > 0 \text{ if and only if } c < c_1 = \frac{a(1-b)}{7+7b+2b^2}.$$

$$W_{N2} = \frac{4a^2(2-b)(3-b^2) - 2a(17-b(4+(7-2b)b))c + 4(3+2b)(3-b^2)c^2}{(5+b-2b^2)^2}, W_{M2} = W_{M1}.$$

$$W_{M2} - W_{N2} = \frac{(1-b)(a-(3+2b)c)(a(1-b) - (13+11b-4b^2-4b^3)c)}{(1+b)(5+b-2b^2)^2} < 0 \text{ if and only if } c_{2b} < c < c_{2a},$$

where  $c_{2b} = \frac{a(1+b)}{13+11b-4b^2-4b^3}$ ,  $c_{2a} = \frac{a}{3+2b}$  and  $c_{2b} < c_{2a}$ .

$$W_{N3} = W_{M3} = \frac{a^2(17-16b-8b^2+8b^3) - 2a(9-8b-4b^2+4b^3)c + (9-4b^2)c^2}{2(3-2b^2)^2}.$$

We assume that  $c < c^* = \frac{a(1+b)}{2(2+b)}$  to assure that the output of each firm is positive in all the cases considered.

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