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Inter-region Subsidy Competition for a New Production Plant: What is the Central Government Optimal Policy?

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Abstract

This paper models inter-regional competition for FDI and optimal government policy intervention to protect the national interest. Two regional authorities bargain with a single multinational over where it will locate. This potentially leads to excessive competition between the regions, favouring the multinational. The federal government obviously wants to limit such competition but lacks information on comparative advantage. This paper examines its optimal policy. Among the main results we have the following two: First, the federal government would use tax policy to create asymmetries even when the underlying structure is symmetrical. Second, there are situations where, even though one MNC is more productive in one region, it is optimal for the country to make it go to the other one.

1 Introduction

It is well known that, in order to take advantage of positive externalities, local jurisdictions are willing to offer subsidies with the aim of attracting new production plants to their site. This results in multinational corporations (MNCs) holding simultaneous negotiations with different local jurisdictions' authorities within a given country to find out which one offers the most profitable conditions for the installation of a new production plant[1].

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[1] However, a similar situation could be found in the new economic blocs like the EU, NAFTA, or Mercosur, where the jurisdictions are the countries that form the blocs.

There is substantial evidence of this kind of subsidy competition. For example, in 1993 the state of Indiana packaged a $300 million deal to attract a United Airlines maintenance facility expected to create 6,300 jobs, while Kentucky issued $140 million in potential tax credits to attract 400 steel jobs (Wall Street Journal, July 6, 1993). A survey of regional incentives programs implemented in other OECD countries can be found in Chandler and Trebilcock (1986). There is also evidence that this intergovernmental competition is quite common between municipalities, which enter 'bidding wars' using firm-specific agreements to attract plants (King, et al. (1993)).

There is also an existing literature that, using different set-ups, models this subsidy competition to attract MNCs to particular locations. For example, Bond and Samuelson (1986) and Doyle and van Wijnbergen (1984) model the fact that the tax competition between countries takes the form of a tax holiday. King and Welling (1992) examine a two-period model in which two regions compete simultaneously in each period. Closer to our approach, Barros and Cabral (2000) analyse "subsidy games" between countries in order to attract foreign direct investment (FDI) from a third country. They do welfare comparisons between the equilibria achieved by competitive subsidy, zero subsidy, and first-best subsidy.

In the present paper we are interested in the particular case where the central government of the country intervenes in this competition process in order to protect the national interest. To the best of my knowledge, Adams and Regibeau (1998) is the only paper that considers such a central government intervention. In a context of the tariff-jumping argument for FDI and the possibility that the local authorities offer subsidies in order to attract MNCs, their paper tries to determine what the optimal import tariff is.

However, there are two puzzling stylised facts that have not been addressed in their paper. First, the fact that central governments favour some regions and not others even when they are similar in terms of, say, level of development and strategic location.

The widespread use of special economic zones by countries all around the world is an important evidence for this type of asymmetric treatment. The privileges that these special economic zones enjoy give them significant competitive advantages relative to other non-favoured areas[2]. Indeed, the best example of this particular asymmetric treatment can be found in China, where at the beginning of the 1980's the central government gave special economic privileges to three cities in Guangdong, one in Fujian, and none in Guangxi (see Litwack and Qian, 1998). In this case the asymmetric treatment was applies even though there was no apparent difference between the three regions in terms of development or strategic location. Another more recent but less successful example is the creation of three special economic zones in Russia in 1997 (i.e. in the Kaliningrad, Nakhodka, and Ingushetia regions). Thus, knowing that a symmetric

[2] According to the ILO database (1993) the number of, what they call, export processing zones and the number of countries hosting them, have expanded rapidly. Thus, there are now more than 1000 export processing zones spread around more than 100 countries and employing more 40 million people.

treatment of similar regions would be desirable in terms of a more even regional development, why the asymmetric policy is chosen instead? Is it because it generates a higher aggregate welfare than the symmetric one?

The main purpose of the present paper is to show that, under certain circumstances, this is indeed the case. The principle underlying this result in our model is that an asymmetric tax treatment of similar regions is more effective than a symmetric one in reducing the adverse effect that the subsidy competition between the regions has on the country's welfare. For, in some circumstances, it reduces the bargaining power of the MNC.

Another worth mentioning result that emerges from our model is that, under some circumstances, the optimal central government policy generates a mismatch between a particular region and a MNC. By mismatch we mean a situation where, even though one MNC is more productive in one region, due to the central government's optimal policy it goes to the other one. The existence of mismatches contrasts with the solution when there is no central government intervention, in which case this never happens. This interesting result stems from the fact that in our model the central government has imperfect information about the type of MNC that is coming to the country. This implies that the taxes set ex-ante by the central government have to be conditional on the regions ultimately chosen by the MNC and not on their own type. Then, the central government faces a trade-off between reducing the inter-region subsidy competition and achieving the best match between region and MNC. In some situations the achievement of the former target gives rise to a mismatch. This result seems to support some critics' views that privileges given to particular regions are made at the cost of creating inefficiencies in the regional allocation of resources. However, in our model, this comes as a result of the central government applying a policy that maximises the country's welfare.

The structure of the paper is as follows. The basic model is presented in Section 2. The first part of this section we begins by assuming one country with two identical regions, but the regions are allowed to differ in the second part. In Section 3 the main results of the model are discussed. Section 4 concludes and makes suggestions for further research.

2 The model

We assume a two-stage game involving the central government, two regions (i.e. 1 and 2), and an MNC. In the first stage, the central government determines the lump sum taxes to be imposed on the MNC[3] in each of the regions in order to maximise the country's welfare[4], which is equal to the local welfare (externality

[3] Whether the federal tax is on the MNC or on the region does not make any difference in terms of the payoff the MNC and the state get.

[4] The in-advance setting of the taxes (a federal government take-it-or-leave-it offer to the MNC) acts as a commitment device for the federal government not to bargain with the MNC. Even though we do not prove it here, it seems obvious that because the federal government cannot prevent the regional subsidies, a take-it-or-leave-it offer would provide a higher country's welfare than a direct bargaining with the MNC. Furthermore, the central government

minus regional subsidy) plus the central government tax. In the second stage, the MNC bargains with the two regional governments on the level of the lump sum subsidies to be paid by the winning region[5]. Initially we assume that the MNC makes no pre-subsidy profit and it only generates positive externalities to the host region. Each regional government maximises its own utility, which is equal to the externality produced by the MNC minus the subsidy[6]. Suppose that, in this stage of the game, all players have perfect information. This means that the externality produced by the MNC in each region, the taxes imposed by the central government in the first stage of the game, and the payoff that the MNC obtains if it does not invest in the country are common knowledge. For simplicity, the later is assumed to be zero.

To model the three-player bargaining process in which each regional government bids a lump-sum subsidy to attract a MNC, we use a version of the non-cooperative bargaining approach developed by Bolton and Whinston (1993). In our context, this is an alternating-offers framework where the MNC alternates in making offers with the two regions. When it is the MNC's turn to make an offer, it can demand either a particular subsidy from one of the regions or it can make no demand. When it is the regions' turn to make an offer, they simultaneously bid the subsidy they are willing to pay. The result of this bargaining framework is that the MNC's payoff is the maximum between: a) half of the after-tax surplus (i.e. externality minus central government tax) it produces in the winning region; and b) the value of its outside option, given by the after-tax surplus it produces in the other region.

2.1 Two identical regions

The simplest case is when there is only one type of MNC and both regions are identical. In this case the externality produced by the MNC is the same in both regions.

commitment is sometimes originated is tax treaties signed decades in advance.

[5] The bargaining seems a very appropriate framework to analyse this kind of problem because this is the most common way the MNCs induce different regions to compete for their production plants. This aspect has been particularly ignored by the literature, which seems to have a preference for the use of an auction framework. Furthermore, we assume here that the regional government cannot pre-commit to subsidies (or taxes) as the federal government does it. The main justification for this assumption is the fact that an MNC would more easily accept a pre-commitment if it is imposed by a third party (in this case the central government) than if it is imposed to itself by the region. Thus, we could say that the federal government is a very good commitment tool for the regions. However, we recognise that it could be worth investigating the effects that the introduction of some regional pre-commitment power has on the model's results.

[6] We are assuming that each region government does not consider the central government tax revenue in its own utility function. Obviously, this is not necessarily a realistic assumption if the way the central government expends this tax revenue result in higher benefits for the competing regions. However, one justification for assuming that can be the existence of a large number of regions in the country. In this case, each region will get negligible benefits from this central government tax revenue. Indeed, the federal government can expend this tax revenue in a way that only increases the utility of the regions that are not participating in the competition for the MNC.

On the one hand, in the absence of central government intervention, the competition between the regions induces them to offer a subsidy equal to the full externality produced by the MNC. Thus, the MNC obtains a benefit equal to the total externality and each region gets zero. The country's welfare is obviously also zero.

On the other hand, in the presence of central government intervention, it is optimal for it to eliminate one region from the competition (by setting a very high tax if the MNC chooses this region) and to charge the MNC a tax equal to the externality it produces in the other region. We will call this an "asymmetric tax policy"[7]. Then, the benefit of the externality is totally absorbed by the country.

In the previous example there was only one type of MNC. However, it is usually the case that a variety of MNCs are involved in negotiations with the different regions of a country. Then, industrial, technological, as well as, financial characteristics may produce differences in the externalities created by each particular MNC. To consider this we allow the existence of two types of MNCs (i.e. a or b), which can produce different externalities, but the regions are still identical. Furthermore, it is usually the case that the central government has less information than the regions about the externalities produced by the MNCs[8]. This feature is captured by assuming that it knows the externality each type of MNC can produce, but it does not know the realisation of the MNC type. In particular, it only knows that an MNC of type a shows up with probability p and an MNC of type b does it with probability $1 - p$. On the contrary, the regions know the MNC's type showing up at each particular time.

Again, in the decentralised solution (the one without central government intervention), the subsidy competition allows the MNC to obtain the full benefit of the externality whatever its type is. Thus, there is no country's welfare derived from the new production plant. However, when the central government intervenes it is natural to think that, given that both regions are identical, it should apply a symmetric tax policy. It also seems reasonable to conjecture that the optimal central government policy is to eliminate one of the regions from the competition and to apply an appropriate tax on the other one (asymmetric tax policy). Indeed, it could be the case that both tax policies are equally optimal. In order to know which one of these alternatives is the right one under each particular setting we use two numerical examples. In both examples we assume that an MNC of type a generates an externality of £40 and an MNC of type b one of £20.

Example 1 *In the first case we additionally assume that the probability of an*

[7] Under the present case, this same result can be obtained by a "symmetric tax policy" which consist in charging the same tax in each region, which must be equal to the externality produced by the MNC.

[8] While central governments may have just as much (or better) information than regional governments they would be unable to use it if they have to set the taxes very well in advance. The result may well be that the information the central governments have at the time of committing to particular taxes is lower than the one the local governments have when they bargain with the MNCs.

MNC of type a showing up is high (say $p = 0.8$). If this is the case, it pays to get the full externality from the MNC of type a, even though this is done at the cost of not attracting the MNC of type b. Thus, the optimal central government tax in each region in the case of the symmetric tax policy, or in the non-eliminated region in the case of the asymmetrical one, is equal to the externality produced by the MNC of type a (£40). Now, the MNC of type b does not come to the country under any of the tax policies, but the full externality is extracted from the MNC of type a. Then, both a symmetric and asymmetric tax policies are equally optimal for the country.

However, a different result is obtained in the next example.

Example 2 *In this second example we assume a low enough p (say $p = 0.2$) as to make it optimal for the central government to attract both types of MNCs. Let's first obtain the country's welfare under the asymmetric tax policy. In this case the central government eliminates one region from the competition (say region 1) and it charges a tax equal to the externality produced by the MNC of type b (£20) in the remaining one. As a result, the central government obtains the full externality produced by an MNC of type b. However, the MNC of type a bargains with the region 1 how to share the after-tax surplus of £20*[9] *(equal to the externality minus the central government tax in this region). As a result of this bargaining process, region 1 only obtains half of this after-tax surplus, for it has to give a subsidy of £10 to the MNC. This means that the country's welfare is £30 (externality minus subsidy) when an MNC of type a shows up and £20 when an MNC of type b does it.*
Let's now obtain the country's welfare under the symmetric tax policy. In this case, the optimal central government tax in each region is equal to the externality produced by an MNC of type b. As before, the central government obtains all the externality produced by an MNC of type b. However, in the case that an MNC of type a shows up, the competition between the regions makes the MNC obtain the full after-tax surplus of £20. Thus, the country's welfare is equal to £20 whichever type of MNC shows up and the symmetric tax policy is dominated by the asymmetric one.

Thus, the following proposition applies.

Proposition 1 *When there are two identical regions, two types of MNCs that produce different externalities, and it is optimal for the country to attract both of them, a dissimilar treatment of similar regions is the only optimal tax policy. For it reduces the subsidy competition when the low type of the MNCs shows up.*

It is interesting to see that it might be optimal to give different tax treatments to identical regions. Indeed, there is no way in which this last result can be achieved though the application of a symmetric tax policy. The reason for this is straightforward. It is true that setting the same tax in both regions,

[9] In this paper, the expression after-tax will refer to the tax imposed by the federal government to the MNC.

equal to the externality produced by an MNC of type b reduces the inter-region competition when this type of MNC shows up. However, this policy is not very effective when an MNC of type a shows up, for the MNC then has a binding outside option that increases the subsidy that the winning region has to pay.

2.2 Two different regions

Although the explanation of the stylised fact that the central governments give asymmetric treatments to similar states is the main aim of the paper, it is interesting to know what we can learn from it when the regions are not similar. So we now examine the central government's optimal policy in a more general setting.

Until now we have assumed that the MNCs do not have any profit. However, given that the addition of MNCs profits makes the model a more general one without increasing its complexity, hereafter we will do so. Then, the surplus that an MNC of type i produces in region j (s_{ij}) is equal to the sum of its profit and the externality (π_{ij} and e_{ij} respectively).

We begin solving the second stage of the game by making a definition. When an MNC of type i (i=a, b) shows up, we define a region j as 'superior' if the after-tax surplus in this region is higher or equal than in region k[10] (i.e. $s_{ij} - g_j \geq s_{ik} - g_k$)[11]. In addition, if this after-tax surplus is higher or equal than the surplus abroad (i.e. $s_{ij} \geq g_j$), this region would become the winner of the MNC of type i. Then, the equilibrium payoff for the MNC is:

$$\pi_{ij}^m = \begin{cases} \max\left\{\frac{s_{ij}-g_j}{2};\ s_{ik} - g_k\right\} & \text{if } s_{ij} \geq g_j \\ 0 \text{ otherwise} \end{cases} \tag{1}$$

Thus, if region j is the winner (i.e. the first line of expression 1 applies) the MNC's payoff would be equal to the maximum between half of the after-tax surplus an MNC of type i produces in the region j (i.e. $\frac{s_{ij}-g_j}{2}$) and the value of its outside option given by the after-tax surplus it produces in region k (i.e. $s_{ik} - g_k$). On the contrary, if the central government tax on the superior region is such that the after-tax surplus in region j is lower than the surplus abroad the MNC does not come to the country (i.e. there is no winner region) and it gets a payoff of zero.

It is obvious that the subsidy that the winning region must pay is such that, the MNC gets the payoff in expression 1. Thus, the equilibrium subsidy is:

$$d_{ij} = \begin{cases} \max\left\{\frac{s_{ij}-g_j}{2} - (\pi_{ij} - g_j);\ (s_{ik} - g_k) - (\pi_{ij} - g_j)\right\} & \text{if } s_{ij} \geq g_j \\ 0 \text{ otherwise} \end{cases} \tag{2}$$

[10] For simplicity we will consider the subscripts j and k as indicating the superior and inferior regions respectively.

[11] The central government tax is represented by the letter g. Furthermore, for simplicity we assume that if the previous weak inequality is satisfied with an equal sign, region j is the superior one.

Again, if the central government tax in the superior region is too high the MNC does not come to the country and the subsidy is equal to zero. In the upper part of expression 2 it is like if the winning region takes the full after-tax profit $(\pi_{ij} - g_j)$ from the MNC, but then it compensates the MNC by giving back the payoff in expression 1. It is obvious that this subsidy can be a negative one (i.e., a local tax) and in a lot of cases this will be the case[12].

Then, by subtracting the equilibrium subsidy from the externality in region j (i.e. e_{ij}) we get the winning region's equilibrium payoff when an MNC of type i shows up:

$$\pi^r_{ij} = \begin{cases} \left[\min\left[\frac{s_{ij}-g_j}{2};\ s_{ij} - g_j - (s_{ik} - g_k)\right]\right] & \text{if } s_{ij} \geq g_j \\ 0 \text{ otherwise} \end{cases} \tag{3}$$

We have already determined all the important analytical expressions of the second stage of the game. In the first stage the central government maximises the expected country's welfare. Thus, given that the ex-post country's welfare produced by each particular type of MNC that builds a plant in the country is equal to the central government tax plus the winning region equilibrium payoff, this expected country's welfare is:

$$\begin{aligned} w = & \begin{cases} \left(g_j + \left[\min\left[\frac{s_{aj}-g_j}{2};\ s_{aj} - g_j - (s_{ak} - g_k)\right]\right]\right) p & \text{if } s_{aj} \geq g_j \\ 0 \text{ otherwise} \end{cases} \\ + & \begin{cases} \left(g_j + \left[\min\left[\frac{s_{bj}-g_j}{2};\ s_{bj} - g_j - (s_{bk} - g_k)\right]\right]\right)(1-p) & \text{if } s_{bj} \geq g_j \\ 0 \text{ otherwise} \end{cases} \end{aligned} \tag{4}$$

The previous expression will be useful in order to accomplish our next task. That is, to determine the optimal central government taxes and to identify the winning regions under different parameter values. However, because the setting of our model includes two types of MNCs and two regions this is a substantially complex task. Hence, for simplicity, we split this setting into what we call 'economic regimes'. There will be twelve of them, but because of symmetry it is enough to only analyse the following six:

$$\textit{Economic regime I}: s_{a1} \geq s_{a2} \geq s_{b2} \geq s_{b1} \geq 0 \tag{5}$$

$$\textit{Economic regime II}: s_{a1} \geq s_{a2} \geq s_{b1} \geq s_{b2} \geq 0 \tag{6}$$

$$\textit{Economic regime III}: s_{a1} \geq s_{b2} \geq s_{a2} \geq s_{b1} \geq 0 \tag{7}$$

$$\textit{Economic regime IV}: s_{a1} \geq s_{b1} \geq s_{a2} \geq s_{b2} \geq 0 \tag{8}$$

[12] As an example, think of the case where there is no outside option, no federal tax, and no externality (the surplus is just equal to the MNC's profit). Then, for the state to get half of this surplus, it has to apply a tax on the MNC.

$$Economic\ regime\ V : s_{a1} \geq s_{b1} \geq s_{b2} \geq s_{a2} \geq 0 \tag{9}$$

$$Economic\ regime\ VI : s_{a1} \geq s_{b2} \geq s_{b1} \geq s_{a2} \geq 0 \tag{10}$$

The knowledge of these economic regimes will be helpful at the time of proving the propositions 2 to 7 and necessary in order to detect the existence of mismatches between states and MNCs already mentioned in the introduction. In these propositions we determine the optimal tax policy for each particular match between regions and MNCs. This procedure guarantee that we are considering all the possible cases and thus allow us to find the optimal tax policies under different parameter values. These last results will be summarised at the end of section 2.2.7. Before moving on, recall that a central government tax policy is the set of taxes that the central government imposes on the MNC, which as we already said are conditional on the region the MNC locates its new production plant.

2.2.1 Tax policy 1

Proposition 2 *When the country only attracts one type of MNC, the optimal tax policy (hereafter tax policy 1) is one that extracts the entire surplus from an MNC of type a in region 1 and eliminates region 2 from the competition (i.e. $g_1 = s_{a1}$ and $g_2 = \infty$).*

Proof. When the country only attracts one type of MNC, the MNC can be of type a or b. If, on the one hand, only an MNC of type a is attracted, it is optimal to eliminate region 2 and make it go to region 1 because it generates a higher surplus there. Then, the optimal tax in region 1 is one that extracts the full surplus produced by this MNC (i.e. $g_1 = s_{a1}$).

On the other hand, it is not optimal for the central government to only attract the MNC of type b. First, it is not possible to only attract the MNC of type b and make it go to region 1. For, in region 1, every tax that is accepted by an MNC of type b will also be accepted by an MNC of type a, what means that both MNC will come. Second, it is not possible to only attract the MNC of type b and make it go to region 2 in economic regimes I, II, and IV, because, again, every tax that is accepted by an MNC of type b will also be accepted by an MNC of type a, what will attract both MNCs to the country. Indeed, given that we attract the MNC of type b to region 2 in economic regimes III, V, and VI, it would be possible and optimal to also attract an MNC of type a to region 1. Thus, we conclude that it is not optimal to only attract the MNC of type b. ■

Then, by replacing tax policy 1 into expression 4 the country's welfare is:

$$w_1 = s_{a1}p \tag{11}$$

2.2.2 Tax policy 2

Proposition 3 *When the country attracts both MNCs and they go to region* 1*, the optimal tax policy (hereafter tax policy 2) is to eliminate region* 2 *from the competition and to set* $g_1 = s_{b1}$.

Proof. First, it is obvious that the two MNCs will not go to region 1 if the tax in this region is $g_1 > s_{b1}$. Second, given that region 2 is eliminated from the competition, a reduction of g_1 below s_{b1} would reduce the country's welfare whichever type of MNC shows up. Finally, given that the central government sets $g_1 = s_{b1}$, it is not optimal not to eliminate region 2. For this region would become a binding outside option, for one or the other MNC depending on the parameter values, what would reduce the country's welfare. ■

By replacing tax policy 2 into expression 4 the country's welfare is:

$$w_2 = \left(s_{b1} + \frac{s_{a1} - s_{b1}}{2} \right) p + s_{b1}(1 - p) \tag{12}$$

2.2.3 Tax policies 3a and 3b

Proposition 4 *When the country attracts both MNCs to region* 2*, the optimal tax policy is to eliminate region* 1 *from the competition and to set* $g_2 = s_{b2}$ *(hereafter tax policy 3a) if* $s_{a2} > s_{b2}$ *(i.e. in economic regimes I, II, and IV) or* $g_2 = s_{a2}$ *(hereafter tax policy 3b) if* $s_{a2} < s_{b2}$ *(i.e. in economic regimes III, V, and VI).*

Proof. First, to eliminate region 1 from the competition and to charge $g_2 > s_{b2}$ when $s_{a2} > s_{b2}$ or to charge $g_2 > s_{a2}$ when $s_{a2} < s_{b2}$, does not attract both MNCs to region 2. Second, to charge a tax $g_2 < s_{b2}$ or not to eliminate region 1 from the competition when $s_{a2} > s_{b2}$ results in a lower country's welfare. Finally, to charge a tax $g_2 < s_{a2}$ or not to eliminate region 1 from the competition when $s_{a2} < s_{b2}$ also result in a lower country's welfare. ■

The country's welfare under tax policies 3a and 3b are respectively given by the following expressions:

$$w_{3a} = \left(s_{b2} + \frac{s_{a2} - s_{b2}}{2} \right) p + s_{b2}(1 - p) \tag{13}$$

$$w_{3b} = \left(s_{a2} + \frac{s_{b2} - s_{a2}}{2} \right) p + s_{a2}(1 - p) \tag{14}$$

2.2.4 Tax policy 4

Proposition 5 *If* $s_{b2} \leq s_{a2}$ *(i.e. in economic regimes I, II, and IV) and* $s_{a1} - s_{a2} - s_{b1} + s_{b2} \geq 0$*, the optimal tax policy (hereafter tax policy 4) that attracts an MNC of type a to region* 1 *and one of type b to region* 2 *is one that sets* $g_1 = s_{a1} - s_{a2} + g_2$ *and* $g_2 = s_{b2}$.

Proof. On the one hand, for an MNC of type a to go to region 1 the two following conditions are necessary.

$$s_{a2} - g_2 \leq s_{a1} - g_1 \tag{15}$$

$$g_1 \leq s_{a1} \tag{16}$$

The first of these conditions says that the after-tax surplus of an MNC of type a must be higher in region 1 than in region 2. The second one imposes that the tax charged in the region 1 has to be low enough as to make the MNC of type a prefer region 1 to going abroad.

On the other hand, the similar conditions are necessary for an MNC of type b to go to region 2. These conditions are given by the following expressions:

$$s_{b2} - g_2 \geq s_{b1} - g_1 \tag{17}$$

$$g_2 \leq s_{b2} \tag{18}$$

Then, by replacing 15 into 17 and rearranging we get the following necessary condition for a tax policy to induce an MNC of type a to go to region 1 and an MNC of type b to go to region 2:

$$s_{a1} - s_{a2} - s_{b1} + s_{b2} \geq 0 \tag{19}$$

On the one hand, it is clear that restriction 19 is always satisfied in economic regime I, but this is not always the case in economic regimes II and IV. However, assuming that restriction 19 is satisfied, the maximum tax that can be applied in region 1 that is compatible with restrictions 15 and 16 is,

$$g_1 = \min\left(s_{a1} - s_{a2} + g_2,\ s_{a1}\right) \tag{20}$$

but because of restriction 18 and that we are assuming $s_{b2} \leq s_{a2}$, this is equivalent to:

$$g_1 = s_{a1} - s_{a2} + g_2 \tag{21}$$

On the other hand, because of 18 and 21 and given that an MNC of type a has to go to region 1 and one of type b has to go to region 2, a reduction in g_2 bellow s_{b2} will decrease the country's welfare whichever type of MNC shows up. For when an MNC of type b shows up, it is obvious that a reduction in g_2 reduces the country's welfare because, under the present tax policy, this type of MNC goes to region 2. Furthermore, when an MNC of type a shows up, a reduction in g_2 produces a fall in g_1 and so a reduction of the country's welfare. Thus, we can conclude that given $g_1 = s_{a1} - s_{a2} + g_2$, it is optimal to set $g_2 = s_{b2}$.

Similarly, given $g_2 = s_{b2}$, a reduction in g_1 bellow $g_1 = s_{a1} - s_{a2} + g_2$ would not increase the country's welfare if an MNC of type b shows up. Indeed, it would reduce it if an MNC of type a shows up. This means that, if $g_2 = s_{b2}$, $g_1 = s_{a1} - s_{a2} + g_2$ would be the optimal tax to be set in region 1. ■

Then, replacing tax policy 4 into expression 4 the country's welfare is[13]:

$$w_4 = [s_{a1} - (s_{a2} - s_{b2})]\,p + s_{b2}(1 - p) \tag{22}$$

2.2.5 tax policy 5

Proposition 6 *If $s_{b2} \geq s_{a2}$ (i.e. in economic regimes III, V, and VI), the optimal tax policy (hereafter tax policy 5) that attracts an MNC of type a to region 1 and an MNC of type b to region 2 is one that sets $g_1 = s_{a1}$ and $g_2 = s_{b2}$.*

Proof. Because we are looking for the optimal tax policy that results in the MNC of type a going to region 1 and the MNC of type b to region 2, restrictions 15, 16, 17, 18 and 19 have to be satisfied. However, given that now we assume $s_{b2} \geq s_{a2}$, restriction 19 is always satisfied.

As before, the maximum tax that can be applied in region 1 such that the MNC of type a chooses this site is given by expression 20. Indeed, since the application of this tax does not upper bound the tax to be charged in region 2, this is the optimal tax to be set in region 1. For, a higher tax would not be able to attract an MNC of type a to region 1, and a lower one would produce a lower country's welfare when an MNC of type a shows up and it would not produce a higher one when an MNC of type b does it.

Furthermore, it is optimal for the central government to set $g_2 = s_{b2}$ and extract the full surplus of an MNC of type b in region 2. For a higher tax would fail in attracting an MNC of type b to region 2 and a lower one would reduce the country's welfare whichever MNC shows up. Then, given that this is the optimal tax in region 2, the expression 20 turns into $g_1 = s_{a1}$. ■

Then, by replacing tax policy 5 into expression 4 the country's welfare is:

$$w_5 = s_{a1}p + s_{b2}(1 - p) \tag{23}$$

Before moving onto the next proposition let's make the following two definitions, which will also be useful in section 3:

Definition 1 *We will define a tax policy as dominated if there are no parameter values for which this tax policy provides the highest country's welfare.*

Definition 2 *We will define a tax policy as regime-dominated in a particular economic regime if there are no parameter values, compatible with this economic regime, for which this tax policy provides the highest country's welfare.*

Then, we continue with proposition 7:

[13] Expression 22 shows that the country's welfare in the case an MNC of type a shows up is only given by g_1. This is explained by the fact that the after tax surplus generated by an MNC of type a in region 1 is equal to the outside option and so the region 1 has to allow the MNC to appropriate all of this after tax surplus by charging a tax equal to zero.

2.2.6 tax policy 6

Proposition 7 *It is not optimal for the central government, under any economic regime, to attract both an MNC of type a to region* 2 *and an MNC of type b to region* 1.

Proof. Similarly to our proof to proposition 5, for the MNC of type b to go to region 1 and the MNC of type a to go to region 2 the four following conditions are necessary:

$$s_{b2} - g_2 \leq s_{b1} - g_1 \tag{24}$$

$$g_1 \leq s_{b1} \tag{25}$$

$$s_{a2} - g_2 \geq s_{a1} - g_1 \tag{26}$$

$$g_2 \leq s_{a2} \tag{27}$$

Then, by replacing 24 into 26 and rearranging we get the following inequality:

$$s_{a1} - s_{a2} - s_{b1} + s_{b2} \leq 0 \tag{28}$$

Thus, the present tax policy is feasible only if restriction 28 is satisfied. However, restriction 28 is never satisfied in economic regime I, III, V, and VI and so we only need to look at economic regimes II and IV.

From restriction 25 we know that the maximum tax that can be imposed in region 1 is $g_1 = s_{b1}$. Furthermore, if $s_{b2} \leq s_{a2}$ (which is the case in economic regimes II and IV), the maximum tax in region 2 that satisfies restriction 24 is $g_2 = s_{b2}$. In other words, it must be the case that $g_1 \leq s_{b1}$ and $g_2 \leq s_{b2}$.

However, the taxes in regions 1 and 2 must not be lower than s_{b1} and s_{b2} respectively. In the case of the tax in region 1 we have that, since we are looking for a case where an MNC of type b goes to region 1, a reduction of g_1 below s_{b1} would produce a fall in the welfare obtained from an MNC of type b. Indeed, by increasing the value of the outside option for an MNC of type a, a reduction in g_1 below s_{b1} would also make necessary to reduce the tax in region 2 producing a lower country's welfare when this last MNC shows up. The same argument applies to explain the fact that it is not optimal to reduce the tax in region 2 bellow s_{b2}.

Then, from the previous two paragraphs we get that the optimal tax policy to achieve this particular match between MNCs and regions is to set $g_1 = s_{b1}$ and $g_2 = s_{b2}$.

Now, to determine what the country's welfare is under this tax policy we need to know whether the outside options are binding or not. On the one hand, it is obvious that, since $g_1 = s_{b1}$ and $g_2 = s_{b2}$, region 2 does not constitute a binding outside option for an MNC of type b[14]. On the other hand, region 1 will not be a binding outside option for an MNC of type a if the following inequality applies.

$$\frac{s_{a2} - g_2}{2} \geq s_{a1} - g_1 \tag{29}$$

[14] Region 2 is not a binding outside option for an MNC of type b if $\frac{s_{b1} - g_1}{2} \geq s_{b2} - g_2$.

Table 1: Tax policies that are not regime dominated

Tax Policy	Tax imposed on each region		MNC that each region gets		Economic Regime
	g_1	g_2	region 1	region 2	
1	$g_1 = s_{a1}$	$g_2 = \infty$	a		I, II, and IV
2	$g_1 = s_{b1}$	$g_2 = \infty$	a, b		I, II, IV, and V
3a	$g_1 = \infty$	$g_2 = s_{b2}$		a, b	I^a
4	$g_1 = s_{a1} - (s_{a2} - g_2)$	$g_2 = s_{b2}$	a	b	I, II^b, and IV^b
5	$g_1 = s_{a1}$	$g_2 = s_{b2}$	a	b	III, V^b, and VI

Note: The superscripts a and b on the number identifying the economic regime specifies the type of MNC for which the particular tax policy does not reach the best match between region and MNC.

Figure 1:

Moreover, by replacing $g_1 = s_{b1}$ and $g_2 = s_{b2}$ into 29, and rearranging we get the following expression.

$$2s_{a1} - 2s_{b1} + s_{b2} - s_{a2} \leq 0 \tag{30}$$

Thus, when inequality 30 is not satisfied in economic regimes II and IV, region 1 is a binding outside option for an MNC of type a. In this case the country's welfare is:

$$w = [s_{a2} - s_{b2} - (s_{a1} - s_{b1})]p + s_{b1}(1 - p)$$

The welfare in the last expression is lower than the one in expression 11 for every parameter values in economic regimes II and IV where the expression 30 is not satisfied. On the contrary, when inequality 30 is satisfied in economic regimes II and IV the region 1 is not a binding outside option for an MNC of type a. In this last case the country's welfare is given by the following expression.

$$w_6 = \left(\frac{s_{a2} - s_{b2}}{2}\right) p + s_{b1}(1 - p) \tag{31}$$

Again, in economic regime II and IV this country's welfare is lower than the one in expression 12. Then, we can conclude that tax policy 6 is a dominated one and so it is not optimal to attract an MNC of type a to region 2 and an MNC of type b to region 1. ■

Table 2: Parameter values under which each tax policy is the optimal one

	It provides a higher welfare than		
	1	2	3a
1		$\frac{s_{bc}+s_{ac}}{2}p - s_{bc} > 0$	$\frac{2s_{ac}-s_{ad}+s_{bd}}{2}p - s_{bd} > 0$
2	$s_{bc} - \frac{s_{bc}+s_{ac}}{2}p > 0$		
3a	$s_{bd} - \frac{2s_{ac}-s_{ad}+s_{bd}}{2}p > 0$	$s_{ad} - s_{ac} + s_{bd} - s_{bc} > 0$	
4	$s_{bd} - s_{ad}\, p > 0^{*}$	$s_{bd} - \left(s_{ad} - \frac{s_{ac}+s_{bc}}{2}\right)p - s_{bc} > 0^{*}$	$2s_{ac} - 3s_{ad} + s_{bd} > 0$
5		$(s_{ac} + s_{bc} - 2s_{bd})p + 2(s_{bd} - s_{bc}) > 0$	

* Recall from proposition 5 that for tax policy 4 to be the optimal one we also need $s_{a1} - s_{a2} - s_{b1} + s_{b2} \geq 0$ to be satisfied, which is not always the case in economic regimes II and IV.

Figure 2:

3 Results

The first result of our paper was stated in proposition 1 at the beginning of our model. By this proposition, we were able to explain the stylised fact that central governments give asymmetric tax treatments to similar regions. It seems striking that a symmetric treatment of similar states is not an optimal tax policy. Furthermore, this is not just a positive result, but also a very interesting normative one.

We can now move on to see what are the main results obtained from the previous six propositions, where we have determined the complete set of non-dominated tax policies (i.e. tax policies 1, 2, 3a, 4, and 5). These results are summarised in the first five columns of table 1. That is, for each tax policy (column 1) we specify the tax imposed in each region (columns 2 and 3) and the distribution of the MNCs between the regions (columns 4 and 5). It is interesting to find the precise parameter values for which each of these tax policies is the optimal one, but this would be easier if, as a first step, we get rid of the tax policies that are regime-dominated in each particular economic regime. Indeed, to do that will help us to detect the existence of mismatches, already mentioned in the introduction, between states and MNCs. The result of this first step is shown in the last column of table 1 where there is a summary of only the economic regimes where each particular tax policy is not regime-dominated (see appendix 1).

Then, to know the precise parameter values for which each tax policy is the optimal one, a comparison of the country's welfare generated by each of them has to be done. However, it is obvious from the last column of table 1 that this comparison is not necessary between some particular pair of policies because there is no overlapping in the economic regimes where they are not dominated (e.g. tax policy 3a is non-dominated in economic regime I and tax policy 5 is non-dominated in economic regimes III, V, and VI). Thus, a summary of the necessary comparisons is shown in table 2, which must be read as follows. For example, if all the expressions in column 1 of table 2 were higher than zero, tax policy 4 would be the optimal one. In a similar way, if all the expressions in row 4 of table 2 were lower than zero, tax policy 4 would be the optimal one. The same interpretation applies for the remaining rows and columns.

We are now in condition to look for the existence of mismatches between states and MNCs produced by the central government policy. Recall that by mismatch we mean a situation where, even though one MNC is more productive in one region, it is optimal for the country to attract it to the other one. Indeed, the existence of mismatches is an interesting result that contrasts with the solution when there is no central government intervention, where this never happens.

By using a numerical example extracted from economic regime I, we can see a case where a mismatch is created. Thus, assume that $s_{a1} = 40$, $s_{a2} = 34$, $s_{b2} = 20$, $s_{b1} = 10$, and $p = 0.5$. In this case, the central government will find it optimal to implement tax policy 3a with the consequence that both MNCs will go to region 2 and region 1 will be eliminated from the competition. Then, it is

clear that there will be a mismatch between the MNC of type a and the region 2, for that type of MNC produces a higher surplus in region 1. This is just an example of the existence of a mismatch, but as it is stated in the note to table 1, it could also appear in economic regimes II, IV, and V.

The mismatches are produced because the central government faces a trade off between reducing the negative effects the inter-region subsidy competition has on the country's welfare and reaching the best match between region and MNC. More specifically, the fact of having imperfect information about the realisation of the MNC's type leaves the central government with only two tools (the taxes in each of the two regions, i.e. g1 and g2) to reach four targets (to achieve the best match between regions and MNCs and to extract the full surplus that each MNC produces in its best match). This problem would not have existed if the central government had perfect information. For in this case it could have set the taxes conditional on both the region and the MNC's type (i.e. ga1, ga2, gb1, and gb2), in which case the central government would have had four tools. As a result each type of MNC would have gone to its best matching region and the full surplus would be extracted by the central government.

Finally, Another interesting result of the present model is that, as can be seen in table 1, the after-tax surplus will be positive only when tax policies 2, 3a, or 4 are the optimal ones and always in the case an MNC of type a shows up. This also implies that there will be no after-tax surplus in economic regimes III and VI. That is, when the highest two surpluses are produced by the MNC of type a in region 1 and the MNC of type b in region 2, in that order. In other words, when each region has advantage only for the MNC from which it gets the highest surplus (MNC a for region 1 and b for region 2), which we can identify as a case of regional high specialisation and low competition. An extreme example of this particular case would be when the regions are dissimilar but perfectly symmetric (e.g. the MNC of type a produces 40 in region 1 and 0 in region 2 and the MNC of type b produces 0 in region 1 and 40 in region 2).

4 Conclusion

With the aim of analysing a very important aspect of the last 20 years we have developed a simple model where an MNC bargains with two local governments to decide the location of its new production plant. The creation of a positive surplus to the host site induces the local governments to get involved in subsidy competition. It is clear that this competition reduces the benefits of the winning region in favour of higher profits for the MNC, with the consequent reduction in the country's welfare. Thus, it is natural to ask: Why does the central government not eliminate or at least limit this competition?

In fact, as we have already mentioned in the introduction, there is some evidence suggesting that central governments are intervening in this competition process. The clearest example is the persistence with which central governments give asymmetric tax treatments to similar regions, what became the main motivation for the present paper.

In our model an imperfectly informed government moves first by setting the taxes that the MNCs have to pay in each region. Then, at the time a particular MNC has to decide where to build a new production plant, it bargains with the two regions the amount of subsidy to be paid. We have solved the model and found some interesting results. Not surprisingly we find that it is optimal for the central government to give relative advantages to some regions in order to reduce the inter-region competition and to increase the country's welfare. This can be seen as an explanation of the existence of the so-called special economic zones or other economic regimes that create asymmetries between the regions of a particular country.

Indeed, we find out that under some particular conditions an asymmetric treatment of similar regions is the only optimal policy. This is the case because, when there are two types of MNCs and it is optimal for the country to attract both of them, a similar tax treatment makes the losing region become a binding outside option for the high type MNC, increasing in this way the subsidy paid by the winning region.

We also find that in several occasions the central government intervention generates a mismatch between region and MNC. This mismatch is produced when, even though one MNC is more productive in one region, it is optimal for the country to make it go to the other one. It is striking that, in our model, the existence of mismatches comes as a result of the central government applying a policy that maximises the country's welfare.

Let's take a look at what drives this last result. The mismatches are produced because the central government faces a trade off between reducing the negative effects the inter-region subsidy competition has on the country's welfare and reaching the best match between region and MNC. More specifically, the fact of having imperfect information about the realisation of the MNC's type leaves the central government with only two tools to reach four targets. Thus, we can say that, given that the subsidies are not observable, this result is driven by the fact that the central government has imperfect information.

However, it is not so obvious that the result also depends, as we have as-

sumed, on the fact that the central government has less information than the regions. It is possible to think of situations where this last assumption would not hold. Then, what would the optimal policy be in a setting where, even though the central government has imperfect information, it is more informed than the regions? It would be interesting to see whether or not the results still apply, and/or under what conditions, in this new and less restrictive setting. However, to model this last setting, a three-player bargaining framework with imperfect information is needed, what demands an adaptation of Bolton and Winston's (1993) bargaining approach.

Another possible extension to the present model would come out by allowing tax pre-commitment capability, not only to the central government, but also to the regions. In the case that this last setting is the appropriate one, it could be modelled by the use of a three-stage game. In the first stage the central government pre-commits to taxes and in the second one the regions. They have the same information as the central government and decide whether to pass a law or not to pre-commit to subsidies (taxes). In the third stage, the regional governments, which now have perfect information, are bound to their commitment or use bargaining. It seems worth doing this and the previous extension, but this should be combined with some empirical research to find out which one is the most appropriate setting.

Finally, two main contributions of the present paper are worth mentioning. The first one is the inclusion of the central government intervention in the inter-region competition process. This, as we have already mentioned was largely ignored by the literature so far. The second one is the use of a bargaining framework as the tool chosen by the MNC to stimulate the inter-region competition, which seems to us the most appropriate one for this particular setting.

5 Appendix

To find the economic regimes for which each tax policy is not regime-dominated we proceed by eliminating all the economic regimes where each tax policy is regime-dominated. To do this we have to compare the country's welfare provided by every tax policy in every economic regime. The result is as follows:

Tax policy 1 is regime-dominated in economic regimes III, V, and VI (by tax policy 5). Tax policy 2 is regime-dominated in economic regimes III and VI (by tax policy 5). Tax policy 3a is regime-dominated in economic regimes II and IV (by tax policy 4); and in economic regimes III, V, and VI (by tax policy 5). Tax policy 3b is regime-dominated in every economic regime (by tax policy 3a in economic regimes I, II, and IV and by tax policy 5 in economic regimes III, V, and VI). The application of tax policy 4 in economic regimes III, V, and VI will not attract the MNC of type a to the country and so it will be regime-dominated (by tax policy 5). In economic regimes I, II, and IV, tax policy 5 is equivalent to tax policy 3a and so it is possible to ignore it in these economic regimes and just to refer to tax policy 3a.

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