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The optimal country's policy to attract an MNC new production plant

by

Osiris J. Parcero

Submitted to the Department of Economics
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy (Ph.D.)

at the

UNIVERSITY OF BRISTOL

2005

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Signature of Author .....
Department of Economics
September 28, 2005

Certified by .....

Professor David de Meza
Thesis Supervisor

Accepted by .....

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Abstract

This thesis models the negotiation process between a country, composed by a central government (the principal) and one or two regions (the agents), and a multinational corporation (MNC) over the location of a new production plant. Because of non-verifiability and the fact that it has to set the taxes in advance (tax posting) the central government cannot tax-discriminate between different types of MNCs, but tax discrimination is possible under the regional bargaining. The central government optimal policy is examined under three different regional negotiation mechanisms: bargaining, tax posting, and a mixed one (where the region can choose between using bargaining and tax posting).
We first analyse the case where the country has only one region. On the one hand, we find that when the country gets an externality in addition to the tax over the MNC, it is not always the case that "bargaining with reservation price" dominates tax posting. Although in a different context this contrasts with Wang (1995) result, who does not allow for externalities.
On the other hand, we find the striking result that, under a very feasible range of values (including the case when the MNCs only produce profits and no externalities to the host site) the country's welfare is higher in the bargaining mechanism than in the mixed one. For the regional choice over the negotiation mechanisms creates a conflict of interests between the region and the country. In particular, it is optimal for the country that the bargaining strategy is used but not for the region.
Under the mixed mechanism context we also analyse inter-region competition. Interestingly, we find that the addition of a second identical region, which also operates under the mixed mechanism, resolves the problem produced by this conflict of interests.
Then, we move on to analyse the case where two regional jurisdictions, both operating under the bargaining mechanism, compete for the attraction of the MNC. The existence of two regions potentially leads to excessive competition, favouring the MNC. The central government wants to limit the adverse effect on the country's welfare produced by such competition, but it cannot tax-discriminate between different types of MNCs. Among the main results we have the following two: First, the central 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.

Thesis Supervisor:
Title: Professor David de Meza

Contents

1 Introduction **6**

1.1 Acknowledgements 9

2 Literature review **10**

2.0.1 Externalities 11

2.0.2 Tax competition between asymmetric countries 12

2.0.3 Competition versus Cooperation 16

2.0.4 Dynamic models 17

3 Bargaining versus posted price selling **18**

3.1 Introduction 18

3.2 What we understand by externality 22

3.3 Distinction between the bargaining and posted-price outcomes 24

3.4 The bargaining mechanism 26

3.5 The posted tax mechanism 31

3.6 Comparison between the bargaining and posted tax mechanisms 40

3.7 Conclusion 46

4 The region can choose between the bargaining and posted tax mechanisms **49**

4.1 Introduction 49

4.2 The model 51

4.3 Comparison between the bargaining and mixed negotiation mechanisms 55

4.4 Comparison between the posted tax and mixed negotiation mechanisms 58

4.4.1 When under the posted tax mechanism the optimal policy is to only attract the MNC of type a. 61
4.4.2 When under the posted tax mechanism the optimal policy is to only attract the MNC of type b. 63
4.5 Results 67
4.5.1 Summary of previous results 67
4.5.2 Choosing the negotiation mechanism 68
4.6 Conclusion 70

5 Competition between regions under the bargaining mechanism 72
5.1 Introduction 72
5.2 The model 74
5.2.1 Two identical regions 75
5.2.2 Two different regions 78
5.3 Results 89
5.4 Conclusion 92

6 Competition between regions under the mixed negotiation mechanism 94
6.1 Introduction 94
6.2 The model 95
6.3 One MNC type 96
6.3.1 The outside option is non-binding 97
6.3.2 The outside option is binding 99
6.4 Two MNC types and two identical regions 101
6.4.1 Numerical example 102
6.5 Conclusion 107

7 Conclusion 108

8 Bibliography 111

9 Appendix 114

List of Figures

3-1 Numerical example: the ex-post regional payoff from the high surplus MNC is lower than the one from the low surplus MNC 39

3-2 Numerical example: the posted tax mechanism dominates the bargaining one 46

4-1 The compound strategy 66

5-1 Numerical examples proving that tax policies 2, 3a, 4, 5a, and 5b are the optimal ones for some specific parameter values 89

5-2 Tax policies that are not regime dominated 90

Chapter 1

Introduction

When a multinational corporation (MNC) has to decide where to build a new production plant, there are market and fiscal considerations that make one location more attractive than another. The MNC prefers the location where the difference between the profits it can obtain and the taxes it has to pay are positive and higher than the ones attainable in other locations. On the other hand, governments also want to attract MNCs' investment if they produce a positive payoff to their site (in terms of taxes collected and externalities generated). Indeed, it is well known that, in order to take advantage of positive externalities, governments are willing to offer subsidies with the aim of attracting new production plants to their territory. This results in MNCs holding simultaneous negotiations with different governments to find out which one offers the most profitable conditions for the installation of a new production plant.

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 inter-governmental competition for foreign direct investment (FDI) 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. A comprehensive survey of it is done in chapter 2.

Thus far we have not been precise about which particular governments conduct these negotiations. However, as it is clear from the previous examples, the competition for new production plants is not just limited to be between countries. It is well known that the competition is even fiercer between regions of different countries as well as of the same country.

In fact, in the present thesis we abstract from inter-country competition and concentrate only on one country and its regions. The reason for proceeding in this way is the existence of some interesting issues in the way the surplus produced by a new production plant is divided between the host country and the MNC. Indeed, this assumption can be justified in those cases where a particular country has some market power in the world with respect to a particular MNC. This is equivalent to assume that the MNC produces a relatively higher surplus in the considered country than abroad. For example, a particular country could have a location and endowments very much appreciated by the MNC. In addition it could be the case that the externalities that the MNC produces in this country are higher than the ones produced elsewhere. To simplify we will assume throughout this thesis that the MNC produces certain positive surplus when it invests in the host country, which can be a combination of profits for the MNC and externalities to the host region, and zero surplus abroad. This assumption eliminates the problem of inter-country competition and simplifies the problem we want to address.

This problem stems from the fact that to attract an MNC to a country both, the central and regional governments are involved in the negotiation process. That is, there are subsidies and/or taxes coming from both governmental levels. Thus, we model a game among an MNC, one central government and one or two regions. Our aim is to find out what is the optimal central government policy in order to maximise the expected country's welfare.

Before moving on it is important to mention a persistent feature in the countries' negotiation process with the MNCs. Namely, the fact that the subsidies to attract MNCs are more frequently used by local rather than central governments. Indeed, it is rarely the case that the central governments bargain with the MNCs, rather regions often do so. This feature is obviously more common in big and relatively more federal countries.

To highlight the importance of this practice we quote the following paragraph taken from the web page of the Minister of Commerce, Industry and Energy of South Korea.

> Lawmakers yesterday criticized the Ministry of Commerce, Industry and Energy for lacking an efficient policy for attracting foreign direct investment in a more systematic manner.
>
> "It's true that foreign direct investment has been on the rise due to the recently launched series of government policies, but the ministry has failed to coordinate its different divisions and the provincial governments," Kim Tae-Hong of the ruling Uri Party during the National Assembly's audit of the ministry.
>
> According to Kim, divisions under the Commerce Ministry seem to be competing for foreign direct investment, while the government is failing to join hands with provincial authorities, MOCIE Related News (OCT. - 13 - 2004).

Still, why is there any role for the local governments to play? Had the central government perfect information it could just decide the right amount of subsidy or tax for the MNC and the regional government would play a very passive role or no role at all. So why is the regional government intervention so widespread and persistent? The framework developed in this thesis makes it easier to understand this stylised fact. This is particularly the case in the third and forth chapters, but a further understanding will be obtained in the fifth and sixth chapters when inter-regional competition is introduced.

Another interesting feature is the fact that the central governments' taxes affecting MNCs are usually set very well in advance. Sometimes these are specific taxes for MNCs, but also some more general ones as the corporate and income taxes. The main reason for this practice is the existence of international treaties, which are also signed well in advance and put restrictions on the central government.

The intention of the present thesis is to analyse what is the optimal central government policy in this particular setting. That is, a central government that has to set the taxes on the MNCs in advance and then the regions having freedom to set additional taxes or subsidies.

The structure of the thesis is as follows. In chapter 2 we conduct a survey of the

literature on competition to attract MNCs. The basic model is presented in chapters 3 and 4. The main characteristic of these chapters is the existence of only one region. In chapter 3 two different regional negotiation mechanisms are considered: bargaining and posted tax. The existence of an established literature considering this issue in a seller-buyer context, determines the particular way in which we begin the introduction of this chapter. In chapter 4 a mixed negotiation mechanism is added. One where the region is not limited to bargain or post a tax, but it can choose between these two mechanisms. In chapter 5 the competition between two regions is analysed, but only under the regional bargaining mechanism. In chapter 6 the competition between the two regions is analysed under the mixed regional negotiation mechanism. Chapter 7 provides a general conclusion of the thesis.

1.1 Acknowledgements

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Chapter 2

Literature review

In this section we write a literature review on the issue of inter-jurisdiction competition to attract MNCs. Janeba (1998) combines elements of strategic trade policy and capital income tax competition. He builds up a model in which the output market is imperfectly competitive and firms are internationally mobile. The owner of each of the two firms is a citizen of each of the two countries and initially has the firm located there. The firms produce a homogeneous good sold in a third market, but given that the production is indivisible any tax differential would produce a complete shifting of production to the most favourable country. The country's governments impose profit taxes on income generated in its own country (source taxation). There is no type of externality in play. The firms maximize their profits which only depend on their own and their competitor's output. The government's welfare is equal to the sum of the producer surplus of the domestic firm plus the levied taxes. Then, given that the locations are identical, the firms locate in the low-tax (high subsidy) country. Thus, the country offering the higher subsidy is the one attracting both firms, but this is at the cost of decreasing its tax revenue since part of the subsidy is given to the foreign firm. It is proved in the paper that a positive subsidy cannot be an equilibrium. Indeed, there is also an incentive for the governments to undercut its neighbour's tax and therefore a positive tax cannot be an equilibrium either. Thus, laissez-faire becomes the only sub-game perfect equilibrium.

2.0.1 Externalities

Kind et al (2000) and Haaland and Wooton (1999) analyse tax competition for internationally mobile firms in a general equilibrium model with spillover effects in the host country. The cause for the spillovers is the existence of vertical linkages between the production of monopolistic firms and the producers of other goods in the host country.

In a "new economic geography" framework, Kind et al (2000) provide a general equilibrium model where capital, goods and firms are internationally mobile. They consider two symmetric countries with transport costs on trade flows between them. There are also two sectors, agriculture and manufacturing. The latter is subject to increasing returns to scale and uses two inputs: labour which is immobile between countries, and capital. Capital movement from one country to the other does not imply migration of purchasing power, since income from capital is assumed to be consumed in the owner's country of residence. The existence of increasing returns to scale in the manufacturing sector will lead a firm to export its whole production from only one country. However, the migration of a single firm intensifies competition in the host country's product and labour markets, what has a negative effect on profits. There are two factors that counterbalance this centrifugal force. First, the existing firms will no more have to pay transport costs on their purchase of intermediates from the new entrant. Second, the domestic demand for intermediates in the host country will increase since the pool of firms has grown. These cost and demand linkages are self-reinforcing, and may dominate over the market competition effect and give rise to agglomeration of manufacturing.

Kind et al focus on two situations: capital and firms may either, ex ante, be concentrated in one single location, or they may be evenly spread between the two countries. On the one hand, if one of the countries already hosts an agglomeration advantage, it would be able to levy a positive tax on mobile firms in equilibrium. However, this tax should be low enough as to not to make it optimal for the firms to relocate to the other country. Indeed, since agglomerated firms are more competitive, they are able to pay a higher price for each unit of capital without making losses, what results in the supply of capital not being perfectly elastic even though it can move without cost between countries. This gives sustainability to the agglomerated equilibrium. On the other hand, in the symmetric equilibrium both countries will equally subsidize capital.

Haaland and Wooton (1999) argue that the justification for subsidising foreign-owned MNCs is that they provide employment opportunities and generate demand for intermediate inputs produced by domestic firms. They use a general equilibrium model with two identical countries and three sectors: 1) a traditional sector; 2) a monopolistically competitive domestic intermediate-goods' sector only selling its production to the foreign-owned MNCs; and 3) a final goods' sector composed by the MNCs selling in a perfectly competitive market and providing knowledge spillovers to the domestic firms. In their model there are agglomeration benefits and costs for the MNCs. For the bigger is the domestic market size the more advantages are obtained from the increasing returns to scale in the monopolistically competitive intermediate sector, but the higher are the wages.

Two main results are obtained from this model. On the one hand, if the agglomeration benefits are high enough all the modern sector ends up in one of the countries, but the necessary subsidies are so high that there are no net benefits for that country. Indeed, the subsidies are a transfer of income from owners of specific factors in the traditional sector both to domestic workers and to the foreign MNCs.

On the other hand, if the agglomeration costs are strong enough to counteract the agglomeration benefits a stable diversified equilibrium appears with the MNCs evenly spread between the two symmetric countries. Indeed, there are still incentives for the countries to attempt to subsidise production in order to try to attract a larger share of the MNCs. However, under some parameter values the offered subsidies are so high that the winning country does not get any net benefit. Yet, as the equilibrium allocation of production is unaffected by the subsidy competition, this competition only results in a transfer of income from the two competing countries to the foreign MNCs.

2.0.2 Tax competition between asymmetric countries

In this literature, countries differ either by their exogenous wage level, their level of technology or their size. In general the result is that in equilibrium taxes are non-zero and countries may subsidize capital if it creates positive externalities. Furthermore, the more a country is at a priori disadvantage compared to the other one (in terms of technology or unemployment), the higher is the positive externalities it can gain from attracting the MNC. As a consequence the disadvantaged country is willing to offer a

higher bid than the other one, what makes it to attract the MNC and to catch up to a certain extent. We move on now to analyse three papers respectively dealing with wage, technological and size differences.

Wage

Haaparanta (1996) investigates a two stage subsidy game between two countries or regions which seek to attract exogenous inward foreign direct investment in order to alleviate domestic unemployment. The unemployment in the two locations in his model is explained by the existence of fixed wages. Then, differences in the exogenously determined national wage levels provide countries with unequal incentives to subsidize capital in order to lower their respective unemployment. Other characteristics of the model are that exports are not possible, the MNC can divide its production between the two locations and the subsidies depend on the amount of capital invested.

In the first stage of the game, the governments maximize welfare which is defined as the labour income of their residents minus the subsidy. Indeed, since wages are fixed exogenously in both countries (creating unemployment), governments are only concerned with the employment effects of FDI. In the second stage of the game the MNC maximises its profits, which positively depends on the investment in each country, labour used, wage rate, market size, and subsidy.

The results of the model show that subsidy competition alters the MNCs' location decision with respect to the no-subsidy case. Higher wage (higher unemployment) countries will bid larger subsidies. Indeed, given that spatial externalities are ignored the results depend on the nature of the technology, and in particular on the elasticity of substitution between labour and FDI. Finally, given that centrifugal forces (like transport costs) are not incorporated into the model, differences in market size do not affect the location decision of the multi-jurisdictional firm and are thus inessential for the optimal tax policies.

Technology

Fumagalli (2002) investigates the welfare consequences of subsidy competition for MNCs in a context where the less technologically advanced region benefits more from the inward investment but, in the absence of incentives, the MNC's preferred location is the

other, more advanced region.

Each of the regions hosts one local firm, and competes to attract the manufacturing plant of a producer from a third region (the MNC). The MNC's problem is whether to build a plant in one of the two regions (and if so, in which one) or to export from the home region. She assumes the existence of the same transport cost between the host region and any of the host regions, but none between the two host regions. In the former case the MNC incurs a fixed set-up cost, while in the latter it has trade costs. When locating in a region, the MNC creates a positive externality in the form of lowering the production cost of the local firm. The intensity of this positive spillover depends on the level of technology in the region. That is, the spillovers are higher the larger is the technological gap between the domestic and the foreign firm.

The model produces some interesting results. Thus, on the one hand, in the case that export is not an optimal option and there is no subsidy competition the MNC invests in the more advanced region. For the reduction of the local production costs induced by the technological spillover is lower in this region and thus the local firm becomes a less fierce competitor. On the contrary, in this same situation the existence of subsidy competition between the regions may switch the MNC's location to the less advanced region and so increase its welfare. It is obvious that the more advanced region's welfare would decrease, but the aggregate welfare for the two regions is not necessarily negative.

On the other hand, in the case that export is the optimal option in the absence of subsidies the introduction of the subsidy competition will have two effects. That is, the MNC will be attracted to the integrated region and it will intensify the competition. The paper shows that if the "competition effect" is very detrimental to local firms (when trade costs from the MNC's home region are very high) any other positive effect associated with subsidies may be completely offset. This implies that the aggregated welfare of the two regions could be reduced even if they are extremely differentiated. By contrast, when trade costs are sufficiently low, the positive role of subsidies may be remarkably fortified. The aggregate welfare may increase, even if they are identical.

Size

Haufler and Wooton (1999) discuss the case of tax competition between two countries of different population size to attract the investment of a single third country MNC and

where export is not possible between the home and hosts countries.

On the one hand, the profits of the MNC depend on the countries' size, level of transport costs, and selling price. Then, in the absence of any subsidy competition, the existence of scale economies combined with transport costs between the two countries give the MNC an incentive to locate in the larger country. On the other hand, in order to maximize the welfare of its representative household, each government is prepared to offer a subsidy in order to save transport costs. This results in the bigger country offering a higher subsidy than the smaller one, but the per capita cost of the subsidy is smaller. Obviously, the bigger country only needs to slightly over cut the smaller country subsidy to attract the MNC.

Their conclusion is that when differences in country sizes are considered, the tax or subsidy competition does not change the investment profile which would have been settled in the no-subsidy case. For the foreign-owned monopolist always chooses to locate in the larger market. That is, competition has no positive effects and merely results in a waste of resources for the host countries.

In a similar way, Barros and Cabral (2000) investigate the choice of location of a foreign-owned MNC between two countries of unequal size. However, the difference with Haufler and Wooton (1999) is that, these countries also differ by their level of unemployment. In particular, the shadow price of labour is lower in the smaller country. As a consequence, the employment gains that this country can extract from FDI are higher than for the larger country. The winning country will thus result from the interaction of these two factors: relative country size and employment gains. The MNC's profit in each location is a function of the country size, the government's subsidy to its marginal cost, and the transportation costs. As in Haufler and Wooton (1999), higher transportation costs favour the larger country.

Furthermore, each country's objective function is to maximise the domestic welfare. On the one hand, the welfare of country i when the monopolist locates in country j is given by its consumers' surplus. On the other hand, if the MNC chooses to locate in country i, welfare is given by consumers' surplus minus total subsidies plus gains from employment creation. They do welfare comparisons between the equilibriums achieved by competitive subsidy, zero subsidy, and first-best subsidy. Interestingly, the paper shows that total welfare may be greater under subsidy competition than under zero

subsidies. For the subsidy competition produces gains in terms of efficient location what may more than compensate the losses from higher subsidies granted to the foreign firm.

Moreover, switching from subsidy competition to zero subsidies or to first-best subsidies (without side payments) produces gains to one country and losses to the other one. Here we only briefly analyse the comparison between subsidy competition and zero subsidies. Thus, it is obvious that the equilibrium welfare of the smaller country cannot be lower under the subsidy equilibrium than under the zero subsidy one. This is the case because without subsidies the home market bias would make the firm to locate in the larger country and so the introduction of subsidy competition has a negative effect on the welfare of the large country. For either it pays a subsidy to attract the MNC. or the latter locates in the smaller country. In this last case, the subsidy granted by the small country is not sufficiently high to compensate for the transportation costs it would have to pay. This result seems to explain why the subsidy competition is so persistent. For given that it produces gains to one country and losses to the other one, it may make difficult to reach a consensus to move away from it.

2.0.3 Competition versus Cooperation

Haufler and Wooton (2001) consider unilateral and regional tax policy for a region of two countries (A and B) that competes with a third potential-host country (C) for the location of a monopolistic MNC. The size of countries A and B are equal, but different from the size of country C. Moreover, transportation costs between A and B are lower than between the region and country C due to geographical proximity, administrative similarity, or other.

In their paper they find that regional tax coordination can lead to two types of welfare gains for the countries undertaking the union (countries A and B in their paper). First, for investments that would have taken place in the union in the absence of coordination, the elimination of tax competition within the union leads to an increase in the equilibrium tax (or reduction in the equilibrium subsidy). This results in a transfer of location rents from the firm to the union. Second, for investments that would have not taken place in the union in the absence of coordination, a coordinated reduction in the union tax (or increase in subsidy) may attract the MNC, resulting in an increase of

the regional welfare. In this last case, the objective of fiscal coordination is not only to avoid a waste of resources but also to present a united front in order to induce a MNC to locate a region which is part of the union.

2.0.4 Dynamic models

There are other models considering some dynamic issues in the inter-regional competition for MNCs, but because they are not very much related to our paper we just give a very brief summary of some of the papers. 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. Competition for foreign direct investment among asymmetric countries has been studied also in a dynamic menu auction framework by Besley and Seabright (1999).

Chapter 3

Bargaining versus posted price selling

3.1 Introduction

Several selling mechanisms can be used by sellers in order to maximise their revenues. For instance they can choose between bargaining, posted price selling, and several types of auctions. The coexistence of these different methods suggests that none of them is optimal for all circumstances. However, what determines the use of one selling mechanism instead of others? A significant amount of literature has intended to deal with this issue. One of the approaches to this optimal selection of selling mechanisms is a pair wise one and derives conditions under which one selling mechanism is better than another. Even though not all feasible selling mechanisms are compared, this approach does yield many intuitive conclusions on the coexistence and the relative advantages of different mechanisms.

In the particular case of the comparison between bargaining and posted price selling two different settings have been analysed, a monopolistic and a multi seller one. Among others, Riley and Zeckhauser (1983), Wang (1995) and Arnold and Lippman (1998) have made important contributions to the monopolistic one. However, there is an important gap in this literature, which is the fact that the seller does not get any 'externality' from the buyer. The intention of the present chapter is to deal with this gap. In order to get a clear understanding of the effect produced by the introduction of this externality the

simplest possible setting will be used, which is the one of a monopolistic seller.

The closest paper to our approach is Wang (1995). He finds that the relative cost of using bargaining versus posted price selling may explain which one is adopted. He assumes the cost of the former is higher than the latter because in the presence of bargaining the monopolist must hire a salesperson, who gets a fixed wage. In addition, when the seller adopts the bargaining mechanism he can commit to any reservation price. As it will be obvious later on, with some variation, this feature will also be present in our model. Wang himself states:

> If the seller chooses to bargain, he is able to discriminate (imperfectly) among buyers with different willingness-to-pay. However, additional employees must be hired to mingle with the potential buyers. On the other hand, posting a fixed, non-negotiable price is simpler and cheaper. But discrimination is then impossible. Therefore, the seller faces a trade-off: bargaining generates more revenues, but it costs more.

However, even in the case that bargaining and posted price selling have the same cost, the former dominates the later in Wang's paper.

In a heterogeneous-buyers setting we also compare bargaining with reservation price versus posted price selling, in terms of the seller's welfare[1] generated for a monopolistic 'seller'. However, we rule out any difference in the relative costs of using bargaining and posted price selling. In this setting we find that it is not always the case that bargaining dominates posted price selling. We analyse this case in a framework where a multinational corporation (MNC, the buyer) has to pay a tax to a country (the seller, which may get externalities) in order to locate a new production plant.

The principle behind both frameworks is the same: The selling of something, a good in the former and the site for a new plant in the latter. This is why we dedicated the first part of the introduction to discuss the seller-buyer framework that represents the focus of most existing literature. As it will become clear throughout the chapter, there are other features that are specific to the country-MNC framework. For that matter, we will use the more general terminology 'negotiation mechanisms' instead of 'selling mechanisms'. For, depending on the parameter values, the country would be

[1] We refer to welfare and not just revenue because of the existence of the externality.

the seller or the buyer and so it would have to choose between "selling" or "purchasing" mechanisms. As an extreme example, consider the case where a MNC only produces externalities to the hosting country but does not get direct profits. In this case the MNC is selling these externalities to the country. Thus, the country will have to pay a price (i.e. subsidy) to the MNC to consummate the exchange.

Following Wang (1995), we assume a principal-agent framework. Even though not essential, this setting facilitates the commitment power necessary for the seller to be able to set a reservation price (tax) in the bargaining mechanism. In our model, the principal is the central government of a country, who in order to maximise the expected country's welfare wants to attract the MNCs' production plant to the only region of the country (the agent).

The assumption that only one region deals with the MNCs may still apply even if there are several regions involved. This might be the case if one region is naturally much more advantageous than the others. For instance, a region could be the only one in possession of a key industrial endowment (e.g. an oil source or a very well established financial hub). An example could be the city of Shanghai in China, which is becoming the most important financial hub of the south east of Asia. Thus, if an international bank or financial company has to choose a region in China, Shanghai would be certainly first in the menu of options. Furthermore, let us assume the only externality the MNC can produce is to the host region and not to any other region of the country.

Both the central government and the region are able to set taxes (subsidies) on the MNCs. However, the central government moves first and sets a tax in advance to be paid by the MNC. In the case that the region can only bargain with the MNC, the central government tax would be equivalent to a "reservation tax". We posit that there are two types of MNCs and that types cannot be verified in a court of law. Non-verifiability and the fact that taxes have to be set in advance imply the central government cannot tax-discriminate between types.

Regional intervention is analysed in two different scenarios. One in which it can only bargain with the MNCs the level of the regional subsidy/tax. We will refer to this as the "bargaining negotiation mechanism". A second scenario is one in which the region can post a subsidy/tax. It will be shown that this second case, referred to as "posted price mechanism", is equivalent to one where there is no regional (or central)

government and the MNC has to pay the central (or regional) government tax. In the case of the bargaining mechanism the region and the MNC bargain in a second stage. However, in the case of posted price mechanism the region posts a tax in the second stage and the MNC chooses between coming to the region and paying the tax, or not coming.

Let us move on now to summarise the main results of the chapter of which an important one stems from the comparison with Wang (1995) result. In order to avoid confusion with the terminology we make the comparison by referring to our framework.

Thus, whenever there are externalities from the buyer to the seller it is not always the case that bargaining dominates posted-tax selling. However, in the special case where there is no externality Wang's result is replicated and the posted-tax mechanism dominates the bargaining one. Still, why is it the case that the existence of externalities can prevent the bargaining from being the dominant one? It must be pointed out that these externalities do not produce any qualitative change in the results under the bargaining mechanism, but they do under the posted-tax one. Indeed, the answer to the previous question is that in some situations the existence of externalities makes the latter mechanism relatively more advantageous.

A clear example with a posted-tax mechanism relative advantage is one where the profits and externalities are such that the two MNCs produce different surpluses even though their profits are identical. Then, given that the posted-tax mechanism always sets the same tax on both MNCs, it permits the country to appropriate their entire surpluses. For, there is no negotiation with the MNCs about the externalities. On the contrary, given that the bargaining mechanism only allows "imperfect surplus discrimination"[2] between the two MNCs it would not be able to extract the entire surplus produced by both MNCs. Part of the externality produced by the high surplus MNC would have to pass from the region to the MNC in the form of subsidies.

The previous example shows why the existence of externalities can prevent bargain-

[2]Imperfect surplus discrimination is defined as the seller's ability of getting higher payoffs from the MNCs producing higher surpluses. This concept is introduced because, with the existence of externalities, it is possible that under the bargaining mechanism optimal policy the high profit MNC pays a lower tax than the low profit one. Obviously, this is not what is conventionally understood by price discrimination. For instance, this is the case when an MNC only produces externalities and the other only produces profits, but the externalities are higher than the profits. Then, under the bargaining mechanism the high profit MNC pays a lower tax than the low profit one.

ing from being the dominant one. However, let us go further and give a more clear intuition of what makes one mechanism relatively more advantageous than the other and vice versa. In order to do that let us first mention an advantageous feature of the bargaining mechanism. That is the fact that, when the two MNCs produce identical surpluses, they are entirely appropriated by the country. However, because of the imperfect surplus discrimination, this advantage decreases with the dispersion of the surpluses. On the contrary, given that the posted-tax mechanism always sets the same tax on both MNCs, its advantageous feature is that, when the two MNCs produce identical profits, their entire surpluses are appropriated by the country. Though, this advantage decreases with the dispersion of the profits.

Last but not least, our model provides clear policy recommendations. First, it determines the optimal central government tax policy for each negotiation mechanisms. Secondly, it establishes the optimal negotiation mechanism under specific ranges of parameter values, what is useful in the case the central government has some control over it.

The structure of the chapter is as follows. In the following section we give a more precise explanation of what we mean by 'externality'. In section 3 the distinction between the bargaining and posted-price outcomes is made. The way in which a central or regional government can impose these outcomes on an MNC is also analysed. Section 4 analyses the bargaining mechanism. Section 5 analyses the posted tax mechanism. In section 5 the comparison between the two mechanisms is made and the main results derived. Section 6 concludes.

3.2 What we understand by externality

The externalities produced by MNCs, which are also referred to as 'productivity spillovers', can basically be divided into two types: technological and host-country-market spillovers.

Perhaps the most important reason why countries try to attract FDI is the prospect of acquiring modern technology, interpreted broadly to include product, process, and distribution technology, as well as management and marketing skill. Foreign investment can result in benefits for host countries even if the MNCs decide to carry out their foreign operations in wholly-owned affiliates, since technology to some extent is a public good.

We could think of the technological spillovers as when the entry or presence of MNC affiliates lead to productivity or efficiency benefits in the host country's local firms, and the MNCs' are not able to internalize the full value of these benefits. The following paragraphs give three examples of these technological spillovers.

First, local firms may be able to improve their productivity as a result of forward or backward linkages with MNC affiliates. In particular, they may imitate MNC technologies, or hire workers trained by MNCs.

A second manifestation of these spillovers is the direct contact with technology users, which appears to be an important factor explaining technology diffusion. Before a new process or product innovation is widely spread in the market, potential adopters have limited information about the costs and benefits of the innovation and may therefore associate it with a high degree of risk. As the potential adopters come in contact with existing users, (e.g. MNC affiliates), information about the technology is diffused. The uncertainty regarding the pros and cons of the innovation is reduced, and the likelihood of adoption or imitation increases. In this way the introduction of new products or processes by MNCs may work as a good example of their profitability and so encourage local firms to also adopt them.

A third source of potential benefit that foreign investment could produce on the host country can be characterised as 'market access spillovers'. MNCs often possess strong competitive advantages in entering world markets, such as experience and knowledge of international marketing, established international distribution networks, and lobbying power in their home countries. As a result of their own export operations, MNCs may produce a contagious effect for local firms to enter the same export markets. For instance, they may create transport infrastructure or disseminate information about foreign markets that can be used also by local firms.

Two other reasons why FDI can generate externalities to the host country are more host-country-market related: the creation of a more competitive host market and the somehow related one inspired in the 'new economic geography'. Let us give a closer look to them.

The main reason for the increase in competition as a result of foreign entry is that foreign affiliates have some characteristics not enjoyed by domestic firms. It is often the case that the entry by new domestic firms into specific industries in potential host

countries is likely to be difficult. There is general agreement that MNCs. are better equipped to overcome the entry barriers of those industries. The entry of MNCs into this kind of monopolistic industry is likely to increase the level of competition and force existing firms to become more efficient. But, foreign entry may, of course, also lead to a fall in the number of firms in the industry if the least efficient local companies are forced out of business. This raises the fear that foreign MNCs may out-compete all local firms and establish monopolies that are even worse than the domestic oligopolies they replace. Nevertheless, Caves (1971, p. 15) asserted that 'whatever the market structure that results from the influence of direct investment, it can be argued that entry by a foreign subsidiary is likely to produce more active rivalrous behaviour and improvement in market performance than would a domestic entry at the same initial scale'.

Finally, the recent economic geography literature, inspired by Krugman (1991), has provided an additional basis for thinking that there are externalities in the location of economic activity. They begin from Marshall's insight that location and production decisions of firms generate external effects on their host economies. In our context, factor and product market linkages are an important source of such externalities, as when a firm locates and thereby affects the market for skilled labour. Even though these are pecuniary externalities, government action (by taxes, subsidies or other means) can be justified if the economy is not otherwise first best. This is the case when there is imperfect competition or unemployment, not only in the particular industry to which the MNC belongs, but also in its upstream and downstream industries. In accordance with this literature the inter-jurisdiction competition for MNCs reflects the belief that history matters, that locational advantage, once gained, tends to perpetuate itself, in that way stressing the importance of agglomeration economies in industrial location.

3.3 Distinction between the bargaining and posted-price outcomes

We should mention that the only difference between the bargaining and posted-price outcomes is in terms of the welfare generated for the country as well as in terms of the regional payoff. That is, under some circumstances one negotiation mechanism produces a more or less country's welfare and/or payoff than the other. In the present thesis we

will focus our attention more on the side of the country's welfare than on the regional payoff.

An interesting question is: how can each of these solutions (bargaining or posting tax) be imposed on the MNC?

The posting tax mechanism: Throughout the thesis we assume that whenever the regional or central governments post a tax, this tax cannot be bargained by the MNC.

This would possibly be the case when some commitment power is behind the posting tax mechanism. In particular we are thinking of the case where the Executive Power of the country (region) has no capability of changing the tax already passed by the country's (regional) congress.

In order to give some intuition of how this commitment power can be put in place, let us exemplify with the case of the central government tax-posting. Arguably, the countries have to set the taxes well in advance to the time where particular MNCs show up, what usually needs parliamentary approval. The main reason for this practice is the existence of international treaties, which are also signed well in advance and put restrictions on the central governments tax manoeuvrability.

The Executive Power of a country does not have discretion in order to change these taxes, particularly at the time an MNC shows up. To pass a new bill in order to change them is a cumbersome and costly process. Thus, it seems reasonable to think that at times the MNC does not have the possibility of bargaining the taxes. Moreover, it is obvious that this in-advance setting of taxes can also apply to the regions.

The bargaining mechanism: On the contrary, it is sometimes the case that the governments, in particular the regional ones, have some degree of discretion in order to give relative privileges to some MNCs. That is, the regional congress gives the Executive Power more discretion in providing privileges to particular MNCs. These privileges take, among others, the following forms: payroll tax credits, tax breaks, property tax abatements, low interest loans etc. As noticed by Davies R.B. (2004) these privileges are generally firm-specific.

Thus, whether the regional government has or not discretion with respect to the taxes charged to specific MNCs the mechanism in place will be a bargaining or a posting tax one.

3.4 The bargaining mechanism

In this section we look at a mechanism where the region has no capability of posting a tax and so its only choice is to bargain with the MNCs. We assume a two-stage game involving the central government, one region, and an MNC. In the first stage, the central government determines the lump sum tax to be imposed on the MNC[3] in order to maximise the expected country's welfare, which is equal to the local payoff (externality plus regional tax) plus the central government tax. In the second stage, the MNC bargains with the regional government on the level of the lump sum tax to be paid by the MNC[4][5]. The regional government maximises its own payoff, which is equal to the externality produced by the MNC plus the regional tax[6]. Suppose that, in this stage of the game all the players have perfect information. This means that the externality produced by the MNC, the tax 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 bargaining process between the MNC and the region we use a Rubinstein framework (Rubinstein 1982). In our context, this bargaining framework works like this. The MNC and the region bargain over the partition of a cake of size s, the "after-

[3] Whether the central government tax is on the MNC or on the region does not make any difference in terms of the payoff the MNC and the region get in the bargaining mechanism.

[4] The choice of this particular setting is based on the fact that it is more common to see the regions, and not the central governments, bargaining with the MNCs. Some evidence of this can be found in Chandler and Trebilcock (1986) and Krause (1998). Furthermore, the central government pre-commitment to taxes is sometimes originated in tax treaties signed well in advance. Finally, for simplicity we assume that the central government cannot prevent the regional subsidies. The main justification for this is that the subsidies can take different forms like infrastructure or other concessions to the MNC, which sometimes are very difficult to be identified as subsidies.

[5] Bargaining is an 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. Most of the literature uses an auction framework, which is less obviously applicable. Furthermore, we assume here that the regional government cannot pre-commit to subsidies (or taxes) as the central 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 on itself by the region and so it is more readily renegotiated. Thus, we could say that the central government is a very good commitment tool for the regions. The existence of regional pre-commitment capability is considered in the next section.

[6] We are assuming that the regional 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 results in higher benefits for the region attracting the MNC. However, one justification for assuming that can be the existence of a large number of regions in the country, but only one being able to attract the MNC. If this were the case, this last region would get negligible benefits from this central government tax revenue. Indeed, the central government can spend this tax revenue in a way that only increases the utility of the regions that are not involved in attracting the MNC.

tax surplus"[7] (where $s > 0$) according to the following, alternating-offers. procedure. At time 0 the MNC makes an offer to the region. An offer is a proposal of a partition of the cake. If the region accepts the offer, then agreement is struck and the players divide the cake according to the accepted offer. On the other hand, if the region rejects the offer, then it makes a counteroffer at time $\Delta > 0$. If this counteroffer is accepted by the MNC, then agreement is struck. Otherwise, the MNC makes a counter-counteroffer at time 2Δ. This process of making offers and counteroffers continues until a player accepts an offer. If the players discount rate are identical and $\Delta \to 0$, in the only subgame perfect equilibrium of the game they divide the cake half and half. Indeed, the agreement is immediately reached. In other words, the result of this bargaining framework in the present context is that the region and MNC payoffs are equal to half of the after-tax surplus produced (i.e. externality minus central government tax).

The simplest case is when there is only one type of MNC. On the one hand, in the absence of central government intervention, the region will only appropriate half of the externality produced by the MNC. On the other hand, in the presence of central government intervention, it is optimal for it to charge the MNC a tax equal to the externality it produces. Then, the benefit of the externality is totally appropriated by the country.

However, it is usually the case that regions have to negotiate with more than one type of MNC. Then, industrial, technological, as well as, financial characteristics may produce differences in the externalities created by each type of MNC. To consider this we allow the existence of two types of MNCs (i.e. a or b), which can produce different externalities. Furthermore, it is appropriate to think that since the taxes are set in advance, it is difficult for the central government to 'tax-discriminate' between the two types of MNCs. That is, it cannot set the tax conditional on the MNC's type[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

[7] The "after-tax surplus" is defined as equal to the surplus (i.e. externality plus the gross profit the MNC gets by investing in the region) minus the central government tax.

[8] In fact, this is a simplifying assumption because it would be enough to just assume an imperfect central government tax discrimination. Indeed, the fact that the central government cannot tax discriminate between the two types of MNCs can be justified by assuming that the type of MNC is a non-verifiable variable. This ultimately means that a tax scheme conditional on types is unfeasible because it cannot be enforced in a court of law. Latter on we will also suggest an alternative explanation for the impossibility of implementing in advance tax discrimination.

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, at the time a particular MNC shows up all the players know the MNC's type.

Again, in the decentralised solution (the one without central government intervention), the region will only appropriate half of the externality produced by each type of MNC. However, what is the result of the game if the central government intervenes by setting taxes in advance? This is the question we now pass to answer.

Thus far 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 (s_i) is equal to the sum of its profit and the externality (π_i and e_i respectively).

Some terminology: Before moving on lets clarify some of the terminology that will be used hereafter. Thus, y, z, w, ez and ew will refer to the MNC's payoff, the regional payoff, the country's welfare, the expected regional payoff and the expected country's welfare respectively. In addition, we will use subscripts to refer to the MNCs being attracted (i.e. a, b, or a, b), and upper scripts to refer to the negotiation mechanisms (b and p for the bargaining and posted tax mechanisms respectively). In the following chapter we will also refer to the 'mix-negotiation mechanism' with the upper script m. Indeed, in that case the upper script will also refer to the particular implemented strategy. That is, (m, b) and (m, p) when the bargaining and posting tax strategies respectively are implemented under the mix-negotiation mechanism.

We begin solving the second stage of the game by making the following definition, where g represents the central government tax. When an MNC of type i ($i = a$, b) shows up and the after-tax surplus is higher or equal than the surplus abroad (i.e. $s_i - g \geq 0$), the region would get the MNC of type i. For simplicity we assume that if the previous weak inequality were satisfied with an equal sign the MNC would come to the country with probability 1. Then, the equilibrium payoff for the MNC is:

$$y_i^b = \begin{cases} \frac{s_i - g}{2} \text{ if } s_i \geq g \\ 0 \text{ otherwise} \end{cases} \tag{3.1}$$

Thus, if the region gets the MNC of type i (i.e. the first line of expression 1 applies) the MNC's payoff would be equal to half of the after-tax surplus an MNC of type i

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produces in the region. On the contrary, if the central government tax is such that the after-tax surplus in the region is lower than the surplus abroad the MNC does not come to the country and it gets a payoff of zero.

It is obvious that the tax that the region must charge is such that, the MNC gets the payoff in expression 3.1. Thus, the equilibrium regional tax is:

$$t_i^b = \begin{cases} (\pi_i - g) - \frac{s_i - g}{2} \text{ if } s_i \geq g \\ 0 \text{ otherwise} \end{cases} \tag{3.2}$$

Again, if the central government tax is too high the MNC does not come to the country and the tax effectively paid is equal to zero. In the upper part of expression 3.2 it is like if the region takes the full after-tax profit $(\pi_i - g)$ from the MNC, but then it compensates the MNC by giving back the payoff in expression 3.1. Notice that t_i can be negative (i.e., a local subsidy) and often this is the case[9].

Then, by adding the equilibrium tax in expression 3.2 to the externality in the region (i.e. e_i) we get the equilibrium 'ex-post' regional payoff when an MNC of type i shows up:

$$z_i^b = \begin{cases} \frac{s_i - g}{2} \text{ if } s_i \geq g \\ 0 \text{ otherwise} \end{cases} \tag{3.3}$$

and the expected regional payoff is

$$ez^b = \left\{ \begin{array}{l} \frac{s_a - g}{2} p \text{ if } s_a \geq g \\ 0 \text{ otherwise} \end{array} \right\} + \left\{ \begin{array}{l} \frac{s_b - g}{2} (1 - p) \text{ if } s_b < g \\ 0 \text{ otherwise} \end{array} \right\} \tag{3.4}$$

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. 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 regional tax and the externality. Thus, by adding g to expression 3.3, the 'ex-post' country's welfare is

[9] As an example, think of the case where there is no central government tax and no profit (the surplus is just equal to the MNC's externality). Then, for the region to get half of this surplus, it has to give a subsidy to the MNC.

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$$w_i^b = \begin{cases} g + \frac{s_i - g}{2} \text{ if } s_i \geq g \\ 0 \text{ otherwise} \end{cases} \tag{3.5}$$

and the expected (ex-ante) country's welfare under the bargaining mechanism is

$$ew^b = \left\{ \begin{array}{l} \left(g + \frac{s_a - g}{2}\right) p \text{ if } s_a \geq g \\ 0 \text{ otherwise} \end{array} \right\} + \left\{ \begin{array}{l} \left(g + \frac{s_b - g}{2}\right)(1-p) \text{ if } s_b \geq g \\ 0 \text{ otherwise} \end{array} \right\} \tag{3.6}$$

To have a better understanding of the bargaining mechanism let's see how it works by using a numerical example.

Example 1 *Assume the surpluses the MNCs produce are* $s_a = \pi_a = 40$ *and* $s_b = \pi_a = 30$. *Then, given the existence of two MNC types and one region, there are only two alternatives for the central government: 1) to only attract the MNC of type a; or 2) to attract both types of MNCs. Obviously, it is not possible to only attract an MNC of type b. For every central government tax that attracts an MNC of type b will also attract an MNC of type a.*

An easy way of searching for the optimal regional policy is to first obtain the optimal central government tax in each of these two alternative cases (i.e. conditional optimums). Then, for each specific parameter values, the conditional optimum producing the highest expected country's welfare is the unconditional optimal policy. Let us then find first the conditional optimums.

Thus, in the case of only attracting the MNC of type a the optimal central government policy is to set $g = 40$. *Then,* $t = 0$ *is the optimal regional subsidy to attract an MNC of type a*[10]. *The MNC and the region get no payoff and the country's welfare is equal to the central government tax. Thus, given that for* $g = 40$ *the MNC of type b does not come to the country, the expected country's welfare derived from expression 3.6 is* $ew_a^b = s_a p = 40p$.

In the case of attracting both MNCs, the optimal central government policy is to set $g = 30$. *Then, when an MNC of type b shows up the after-tax surplus is equal to zero and there is nothing to be shared between the region and the MNC. Both the region and*

[10] *The region cannot set a tax higher than zero. For it would make the MNC to have a negative net profit.*

the MNC get no profit and the expected country's welfare is equal to the central government tax times the probability of this MNC showing up (i.e. $g(1-p) = s_b(1-p)$*). On the contrary, when an MNC of type a shows up the bargaining between the region and the MNC for the after-tax surplus of* 10 *results in a regional tax of* 5*. Thus, the expected country's welfare is equal to the addition of the central government tax plus the part of the after-tax surplus kept by the region*[11] *multiplied by the probability of this MNC showing up (i.e.* $ew = (30+5)\,p = 35p$*).*

Thus, the analytical expressions for the country's welfare derived from 3.6 are:

$$ew_a^b = s_a p \tag{3.7}$$

when only the MNC of type a is attracted and

$$ew_{a,b}^b = \left(s_b + \frac{s_a - s_b}{2}\right) p + s_b(1-p) \tag{3.8}$$

when both MNC types are attracted.

Then, from the comparison of the expected country's welfare in expressions 3.7 and 3.8 we get that it would be optimal to only attract the MNC of type a if and only if s_a and p are high enough as to satisfy the following inequality

$$s_a > s_b \frac{2-p}{p} \tag{3.9}$$

On the contrary, if the inequality in expression 3.9 is not satisfied it would be optimal for the country to attract both MNCs, and an equality would mean to leave the country indifferent between the two policies.

3.5 The posted tax mechanism

In this section we look at a mechanism where the region has no bargain capability and so its only choice is to post a tax. This case is interesting for two reasons. First, as an intermediate step in order to arrive to the most general one where the region can choose

[11] *Because the MNC only produces profits and no externality to the region the after-tax surplus kept by the region is just equal to the regional tax.*

between bargaining and posted tax ('mixed mechanism'). Second, to better understand the difference between this last more complex mechanism and the bargaining one.

Moreover, it is sometimes the case that the setting of taxes in advance is the only instrument in the region's hands. For sometimes regional governments do not find easy to bargain with MNCs. A justification for that could be the same one we have mentioned for the central government inability to bargain. That is, the existence of treaties signed in advance, which impose the necessity of the taxes to be also set in advance. However, some other reasons will be mentioned in the results section of this chapter.

Furthermore, as it is the case for the central government, under the posted tax mechanism the regional government cannot tax-discriminate between the two types of MNCs. That is, it cannot set the tax conditional on the MNC's type. This feature is captured by assuming that it knows the externalities and profits each type of MNC can produce, but it does not know the realisation of the MNC type. Again, the justification for this assumption is the fact that the type of MNC is a non-verifiable variable. This ultimately means that a tax scheme conditional on types is unfeasible because it cannot be enforced in a court of law.

Let us continue assuming the existence of only one region and two MNCs, a and b. Until now it did not make any difference whether the MNCs surpluses were composed by profits, externalities, or a combination of the two. However, as it will be obvious later on, in the posted tax mechanism the composition of the surplus can be important. Assume again that the surpluses produced by the two MNCs are $s_a = \pi_a + e_a$ and $s_b = \pi_b + e_b$ respectively.

Thus, in the present section we deal with a three stage game. In the first stage the central government sets a lump sum tax g. In the second stage the region sets a lump sum tax t. Finally, in the third stage an MNC shows up and decides whether to locate or not in the region. In the case it locates in the region it has to pay both the regional and central governments taxes, but no bargaining takes place.

Third stage of the game: When an MNC of type i ($i = a, b$) shows up and the after-tax profit[12] is higher or equal than the MNC's payoff abroad (i.e. $\pi_i - g - t \geq 0$), the region gets the MNC of type i. Where g and t are the central government and

[12] Under the posted tax mechanism the after-tax profit is equal to the MNC's gross profit minus both the central and regional government taxes.

regional taxes respectively. For simplicity we are assuming that if the previous weak inequality were satisfied with an equal sign the MNC would come to the country with probability 1. Then, the equilibrium payoff for the MNC is:

$$y_i^p = \begin{cases} \pi_i - g - t \text{ if } \pi_i - g - t \geq 0 \\ 0 \text{ otherwise} \end{cases} \tag{3.10}$$

Thus, if the after-tax profit (i.e., $\pi_i - g - t$) in the region is higher than the MNC can get abroad, the MNC of type i comes to the country and gets the payoff in the first line of expression 1. Otherwise, the MNC does not come to the country and it gets a payoff of zero.

Second stage of the game: In the case the MNC of type i is attracted the regional tax must be such that the MNC gets at least the payoff in expression 3.10 (i.e., $t \leq \pi_i - g$). Then, the ex-post regional payoff from an MNC of type i is:

$$z_i^p = \begin{cases} t + e_i \text{ if } \pi_i - g - t \geq 0 \\ 0 \text{ otherwise} \end{cases} \tag{3.11}$$

and the expected regional payoff is

$$ez^p = \left\{ \begin{array}{l} (t + e_a)\, p \text{ if } \pi_i - g - t \geq 0 \\ 0 \text{ otherwise} \end{array} \right\} + \left\{ \begin{array}{l} (t + e_b)\,(1 - p) \text{ if } \pi_i - g - t \geq 0 \\ 0 \text{ otherwise} \end{array} \right\} \tag{3.12}$$

Obviously, the optimal regional tax is the one maximising expression 3.12. Given that there are two types of MNCs there are three possible strategies for the region in order to maximise 3.12: to attract both types of MNCs (i.e., a and b) or only one type (i.e., a or b). Then, the simplest way of finding the regional optimal tax is to first find the regional "conditional optimal taxes". By conditional optimal taxes we mean the regional optimal taxes conditional on one of the mentioned three strategies being adopted. Then, the conditional optimal tax providing the highest regional payoff will be the unconditional regional optimal tax (or simply regional optimal tax). The conditional optimal tax is[13]

[13] For simplicity we assume that if no MNC is attracted $t^c = 0$.

$$t^c = \begin{cases} \min(\pi_a - g,\ \pi_b - g) & \text{if both MNCs are attracted,} \\ \max(\pi_a - g,\ \pi_b - g) & \text{if only the high profit MNC is attracted,} \\ 0 & \text{if no MNC is attracted} \end{cases} \tag{3.13}$$

Then, the optimal regional tax is

$$t^* = \arg\max_{t^c} \left\{ \begin{Bmatrix} (t^c + e_a)\, p \text{ if } \pi_i - g - t^c \geq 0 \\ 0 \text{ otherwise} \end{Bmatrix} + \begin{Bmatrix} (t^c + e_b)\,(1-p) \text{ if } \pi_i - g - t^c \geq 0 \\ 0 \text{ otherwise} \end{Bmatrix} \right\} \tag{3.14}$$

First stage of the game: Given the optimal regional tax we can find the ex-post country's welfare from an MNC of type i by just adding the central government tax to the ex-post regional payoff in expression 3.11

$$w_i^p = \begin{cases} g + t^* + e_i \text{ if } \pi_i - g - t^* \geq 0 \\ 0 \text{ otherwise} \end{cases} \tag{3.15}$$

and the expected country's welfare is

$$ew^p = \begin{Bmatrix} (g + t^* + e_a)\, p \text{ if } \pi_i - g - t^* \geq 0 \\ 0 \text{ otherwise} \end{Bmatrix} + \begin{Bmatrix} (g + t^* + e_b)\,(1-p) \text{ if } \pi_i - g - t^* \geq 0 \\ 0 \text{ otherwise} \end{Bmatrix} \tag{3.16}$$

Let us begin assuming that there is no central government or that the central government sets a tax $g = 0$. It will be obvious later on that $g = 0$ is an optimal central government tax in this setting.

Then, as we already mentioned, given the existence of two MNC types and one region, there are three possible strategies that can be followed by the region. That is: 1) to only attract the MNC of type a; 2) to attract both types of MNCs, or 3) to only attract the MNC of type b. Here we see the first difference with respect to the bargaining mechanism. That is, the fact that under the posted tax mechanism it is

possible to only attract the MNC of type b. Indeed, we will soon see that this tax policy can be also the equilibrium one for the country.

Thus, an easy way of searching for the optimal regional policy is to first obtain the optimal regional tax for each of these strategies (i.e. conditional optimums). Then, for each specific parameter values, the conditional optimal tax producing the highest expected country's welfare is the unconditional optimal tax. The conditional optimal taxes, the conditional expected regional payoffs, and the conditional country's welfare are obtained in the following three propositions.

However, before moving on lets clarify some of the terminology that will be used hereafter. By now we know that ez and ew refer to the expected regional payoff and the expected country's welfare respectively. In addition, we will use subscripts to refer to the MNCs being attracted (i.e. a, b, or a, b), and upper scripts to refer to the negotiation mechanisms (b and p for the bargaining and posted tax mechanisms respectively). In the following chapter we will also refer to the mix negotiation mechanism with the upper script m. Indeed, in that case the upper script will also refer to the particular implemented strategy. That is, (m, b) and (m, p) when the bargaining and posting tax strategies respectively are implemented under the mixed negotiation mechanism.

Proposition 2 *When there are two types of MNCs, one region that can only post a tax, and no central government intervention (or a zero central government tax), an MNC of type a can be the only attracted one if and only if $\pi_a > \pi_b$. Moreover, the conditional optimal regional tax that only attracts an MNC of type a is $t = \max(\pi_a - g,\ \pi_b - g) = \pi_a$.*

Then, when only the MNC of type a is attracted, we get from 3.12 that the expected regional payoff, which is equal to the expected country's welfare, is[14]:

$$ez_a^p = ew_a^p = s_a p \quad \text{if } \pi_a > \pi_b \tag{3.17}$$

Proof. It is obvious that a tax higher than $t = \pi_a$ does not attract any MNC and a lower one produces a lower expected country's welfare than the one in expression 3.17

[14] It is obvious that in the case that the central government sets a tax $g = 0$ the regional payoff would be equal to the country's welfare. For, the country's welfare is equal to the regional payoff plus the central government tax.

or attracts both MNCs. ■

Another proposition is:

Proposition 3 *When there are two types of MNCs, one region that can only post a tax, and no central government intervention (or a zero central government tax), the conditional optimal regional tax attracting both types of MNCs is* $t = \min(\pi_a,\ \pi_b)$.

Then, from 3.12 we get that the expected regional payoff, which is equal to the expected country's welfare, is:

$$ez^p_{a,b} = ew^p_{a,b} = (\min(\pi_a,\ \pi_b) + e_a)\,p + (\min(\pi_a,\ \pi_b) + e_b)\,(1-p) \tag{3.18}$$

Proof. It is obvious that a tax higher than $t = \min(\pi_a,\ \pi_b)$ does not attract both MNCs and a lower one produces a lower expected country's welfare than the one in expression 3.18. ■

Another proposition is:

Proposition 4 *When there are two types of MNCs, one region that can only post a tax, and no central government intervention (or a zero central government tax), an MNC of type b can be the only attracted one if and only if* $\pi_b > \pi_a$. *Moreover, to only attract an MNC of type b is the unconditional optimal policy under some parameter values and, when this is the case the unconditional optimal regional tax is* $t = \max(\pi_a - g,\ \pi_b - g) = \pi_b$.

Then, from 3.12 we get that the expected regional payoff, which is equal to the expected country's welfare, is:

$$ez^p_b = ew^p_b = s_b\,(1-p) \qquad \text{if } \pi_b > \pi_a \tag{3.19}$$

Proof. In the following numerical example we show that $t = \pi_b$ is the unconditional optimal regional tax only attracting the MNC of type b.

That is, assume the MNCs of type a and b produce externalities of $e_a = 40$ and $e_b = 20$ respectively and profits of $\pi_a = 20$ and $\pi_b = 30$ respectively (i.e. $s_a = 60$ and $s_b = 50$), and $p = 0.1$. Then, given that $\pi_a < 30$, it is obvious that setting $t = s_b = 30$ would be the conditional optimal tax only attracting the type b's MNC. Note that, a regional tax

higher than $t = \pi_b = 30$ would not attract the MNC of type b and, given that $g = 0$. a lower one would reduce the expected country's welfare or attract both MNCs. Moreover, the expected country's welfare is higher under this policy (equal to 45 in expression 3.19) than under the one that only attracts the type a MNC (equal to 6 in expression 3.17) and the one attracting both MNC (equal to 42 in expression 3.18). ■

In the previous three propositions we have determined the optimal taxes for the region conditional on each particular match between region and MNC being achieved. Then, for each specific parameter values, the conditional optimum producing the highest expected country's welfare is the unconditional regional optimal policy. In order to find it a comparison between the expected country's welfare in expressions 3.17, 3.18, and 3.19 is necessary.

Not surprisingly, the region can find it optimal to attract both MNCs or to only attract the MNC of type a. However, given the results under the bargaining mechanism, it is no so obvious why it can be optimal and even possible to only attract an MNC of type b. We have just used a numerical example to justify why this can be the case under the present mechanism. However, in order to get a more comprehensive understanding of this result we look at it in some more detail.

First, it should be obvious that for this case to be an equilibrium it is necessary that the maximum tax an MNC of type b can pay is higher than the one the MNC of type a can pay (i.e. $\pi_b > \pi_a$). For, if this were not the case every tax accepted by an MNC of type b would also be accepted by an MNC of type a, and the two MNCs would be attracted. Indeed, given that this condition is satisfied, it would be optimal to only attract an MNC of type b only if the expected country's welfare in expression 3.19 were higher or equal than the ones in expressions 3.17 and 3.18. That is, when the following two inequalities apply:

$$\pi_b \geq s_a \frac{p}{(1-p)} - e_b \tag{3.20}$$

and

$$\pi_b (1-p) \geq \pi_a + e_a p \tag{3.21}$$

We have already determined the regional optimal policy assuming that there was no central government intervention or that the central government imposed a zero tax on the MNC. However, in the case that there is a central government: Would a tax $g = 0$

be an optimal one? And, if this were the case, would this tax be the only optimal one? Let us prove that the answer to the first question is an affirmative one. On the one hand, it is obvious that when the country only attracts one type of MNC this is an optimal policy. For, in this case it would be optimal for the region to sets $t = \pi_a$ ($t = \pi_b$), what would allow the region to appropriate the entire surplus produced by the MNC. On the other hand, this is also an optimal central government policy when the country attracts both MNCs types. For, the combination $g = 0$ and $t = \min(\pi_a, \pi_b)$ charges the highest possible tax that would be accepted by both MNCs and it also extracts the entire externality produced by both of them.

Let us move on now to answer the second question. That is: Is $g = 0$ the only optimal central government tax? The answer to this question is no. To prove that this is the case it is enough to look at the strategy only attracting the MNC of type a. Given that this is the optimal strategy for the country, the central government could charge any tax $-\infty \leq g \leq \pi_a$. Then, the optimal regional tax is $t = \pi_a - g$, what implies that the total tax paid by the MNC is $g + t = \pi_a$.

Let us move on now to analyse an interesting case, which provides the same result as in the previous setting. This case is one where, given the central government in advance setting of taxes, the region can neither use the bargaining nor the posted tax mechanism. This would perhaps be the case of some municipalities and local governments with very low levels of autonomy and capability of making any important decision. Then, the following proposition applies:

Proposition 5 *When there are two types of MNCs and one region the expected country's welfare is the same in the following three cases: a) the central government can only post a tax and the region can neither post a tax nor bargain, b) the region can only post a tax and the central government can neither post a tax nor bargain, and c) both can only post a tax.*

In virtue of the previous proposition, from now on the expression "posted tax mechanism" will refer to any of these three cases.

An interesting result under the posted tax mechanism appears when, given $g = 0$, it is optimal to attract both MNCs. We know from proposition 3 that in this case the optimal regional tax is $t = \min(\pi_a, \pi_b)$. Then, it can be the case that the ex-post

Posted tax mechanism			
Country's welfare		Ex-post payoff from MNC	
		a	b
w_a^p	13.92		
w_b^p	41.04		
$w_{a,b}^p$	48.96	33	54

Figure 3-1: Numerical example: the ex-post regional payoff from the high surplus MNC is lower than the one from the low surplus MNC

payoff the region gets from an MNC of type a (i.e. $\min(\pi_a,\ \pi_b) + e_a$) is lower than the one it gets from an MNC of type b (i.e. $\min(\pi_a,\ \pi_b) + e_b$). This is an interesting result because it never happens in the bargaining mechanism. The intuition of this result is very straightforward. Given that in the tax posting mechanism the tax charged to a MNC does not vary with its type, the only difference between the ex-post payoff the region gets from both MNCs come from the externalities. Thus, the ex-post payoff the region gets will be higher from the MNC producing the higher externality and not necessarily the one producing the higher surplus. Let us see this result in the following numerical example.

Example 6 *Assume the MNCs of type a and b produce externalities of* $e_a = 1$ *and* $e_b = 22$ *respectively and profits of* $\pi_a = 57$ *and* $\pi_b = 32$ *respectively (i.e.* $s_a = 58$ *and* $s_b = 54$*), and* $p = 0.24$*. Figure 3-1 shows the expected country's welfare produced by the three alternative policies under the posted tax mechanism and the ex-post payoffs the region gets from each of the MNCs under the policy attracting both MNCs. It is obvious that the optimal policy is to attract both MNCs and that the ex-post payoff the region gets from an MNC of type a is lower than the one it gets from an MNC of type b.*

3.6 Comparison between the bargaining and posted tax mechanisms

In the previous two sections we have identified, for each negotiation mechanism, the optimal tax policies under different parameter values. We saw that, on the one hand, to only attract the MNC of type a or both MNCs are the only alternatives under the bargaining mechanism and the expected country's welfare for these two strategies are given by expressions 3.7 and 3.8 respectively. On the other hand, to only attract an MNC (of type a or b) or both MNCs are the alternatives under the posted tax mechanism and the expected country's welfare for these three strategies are given by expressions 3.17, 3.19 and 3.18 respectively.

In this section we want to make a comparison between the bargaining and posted tax mechanism. In particular, we want to answer the following question: Under what parameter values does one negotiation mechanism provide a higher expected country's welfare than the other one? In order to get an answer to this question we first need to obtain some intermediate results. These intermediate results, which are shown in propositions 7 and 9 and definition 8, come from the comparison of the expected country's welfare obtained under each of the possible alternatives in each mechanism. Then, the answer to the previous question is in propositions 10 and 11.

Proposition 7 $ew_a^b = ew_a^p$.

Proof. From the comparison of expressions 3.7 and 3.17. ■

An obvious implication of the previous proposition is that when in both mechanisms it is optimal to only attract an MNC of type a the expected country's welfare is the same under both mechanisms. Thus, for the sake of simplicity, we make the following definition:

Definition 8 $ew_a = ew_a^b = ew_a^p$.

Proposition 9 $ew_{a,b}^b > ew_b^p$.

Proof. From the comparison of expressions 3.8 and 3.19. ■

An implication of the last proposition is that when it is optimal to only attract the MNC of type b under the posted tax mechanism, this mechanism provides a lower expected country's welfare than the bargaining one.

Now we are in conditions to determine under what parameter values one negotiation mechanism provides a higher expected country's welfare than the other one. This is done in the following four propositions.

Proposition 10 *The bargaining mechanism strictly (weakly) dominates the posted tax one if and only if* $ew^b_{a,b} > (\geq) \max\left(ew_a,\ ew^p_{a,b}\right)$.

Proof. The bargaining mechanism strictly dominates[15] the posted tax one only when $\max\left(ew^b_a,\ ew^b_{a,b}\right) > \max\left(ew^p_a,\ ew^p_b,\ ew^p_{a,b}\right)$ what, given that $ew^b_a = ew^p_a = ew_a$ and $ew^b_{a,b} > ew^p_b$, is equivalent to $ew^b_{a,b} > \max\left(ew_a,\ ew^p_{a,b}\right)$. ■

Proposition 11 *The posted tax mechanism strictly (weakly) dominates the bargaining one if and only if* $ew^p_{a,b} > \max\left(ew_a,\ ew^b_{a,b}\right)$.

Proof. The posted tax mechanism strictly dominates[16] the bargaining one only when $\max\left(ew^p_a,\ ew^p_b,\ ew^p_{a,b}\right) > \max\left(ew^b_a,\ ew^b_{a,b}\right)$ what, given that $ew^b_a = ew^p_a = ew_a$ and $ew^b_{a,b} > ew^p_b$ is equivalent to $ew^p_{a,b} > \max\left(ew_a,\ ew^b_{a,b}\right)$. ■

From the previous propositions the following two corollaries are derived.

Corollary 12 *when to attract both MNCs is the optimal policy under one mechanism, but the attraction of only one MNC is the optimal policy under the other one, the mechanism for which it is optimal to attract both MNCs strictly welfare dominates the other one.*

Corollary 13 *A necessary condition for a mechanism to strictly dominate the other one is that the attraction of both MNCs is the optimal policy under the former. Indeed, a sufficient condition for a mechanism to strictly dominate the other one is that the attraction of both MNCs is the optimal policy under the former and this policy provides a higher expected country's welfare than the attraction of both MNCs under the latter.*

Before giving a more formal explanation of what makes one mechanism relatively more advantageous than the other let us begin with some intuition. Thus, let us first mention a relative advantage of the bargaining mechanism. That is the fact that,

[15] The proof for the week domination is the same but the strict inequalities are replaced by weak ones, except for $w^b_{a,b} > w^p_b$.

[16] See previous note.

when the two MNCs produce identical surpluses, they are entirely appropriated by the country. However, because of the imperfect surplus discrimination[17], this advantage decreases with the dispersion of the surpluses. On the contrary, given that the posted-tax mechanism always sets the same tax on both MNCs, its relative advantage is that, when the two MNCs produce identical profits, their entire surpluses are appropriated by the country. Though, this advantage decreases with the dispersion of the profits. We can summarise these two results by saying that the relative advantage of the bargaining mechanism over the posted-tax one is higher the lower (higher) is the dispersion of the surpluses (profits) between the two MNCs.

Let us move on now to give a more formal explanation of these relative advantages. It is obvious from the first part of corollary 13 that in order to look for these relative advantages we have to concentrate in the cases where to attract both MNCs is the optimal policy for at least one of the mechanisms. Thus, we have to examine three different situations. The case where to attract both MNCs is the optimal policy under both mechanisms. The two cases where it is optimal to attract both MNCs in the bargaining mechanism but only the MNC of type a or b in the posted-tax one. Finally, the case where it is optimal to attract both MNCs in the posted-tax mechanism but only the MNC of type a in the bargaining one.

Let us begin analysing the case where to attract both MNCs is the optimal policy under both mechanisms. Thus, knowing that $s_b = \pi_b + e_b$ and $s_a = \pi_a + e_a$ and that the optimal central government policy attracting both MNCs under the bargaining mechanism is $g = s_b$, expression 3.8 is equivalent to:

$$ew^b_{a,b} = \left((\pi_b + e_b) + \frac{\pi_a + e_a - (\pi_b + e_b)}{2} \right) p + (\pi_b + e_b)(1 - p) \tag{3.22}$$

The expressions 3.18 and 3.22 have the same interpretation. That is, the first and second terms are the expected total taxes (i.e. expected sum of the central government and regional taxes) charged on the MNCs of type a and b respectively. Indeed, it is clear from looking at the second term of both expressions that the total tax on the MNC of type b in the posted-tax mechanism is lower or equal than in the bargaining one (i.e. $\min(\pi_a, \pi_b) + e_b \leq \pi_b + e_b$). However, to get a more precise understanding of the effects

[17] See footnote 2.

that different parameters have on the relative advantage of the bargaining mechanism over the posted-tax one, let us subtract 3.18 from 3.22:

$$\begin{aligned} ew^b_{a,b} - ew^p_{a,b} = & \left(\tfrac{\pi_a - e_a + \pi_b + e_b}{2} - \min(\pi_a,\ \pi_b)\right) p \\ & + (\pi_b - \min(\pi_a,\ \pi_b))(1-p) \end{aligned} \tag{3.23}$$

The first and second terms of the previous expression are the bargaining mechanism relative advantages from attracting the MNCs of type a and b respectively. Then. in the case that $\pi_a > \pi_b$ the only difference between the two mechanisms comes from the total tax paid by the MNC of type a. For by replacing $\min(\pi_a,\ \pi_b) = \pi_b$ into expression 3.23 we get that:

$$ew^b_{a,b} - ew^p_{a,b} = \left(\frac{\pi_a - \pi_b}{2} + \frac{e_b - e_a}{2}\right) p \tag{3.24}$$

On the contrary, if $\pi_a < \pi_b$ the bargaining mechanism would generate relatively more country's welfare than the posted-tax mechanism from the MNC of type b, but less from the MNC of type a. For by replacing $\min(\pi_a,\ \pi_b) = \pi_a$ into expression 3.23 we get that:

$$ew^b_{a,b} - ew^p_{a,b} = \frac{e_b - e_a}{2} p + (\pi_b - \pi_a)\left(1 - \frac{p}{2}\right) \tag{3.25}$$

From expressions 3.24 and 3.25 we get that the likelihood that the posted-tax mechanism dominates the bargaining one is higher the lower are e_b and the dispersion of the profits ($|\pi_a - \pi_b|$) and the higher is e_a[18]. However, the effect from p is indeterminate because it is positive in expression 3.24 but negative in expression 3.25.

Thus, let us move on and explain the intuition of the previous results. We have that, on the one hand, the lower is the dispersion of the profits the lower is the posted-tax mechanism disadvantage produced by the inability of applying tax discrimination.

On the other hand, the effect coming from e_b and e_a can be explained by the fact that the relative advantage of the bargaining mechanism over the posted-tax one is higher the lower is the dispersion of the surpluses between the two MNCs. However, we know that a lower profits dispersion also increases the tax posting mechanism relative advantage

[18] The effect from $|\pi_a - \pi_b|$ is produced by the fact that the likelihood that the posted-tax mechanism dominates the bargaining one is higher the lower is $\pi_a - \pi_b$ (the lower is $\pi_b - \pi_a$) in expression 3.24 (expression 3.25) where $\pi_a > \pi_b$ (where $\pi_a < \pi_b$).

over the bargaining one. Then, the only way of reducing the surpluses dispersion and consequently increasing the relative advantage of the bargaining mechanism is by a rise in e_b and/or a fall in e_a. For, given $s_a > s_b$, this would reduce the surpluses dispersion.

We can also see this result in expressions 3.18 and 3.22. Thus, under both the bargaining and tax posting mechanisms the externality produced by the low surplus MNC (i.e., type b) has the same positive effect on the country's welfare when this MNC shows up. However, when the high surplus MNC (i.e., type a) shows up the externality produced by the low surplus MNC has no effect under the tax posting mechanism, but it allows a higher "reservation tax" under the bargaining one. Furthermore, the externality produced by the high surplus MNC has a lower positive effect on the country's welfare under the bargaining mechanism than under the tax posting one. For, under the bargaining mechanism this externality increases the size of the cake[19] which is subject to negotiation between the region and the MNC. On the contrary, this cake is completely appropriated by the country under the tax posting mechanism.

We can summarise the previous results by mentioning the respective advantageous features of the bargaining and posted-tax mechanisms. The advantageous feature of the bargaining mechanism is the fact that, when the two MNCs produce identical surpluses, they are entirely appropriated by the country. However, because of the imperfect surplus discrimination, this advantage decreases with the dispersion of the surpluses. On the contrary, given that the posted-tax mechanism always sets the same tax on both MNCs, its advantageous feature is that, when the two MNCs produce identical profits, their entire surpluses are appropriated by the country. Though, this advantage decreases with the dispersion of the profits.

By now we have analysed the relative advantages and disadvantages of the bargaining mechanism assuming that to attract both MNCs is the optimal policy in both mechanisms. However, does this explanation still apply when it is optimal to only attract one MNC in one or the other mechanism? As we already said, to give an answer to this question it is necessary to analyse the following three cases. The first two cases are when it is optimal to attract both MNCs in the bargaining mechanism but only the MNC of type a or b in the posted-tax one. The third case is when it is optimal to attract both MNCs in the posted-tax mechanism but only the MNC of type a in the

[19] The after reservation tax surplus.

bargaining one.

Consider first the case where it is optimal to attract both MNCs in the bargaining mechanism but only the MNC of type b in the posted-tax one. It should be obvious that the bargaining mechanism advantage in terms of surplus discrimination would still be present in this case. Indeed, the advantage of attracting two MNCs instead of one would be added.

Now, knowing that to only attract the MNC of type a produces the same country's welfare in both mechanisms, let us move on to analyse the case where to only attract this MNC is the optimal policy in the posted-tax mechanism, but the attraction of both MNCs is the optimal one in the bargaining one. It is obvious that if this were the case, the advantage provided by the bargaining mechanism, when attracting both MNCs, would be relatively higher than the one provided by the posted-tax one. Exactly the contrary explanation applies to the case where to only attract the MNC of type a is the optimal policy in the bargaining mechanism, but the attraction of both MNCs is the optimal policy in the posted-tax one. That is, the advantages provided by the posted-tax mechanism are relatively more significant than the advantages provided by the bargaining one.

In order to have a more graphical understanding of a situation where the posted tax mechanism strictly dominates the bargaining one let's take a look at the following numerical example.

Example 14 *Assume the MNCs of type a and b produce externalities of* $e_a = 80$ *and* $e_b = 20$ *respectively and profits of* $\pi_a = \pi_b = 30$ *(i.e.* $s_a = 110$ *and* $s_b = 50$*), and* $p = 0.5$. *Figure 3-2 shows the expected country's welfare produced by the two alternative policies under the bargaining mechanism and the three alternative ones under the posted tax one. It is clear that the highest expected country's welfare is achieved when both MNCs are attracted under the posted tax mechanism, what implies that this mechanism dominates the bargaining one. Indeed, as suggested before,* $|\pi_a - \pi_b|$ *is low and there is a high correlation between the externalities and the surpluses produced by the MNCs.*

Finally, it is important to take a look at a special case (Wang's case) for which the bargaining mechanism weakly dominates the posted tax one. This special case is the one where MNCs only produce profits. That is, assume that the MNCs of type a and

Bargaining mechanism	
ew_a^b	55
$ew_{a,b}^b$	**65**
Posted tax mechanism	
ew_a^p	55
ew_b^p	25
$ew_{a,b}^p$	**80**

Figure 3-2: Numerical example: the posted tax mechanism dominates the bargaining one

b produce respective profits of 40 and 30. It should be obvious that in this particular example there is no policy that attracts only an MNC of type b. For every tax that is accepted by an MNC of type b would be also accepted by an MNC of type a. Thus, independently of the mechanism, the only possibilities are to only attract an MNC of type a or to attract both MNCs. Then, on the one hand, we already know that if the policy only attracting the MNC of type a is the optimal one under both mechanisms, there would be no difference in the expected country's welfare they produce. On the other hand, the optimal central government policy in order to attract both MNCs is to set $g = s_b = 30$ and $g = \min(\pi_a,\ \pi_b) = \pi_b = s_b = 30$ under the bargaining and posted tax mechanisms respectively. However, from expressions 3.8 and 3.18 we have that the expected country's welfare are $ew_{a,b}^b = 35p + 30(1-p)$ and $ew_{a,b}^p = 30$ respectively, what implies that the bargaining mechanism dominates the posted tax one.

3.7 Conclusion

We have developed a framework where, in a heterogeneous buyers setting, two selling mechanisms have been compared, bargaining with reservation price versus posted price selling, in terms of the revenues generated for a monopolistic seller.

This comparison has been done in a setting where a country and an MNC negotiate the tax to be paid for the installation of a new production plant. In order to simplify the analysis we have ruled out any competition coming from another country and assumed

the existence of only one region. One innovative feature in our setting of the problem is that the seller (the country) gets a non-monetary gain (an externality) in addition to the selling price (the tax). Indeed, our model is general enough as to also incorporate the case where the one choosing between the two selling mechanism (in our case the country) is the buyer.

We have considered the stylized fact that the central government has to set the taxes in advance (tax posting), but depending on the negotiation mechanism, the regional government can either bargain or post a tax. Furthermore, the MNC has to accept whichever negotiation mechanism is in place and decide whether to establish its new production plant in the country.

Interesting results have been found. In particular, when the seller also gets a non-monetary gain in addition to the selling price, it is not always the case that bargaining dominates posted price selling. However, we also saw that from the seller's perspective the bargaining mechanism is superior to the posted tax one for a very plausible range of parameter values which, as in Wang (1995), includes the case where the MNCs only produce profits and no externalities to the region.

We have shown that the bargaining mechanism optimality decreases with the dispersion of the surpluses and that the posted-tax one does it with the dispersion of the profits. Indeed, we have proved that, even though the dispersion in the profits has a positive correlation with the dispersion in the surpluses, a lower dispersion in profits has a higher positive effect on the country's welfare under the posted-tax mechanism than under the bargaining one. This led us to conclude that the likelihood that the bargaining mechanism dominates the posted-tax one is higher the higher is the dispersion of the profits and the lower is the externality of the high surplus MNC with respect to the one produced by the low surplus one.

As a consequence of the previous explanation we also find that the composition of the surplus between profits and externalities does not produce any effect on the equilibrium expected country's welfare in the bargaining mechanism. However, it does in the posted tax one. Indeed, this is the main reason leading to the result that to only attract the low surplus MNC can be the optimal policy under the posted tax mechanism and not under the bargaining one.

Two important policy recommendations are derived. On the one hand, our model

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determines the optimal central government tax policy under each of the negotiation mechanisms. On the other hand, it establishes the optimal negotiation mechanism under specific ranges of parameter values, what becomes important in the case the central government of the country has some control of it.

Our model can also be applied to other frameworks where the main issue is the choice between bargaining with reservation price or posted price selling. An example could be the subsidies offered by cities or regions in order to attract specific airlines to their local airports. This type of subsidy is very common all around the world, though not allowed in the European Union.

Finally, we recognise that an important limitation of our model is the fact that it can only be applied to a country with only one region (agent). That is, there was no consideration of the effects from the competition coming from a second region. Indeed, the results of the model depend on the existence of only two types of MNCs. I could be interesting to explore how the results are affected by the consideration of a more general distribution function of MNCs types. This last point is though left for future research.

Chapter 4

The region can choose between the bargaining and posted tax mechanisms

4.1 Introduction

In the previous chapter we have analysed the negotiation process between an MNC and the host country assuming that the only region of the country can only use bargaining or tax posting. No consideration has been made of a case where the region can choose between these two mechanisms. We will refer to the mechanism where the region can choose between using bargaining and tax posting as the "mix-negotiation mechanism". The analysis of this last mechanism is the main aim of the present chapter.

However, let us explain the decision of writing the mixed negotiation mechanism in a separate chapter. The reason is not because it is completely different from the two mechanisms analysed in the previous chapter. As it will be clear soon there is substantial overlapping between the two chapters. However, the comparison of the two regimes of the previous chapter comes to fill a gap in the literature on the optimal selection mechanisms. Then, we have considered prudent to address this gap in that chapter and leave the analysis of the mixed negotiation mechanism for the present one.

Some interesting results are found. The most important one is that, for those parameter values where the bargaining mechanism is welfare superior to the posted tax one,

we also find that the addition of the posting tax strategy to the regional options not only cannot increase the expected country's welfare, but it reduces it in some cases. It seems striking that the addition of another negotiation tool to the region reduces the expected country's welfare. The intuition of this result is that the existence of a regional choice between bargaining and posted tax creates a conflict of interests between the region and the central government. That is, it is optimal for the country that the bargaining strategy is used in order to attract both MNCs but not for the region. Interestingly, this conflict of interests does not exist when the region cannot choose between strategies.

The structure of the chapter is as follows. Section 2 presents the model. Section 3 compares the mixed and the bargaining mechanisms. Section 4 compares the mixed and the posted tax mechanisms. The main results are summarised in section 5. Section 6 concludes.

4.2 The model

We assume a three-stage game involving the central government, one region, and a MNC, which can be of type a or b. In the first stage, in order to maximise the expected country's welfare the central government posts a lump sum tax to be paid by the MNCs. In the second stage the regional government chooses its optimal taxing strategy. That is, whether or not to post a particular tax to be paid by the MNC in the third stage. Finally, in the third stage an MNC shows up and negotiates the tax with the region.

Let us begin analysing the third stage of the game. On the one hand if the region has chosen bargaining in the second stage, it would have to bargain with the MNC in the third stage. On the other hand, if the region has chosen to post a tax in the second stage and in the case the MNC decides to build the plant in the region, the MNC would have to accept the posted tax. In this last case, we already know from the previous chapter that the region has the three following strategies: To only attract an MNC of type a, to only attract an MNC of type b, or to attract both types of MNCs. As in the previous chapter we will first find the optimal regional tax under each possible regional strategy. Then, the optimal regional strategy will be the one providing the highest payoff.

It must be noticed that we cannot use here the expressions 3.17, 3.18, and 3.19 obtained in the previous chapter to calculate the expected regional payoff under each strategy because, for simplicity, these expressions were obtained under the assumption that $g = 0$. Thus, in order to obtain the expected regional payoffs under each of these strategies in the mixed negotiation mechanism we replace t from expression 3.13 into expression 3.12. Then, we get that

$$ez_a^{p,m} = (s_a - g)p \quad \text{if } \pi_a > \pi_b \tag{4.1}$$

if a tax that only attracts an MNC of type a is posted[1],

$$ez_b^{p,m} = (s_b - g)(1 - p) \quad \text{if } \pi_b > \pi_a \tag{4.2}$$

[1]It is obvious that the MNC of type a would be attracted iff $s_a \geq g$. However, for the sake of simplicity the second line of expression 3.12 is eliminated from expressions 4.1, 4.2, and 4.3. Similar procedure will be used in the following expressions for the regional payoff as well as for the country's welfare.

if a tax that only attracts an MNC of type b is posted,

$$ez_{a,b}^{p,m} = \min(\pi_a,\ \pi_b) + e_a p + e_b(1-p) - g \tag{4.3}$$

if a tax that attracts both MNCs is posted.

In the case that the region uses a bargaining mechanism and depending on the central government tax, it is able to attract both types of MNCs or only an MNC of type a. Then, the expected regional payoffs, which are derived from expression 3.3 are:

$$ez_a^{b,m} = \left(\frac{s_a - g}{2}\right) p \tag{4.4}$$

if only the MNC of type a is attracted when bargaining is chosen (if $s_a \geq g$ but $s_b < g$), and

$$ez_{a,b}^{b,m} = \frac{s_a - g}{2} p + \frac{s_b - g}{2}(1-p) \tag{4.5}$$

if the two MNCs are attracted when bargaining is chosen (if s_a, $s_b \geq g$).

Let us now move on to the second stage of the game and use h to refer to the five possible strategies for the region. That is, the three posting tax strategies plus the two bargaining ones respectively attracting one or both MNCs. Moreover, let us refer to h^* as the optimal regional strategy. That is, the strategy that provides the maximum expected regional payoff

$$ez_i^{h^*} = \max\left(ez_a^{p,m},\ ez_b^{p,m},\ ez_{a,b}^{p,m},\ ez_a^{b,m},\ ez_{a,b}^{b,m},\ 0\right)$$

Recall that the upper script m stands for 'mix-mechanism' and the upper scripts p and b indicate whether a tax posting or bargaining strategy is selected.

Let us analyse the first stage of the game. In this stage the central government maximises the expected country's welfare. The best way to find the unconditional maximum expected country's welfare is to first obtain the conditional ones. That is, the maximum expected country's welfare conditional on each particular strategy being the optimal one for the region. Then, the maximum of these conditional maximum expected country's welfares is the unconditional one. Finally, the central government tax necessary to achieve this unconditional maximum expected country's welfare is the optimal central government tax.

Let us move on then to find these conditional maximum expected country's welfares. We know from 3.11 that the ex-post regional payoff is $z_i = t_i + e_i$, and from expression 3.15 that the ex-post country's welfare is $w = g + t_i + e_i$. This means that in order to pass from the ex-post regional payoff to the ex-post country's welfare we only need to add g to expressions 4.1, 4.2, 4.3, 4.4, and 4.5. This is done in expressions 4.6, 4.7, 4.8, 4.9, and 4.10, in order to obtain the conditional maximum expected country's welfares.

$$
\begin{aligned}
ew_i^{h^*(c)} &= ew_a^{p,m(c)} = s_a p && \text{iff } ez_i^{h^*} = ez_{a,b}^{b,m} && (4.6)\\
&= ew_b^{p,m(c)} = s_b\,(1-p) && \text{iff } ez_i^{h^*} = ez_b^{p,m} && (4.7)\\
&= ew_{a,b}^{p,m(c)} = \min\left(\pi_a,\ \pi_b\right) + e_a p + e_b(1-p) && \text{iff } ez_i^{h^*} = ez_{a,b}^{p,m} && (4.8)\\
&= ew_a^{b,m(c)} = \left(g + \frac{s_a - g}{2}\right) p && \text{iff } ez_i^{h^*} = ez_a^{b,m} && (4.9)\\
&= ew_{a,b}^{b,m(c)} = \left(\frac{s_a + g}{2}\right) p + \left(\frac{s_b + g}{2}\right)(1-p) && \text{iff } ez_i^{h^*} = ez_{a,b}^{b,m} && (4.10)
\end{aligned}
$$

where the upper script (c) indicates that these expected country's welfares are conditional on the particular strategy being the optimal one for the region. For instance, in (4.6) this condition is stated in the expression "iff $ez_i^{h*} = ez_{a,b}^{b,m}$". The upper script h^* indicates the particular regional strategy being implemented.

Then, the unconditional maximum expected country's welfare is:

$$ew_i^{h*} = \max\left(ew_a^{p,m(c)},\ ew_b^{p,m(c)},\ ew_{a,b}^{p,m(c)},\ ew_a^{b,m(c)},\ ew_{a,b}^{b,m(c)}\right) \tag{4.11}$$

Finally, the optimal central government tax, g^*, is the particular tax solving the following expression

$$g^* = \arg\max_g \left(ew_i^{h*}\right) \tag{4.12}$$

Let us make a clarification. That is, the fact that the expected country's welfare in expressions 4.6, 4.7, and 4.8 (under the three posted tax strategies) are conditional (on the particular strategy also being the optimal one for the region) is not a problem. For by setting $g = 0$ the expected regional payoff is equal to the expected country's welfare for each of these strategies and so the implementation of the country's optimal one is guaranteed. Moreover, for simplicity, we can ignore the alternative of only attracting an MNC of type a by the use of a bargaining strategy (expression 4.9). For, at most,

it provides the same expected country's welfare than the posting tax strategy that only attracts this type of MNC (expression 4.6).

Let us move on now to show some identities in order to simplify the notation to be used in the following two sections of the chapter. They are identities between the expected country's welfare produced by particular strategies under the three different negotiation mechanisms. That is, the mixed negotiation mechanism of this chapter and the bargaining and posted price mechanisms of the previous one. This is done in the following three propositions

Proposition 15 *If optimally designed, a strategy only attracting an MNC of type a produces the same country's welfare, whether the mechanism is of the bargaining, posted tax, or mixed type (i.e.* $ew_a^{b(c)} \equiv ew_a^{p(c)} \equiv ew_a^{p,m(c)} \equiv ew_a^{b,m(c)}$*).*

Proof. This is obvious from the comparison of expressions 3.7, 3.17, 4.6, and 4.9. In the case of expression 4.9 the optimal central government tax is $g = s_a$. ■

Proposition 16 *A strategy only attracting an MNC of type b produces the same country's welfare in the posted tax and mixed negotiation mechanisms (i.e.* $ew_b^{p(c)} \equiv ew_b^{p,m(c)}$*).*

Proof. This is obvious from the comparison of expressions 4.7 and 3.19. ■

The previous two propositions allows us to make the following definitions

Definition 17 $ew_a^{b(c)} \equiv ew_a^{p(c)} \equiv ew_a^{p,m(c)} \equiv ew_a^{b,m(c)} \equiv ew_a^{(c)}$

Definition 18 $ew_b^{p(c)} \equiv ew_b^{p,m(c)} \equiv ew_b^{(c)}$.

As a consequence of the previous two definitions, from now on and independently of the mechanism being considered, we will just refer to the "strategy that only attracts an MNC of type a" and the "strategy that only attracts an MNC of type b". Indeed, we will just use $ew_a^{(c)}$ and $ew_b^{(c)}$ to refer to the expected country's welfare under these strategies. Furthermore, we leave the term "bargaining strategy" to refer to the bargaining strategy attracting both MNCs.

Proposition 19 *A strategy attracting both MNCs produces the same expected country's welfare in the posted tax and mixed negotiation mechanisms (i.e.* $ew_{a,b}^{p(c)} \equiv ew_{a,b}^{p,m(c)}$*).*

Proof. This is obvious from the comparison of expressions 4.8 and 3.18. ■

4.3 Comparison between the bargaining and mixed negotiation mechanisms

In this subsection we are interested in comparing the expected country's welfare in the bargaining and mixed negotiation mechanisms. The first result is stated in the following proposition:

Proposition 20 *For the range of values where the posted tax mechanism strictly (weakly) dominates the bargaining one, the equilibrium expected country's welfare is the same in the mixed and posted tax mechanisms and so the mixed negotiation mechanism strictly (weakly) dominates the bargaining one.*

Proof. This is the case because, as we already said, by setting $g = 0$ the central government guarantees the implementation of the optimal posting tax strategy. ■

For those parameter values where the posted tax mechanism strictly dominates the bargaining one this proposition has the following two implications. First, the addition of a bargaining tool to a region that already has a posted tax one would not alter the expected country's welfare. Second, the addition of a posted tax negotiation tool to a region that already has a bargaining one would increase the expected country's welfare.

However, what happens to the expected country's welfare when the addition of the posted tax negotiation tool to the region is made for those parameter values where the bargaining mechanism strictly dominates the posted tax one? In the rest of this section we will look for an answer to this question, what requires a comparison between the mixed and bargaining mechanisms. At first glance it seems that the addition of the posted tax negotiation tool to the region should not produce any reduction in the expected country's welfare. But, we will see that it does.

Let us see why it is that. Note that for the rest of the section we will assume that the parameter values are such that the bargaining mechanism strictly dominates the posted tax one. We already know that if the attraction of only the MNC of type a is the optimal policy under the bargaining mechanism, the mixed and the bargaining mechanisms would produce the same equilibrium expected country's welfare. Surprisingly, if the optimal policy under the bargaining mechanism is to attract both MNCs, the equilibrium expected country's welfare would be higher than under the mixed one. The reason for this last result becomes apparent in the following numerical example.

Example 21 *Assume the MNCs of type a and b produce respective profits of* 40 *and* 30. *zero externalities, and the probability of an MNC of type b showing up is high enough as to make it optimal for the country to attract both MNCs under the bargaining mechanism (say* $1 - p = 0.8$*). That is, the expected country's welfare in expression 3.8 is higher than the one in expression 3.7. Thus, it is optimal for the central government to charge a tax* $g = \pi_b = 30$ *and the expected country's welfare is given by expression 3.8 (i.e.* $ew = 35p + 30(1-p) = 31$*).*

On the contrary, if the central government sets this same tax $g = 30$ *under the mixed negotiation mechanism, the region would have an incentive to post a tax that only attracts the MNC of type a. That is, it would be optimal for the region to post a tax equal to* 10. *The region gets the entire after-tax surplus produced by an MNC of type a, but the MNC of type b does not come to the country*[2]*. Then, the expected country's welfare is the same as the one achieved by the tax policy that only attracts the MNC of type a (expression 4.6).*

This result is a direct consequence of the fact that, as we already said, it is not enough for the bargaining strategy to be optimal for the country, but it has to be also optimal for the region. That is, the expected country's welfare in expression 4.10 is conditional on the fact that the bargaining strategy is also the optimal one for the region.

The previous numerical example made it clear that the bargaining strategy cannot be the optimal one under the mixed negotiation mechanism if $g = \pi_b$. Then, the question is: could the bargaining strategy be the optimal one if $g < \pi_b$. We will see later on that under very special circumstances this is the case. However, even if this were the case we know from the comparison of expressions 3.8 and 4.10 that $ew^{b}_{a,b} > ew^{b,m(c)}_{a,b}$. That is, the expected country's welfare produced by the bargaining strategy attracting both MNCs is higher under the bargaining mechanism than under the mixed one.

Then, given that $ew^{p,m(c)}_{a} = ew^{b}_{a} = ew^{p}_{a} = ew_a$, we can make the following definition:

Definition 22 *The bargaining mechanism strictly (weakly) dominates the mixed one if and only if* $ew^{b}_{a,b} > ew^{h*}_{i}$ $(ew^{b}_{a,b} \geq ew^{h*}_{i})$.

[2] *This strategy gives the region a payoff equal to* 10p, *which is higher than the one obtained when it chooses bargaining, equal to* (10/2)p.

Thus, the following proposition applies:

Proposition 23 *For those parameter values where the bargaining mechanism strictly dominates the posted tax one, it also strictly dominates the mixed negotiation mechanism.*

Proof. From proposition 10 we have that the bargaining mechanism strictly dominates the posted tax one if $ew^b_{a,b} > \max\left(ew_a, ew^p_{a,b}\right)$ and from proposition 9 we have $ew^b_{a,b} > ew^p_b$. Then, given that $ew^b_{a,b} > ew^{b,m(c)}_{a,b}$, it must be also the case that $ew^b_{a,b} > ew^{h*}_i$. ■

In the previous chapter we have found that the bargaining mechanism was welfare superior to the posted tax one for a very plausible range of parameter values. For this same range of values, we find now that the addition of the posting tax tool to a region that was already able to use the bargaining one cannot increase the expected country's welfare. Indeed, it reduces it under some parameter values. It seems striking that the addition of another negotiation tool to the region reduces the expected country's welfare. What produces this result is that, in some circumstances, the existence of a regional choice between bargaining and posted tax creates a conflict of interests between the region and the country. That is, it is optimal for the country that the bargaining strategy is used in order to attract both MNCs but not for the region. It is obvious that this conflict of interests does not exist when the region can only use the bargaining mechanism or it can only use the posted tax one.

Finally, it could be that the reason why the regional government has only the bargaining negotiation mechanism is because the central government does not allow it to post a tax. If this were the case, the previous result would imply that, for those parameter values where the bargaining mechanism dominates the mixed one, it is optimal for the central government not to allow the regional posted tax and leave the region with only the bargaining negotiation mechanism.

4.4 Comparison between the posted tax and mixed negotiation mechanisms

In the present section we want to make a comparison between the posted tax and mixed negotiation mechanisms in order to find which one produces a higher expected country's welfare. We know that by setting $g = 0$ in the mixed negotiation mechanism the central government can get the same equilibrium expected country's welfare than under the posted tax one. As stated in proposition 20, this results in the mixed negotiation mechanism producing the same expected country's welfare than the posted tax one. Then, it is obvious that the only case where the mixed negotiation mechanism has some chances of dominating the posted tax one is when the bargaining strategy attracting both MNCs is the equilibrium one[3]. Indeed, under some parameter values this will be the case. However, as we will see later on, this happens under very special circumstances.

Let us take a closer look to this particular case where the mixed negotiation mechanism dominates the posted tax one. In order to find this case we follow three steps. First, under the mixed negotiation mechanism, we find the particular parameter values and central government taxes for which the bargaining strategy is the optimal one for the region. In fact we will soon see that there is only one central government tax satisfying this. Second, we check if this particular tax policy is also the optimal one for the central government and so the equilibrium one in the mixed negotiation mechanism. Finally, we check if this optimal policy under the mixed negotiation mechanism dominates the one under the tax posting one. If this were the case we would conclude that the mixed negotiation mechanism dominates the posted tax one.

Let us work out the first step and find the particular parameter values and central government tax under which the bargaining strategy is the optimal one for the region. On the one hand, it is necessary that the bargaining strategy provides the region a higher payoff than both the posted tax only attracting an MNC of type a (i.e. $ez_{a,b}^{b,m} > ez_a^{p,m}$) and a posted tax only attracting an MNC of type b (i.e. $ez_{a,b}^{b,m} > ez_b^{p,m}$). On the other hand, it requires that the bargaining strategy provides the region a higher payoff than

[3]That is, it is the optimal one for both the region and the central government. In fact, if the bargaining strategy attracting both MNCs is the optimal one in the mix regime we can be sure that the bargaining regime dominates the pre-commitment one. However, we will soon see that the reverse is not always true.

a posted tax one attracting both MNCs (i.e. $ez_{a,b}^{b,m} > ez_{a,b}^{p,m}$).

Let us analyse the first of these requisites. Given expressions 4.5. 4.1. and 4.2. $ez_{a,b}^{b,m} > ez_{a}^{p,m}$ and $ez_{a,b}^{b,m} > ez_{b}^{p,m}$ imply that the following two weak inequalities have to be satisfied:

$$\frac{s_b - g}{2}(1-p) \geq \frac{s_a - g}{2}p \tag{4.13}$$

and

$$\frac{s_a - g}{2}p \geq \frac{s_b - g}{2}(1-p) \tag{4.14}$$

It is obvious that given $p > 0$, $g < s_b$ is necessary in order for inequality 4.13 to be satisfied. The only way for these two weak inequalities to be satisfied is that they apply with an equal sign. This implies

$$(s_b - g)(1-p) = (s_a - g)p \tag{4.15}$$

This means that in order for the region to be willing to implement the bargaining strategy it is necessary that the previous mentioned three strategies provide the same expected regional payoff (i.e. $ez_{a,b}^{b,m} = ez_{a}^{p,m} = ez_{b}^{p,m}$). Then, for the bargaining strategy to be the optimal one for the region, the central government tax must be equal to:

$$g = \frac{s_b(1-p) - s_a p}{(1-2p)} \tag{4.16}$$

It is obvious that for this value of g the region is indifferent between the three strategies, bargaining (i.e., $b(a,b)$) or the two posting price strategies attracting only one type of MNC (i.e., $p(a)$, and $p(b)$). Then, it seems reasonable to think that it would choose each of them with equal probability (i.e. 1/3%). Let us refer to this strategy as the "compound strategy". Obviously, the expected regional payoff under this conditional strategy is $ez^{cs,m} = ez_{a}^{p,m} = ez_{b}^{p,m} = ez_{a,b}^{b,m}$.

Let us now analyse the second mentioned requisite. That is, the fact that the bargaining strategy provides the region a higher payoff than a posted tax one attracting both MNCs (i.e. $ez_{a,b}^{b,m} > ez_{a,b}^{p,m}$). This issue is dealt with in propositions 24, 25, and 26. Proposition 24 shows that this would not be the case if to attract both MNCs is the optimal policy under the posted tax mechanism. For, in this case, the mixed negotiation mechanism would provide the same expected country's welfare than the posted tax one.

On the contrary, propositions 25 and 26 show that this is the case if to only attract an MNC of type a or b is the optimal policy under the posted tax mechanism and the bargaining mechanism dominates the posted tax one.

Proposition 24 *If the optimal policy under the posted tax mechanism is to attract both MNCs (i.e.* $ew^p_{a,b} > \max\left(ew^p_a,\ ew^p_b\right)$*) the bargaining strategy would not be implemented by the region in a mixed negotiation mechanism.*

Proof. If the parameter values were such that under the posted tax mechanism it is optimal to attract both MNCs (i.e. $ew^p_{a,b} > \max\left(ew^p_a,\ ew^p_b\right)$), the optimal central government tax would be such that $ez^p_{a,b} > \max\left(ez^p_a,\ ez^p_b\right)$ applies[4]. Then, from expressions 3.18, 3.17, 3.19, 4.1, and 4.2, we get that $ez^{p,m}_{a,b} > \min\left(ez^{p,m}_a, ez^{p,m}_b\right)$. However, from expression 4.15 we know that for bargaining not to be a dominated strategy under the mixed negotiation mechanism it must be that $ez^{b,m}_{a,b} = ez^{p,m}_a = ez^{p,m}_b$. Thus we can conclude that $ez^{p,m}_{a,b} > ez^b_{a,b}$ and so the bargaining strategy would not be implemented by the region. ■

Even though it is not central to the point we are looking for, the previous proposition has the obvious implication that, if the parameter values are such that the optimal policy under the posted tax mechanism is to attract both MNCs, but the bargaining mechanism dominates the posted tax one, the expected country's welfare is the same under both the posted tax and the mixed negotiation mechanisms.

Proposition 25 *If the optimal policy under the posted tax mechanism is to only attract the MNC of type a (i.e.* $ew^p_a > \max(ew^p_{a,b}, ew^p_b)$*) and the bargaining mechanism dominates the posted tax one, it is also the case that* $ez^{b,m}_{a,b} > ez^{p,m}_{a,b}$*. That is, the bargaining strategy provides the region a higher payoff than a posted tax one attracting both MNCs.*

Proof. We know that $ew^p_a > ew^p_{a,b}$ implies $ez^{p,m}_a > ez^{p,m}_{a,b}$, what given $ez^{p,m}_a = ez^{b,m}_{a,b}$ also implies $ez^{b,m}_{a,b} > ez^{p,m}_{a,b}$. ■

Proposition 26 *When under the posted tax mechanism the optimal policy is to only attract the MNC of type b (i.e.* $ew^p_b > \max(ew^p_{a,b}, ew^p_a)$*) and the bargaining mechanism*

[4] If, for example, the central government tax were $g = s_b$ it would not be the case that $ez^p_{a,b} > \max\left(ez^p_a,\ ez^p_b\right)$.

dominates the posted tax one, it is also the case that $ez_{a,b}^{b,m} > ez_{a,b}^{p,m}$. *That is, the bargaining strategy provides the region a higher payoff than a posted tax one that attracts both MNCs.*

Proof. We know that $ew_b^p > ew_{a,b}^p$ implies $ez_b^{p,m} > ez_{a,b}^{p,m}$, what given $ez_b^{p,m} = ez_{a,b}^{b,m}$ also implies $ez_{a,b}^{b,m} > ez_{a,b}^{p,m}$. ■

Thus, from proposition 24 we can conclude that, if the optimal policy under the posted tax mechanism is to attract both MNCs, the bargaining strategy could not be the optimal one for the region in the mixed negotiation mechanism. On the contrary, from propositions 25 and 26 we get that, if the optimal policy under the posted tax mechanism is to only attract an MNC of type a or b and the bargain mechanism dominates the posted tax one, the bargaining strategy provides the region a higher payoff than the posted tax one attracting both MNCs. In this last case, the only restrictions for the bargaining strategy to be an optimal one for the region are the ones in expression 4.13 and 4.14. As we already saw they are equivalent to g being given by expression 4.16 and in this case the region is indifferent between the three strategies $b(a,b)$, $p(a)$, and $p(b)$. We have also said that if the central government sets this tax, the region will choose each of these strategies with equal probability (i.e. 1/3%) and so the bargaining strategy attracting both MNCs would be implemented with positive probability.

4.4.1 When under the posted tax mechanism the optimal policy is to only attract the MNC of type a.

We have already determined that under some parameter values the bargaining strategy attracting both MNCs has some probability of being implemented by the region. We have also shown that this would be the case for those parameter values where the optimal policy under the posted tax mechanism is to only attract an MNC of type a or b. Indeed, we know that the central government tax has to be the one in expression 4.16, what makes the region choose between the strategies $b(a,b)$, $p(a)$, and $p(b)$ with equal probability. Then, using 4.6, 4.7 and 4.10 we get that the expected country's welfare is given by the following expression:

$$ew^{cs,m} = \left(\left(g + \frac{s_a - g}{2}\right)p + \left(g + \frac{s_b - g}{2}\right)(1-p) + s_a p + s_b(1-p)\right)/3 \qquad (4.17)$$

Then, in order to know if the tax given by expression 4.16 is also an equilibrium for the central government, it has to be the case that the expected country's welfare in the previous expression is higher than the one produced by each of the other available strategies (i.e. $p(a)$, $p(b)$, and $p(a,b)$). In the present section we check if this is the case when under the posted tax mechanism the optimal policy is to only attract the MNC of type a, and in the next one we check if this is the case when under the posted tax mechanism the optimal policy is to only attract the MNC of type b.

Thus, if under the posted tax mechanism the optimal policy were to only attract the MNC of type a it must be also the case that:

$$\max\left(ew_a^{p,m(c)},\, ew_b^{p,m(c)},\, ew_{a,b}^{p,m(c)}\right) = ew_a^{p,m(c)} = s_a p. \tag{4.18}$$

That is, it must also be the optimal posted tax strategy under the mixed mechanism[5].

Thus, for the "compound strategy" to be the optimal one for the central government and so the bargaining strategy to have 1/3% probability of being played it has to be the case that the expected country's welfare in expression 4.17 is higher than $s_a p$:

$$\left(\left(g+\frac{s_a-g}{2}\right)p+\left(g+\frac{s_b-g}{2}\right)(1-p)+s_a p+s_b(1-p)\right)/3 > s_a p \tag{4.19}$$

It is obvious that, given that all the posting tax strategies are available under the mixed negotiation mechanism, if the "compound strategy" were the equilibrium one (inequality 4.19 is satisfied) the mixed negotiation mechanism would dominate the posted tax one.

Let us find now the parameter values for which the inequality 4.19 is satisfied. By replacing 4.16 into 4.19 and simplifying we get:

$$\frac{s_b(1-p)-s_a p}{(1-2p)} + 3s_b(1-p) > 3s_a p \tag{4.20}$$

From expressions 4.7 and 4.18 we know that $s_b(1-p) < s_a p$, what implies that $3s_b(1-p) < 3s_a p$. Then, for inequality 4.20 to be satisfied it has to be the case that $\frac{s_b(1-p)-s_a p}{(1-2p)} > 0$[6], what requires $p > \frac{1}{2}$.

[5] For, we know that by setting $g = 0$ the country would be able to obtain the maximum welfare achievable under the posted tax mechanism.

[6] This also implies that the optimal central government tax is positive.

Furthermore, we know that for bargaining to be the central government optimal strategy under the mixed negotiation mechanism, it must be the case that expression 4.10 is higher than 4.6, what implies:

$$\frac{s_a}{2}p + \frac{s_b}{2}(1-p) + \frac{g}{2} > s_a p \tag{4.21}$$

Then, from expressions 4.16 and 4.21 we get:

$$s_b\,(pp - 2p + 1) > s_a\,(-pp + p) \tag{4.22}$$

On the one hand, the roots of $pp - 2p + 1 = 0$ are p_1, $p_2 = 1$, 1, what implies that $pp - 2p + 1 > 0$, except for $p = 1$. On the other hand $-pp + p > 0$ for every $0 < p < 1$. Then, given $s_a > s_b$, it must also be the case that:

$$(pp - 2p + 1) > (-pp + p) \tag{4.23}$$

what is equivalent to

$$2pp - 3p + 1 > 0 \tag{4.24}$$

The roots of $2pp - 3p + 1 = 0$ are p_1, $p_2 = \frac{1}{2}$, 1. This means that inequality 4.24 is only satisfied for $0 < p < \frac{1}{2}$. However, we know from before that $\frac{1}{2} < p < 1$. Then, we conclude that the bargaining strategy will not be implemented in the mixed negotiation mechanism if to only attract the MNC of type a is the optimal policy under the posted tax mechanism.

4.4.2 When under the posted tax mechanism the optimal policy is to only attract the MNC of type b.

Again, in order to know if the tax given by expression 4.16 is also an equilibrium for the central government, it has to be the case that the expected country's welfare in expression 4.17 is higher than the one produced by each of the other available strategies (i.e. $p(a)$, $p(b)$, and $p(a,b)$). In the present section we check if this is the case when under the posted tax mechanism the optimal policy is to only attract the MNC of type

b. Thus, it must be the case that:

$$\max\left(ew_a^{p,m(c)},\ ew_b^{p,m(c)},\ ew_{a,b}^{p,m(c)}\right) = ew_b^{p,m(c)} = s_b(1-p). \tag{4.25}$$

That is, it must also be the optimal posted tax strategy under the mixed mechanism[7].

Thus, for the "compound strategy" to be the optimal one for the central government and so the bargaining strategy to have 1/3% probability of being played it has to be the case that the expected country's welfare in expression 4.17 is higher than $s_b(1-p)$:

$$\left(\left(g+\frac{s_a-g}{2}\right)p+\left(g+\frac{s_b-g}{2}\right)(1-p)+s_ap+s_b(1-p)\right)/3 > s_b(1-p) \tag{4.26}$$

In fact, given that all the posting tax strategies are available under the mixed negotiation mechanism, it is obvious that if the "compound strategy" were the equilibrium one (inequality 4.26 is satisfied) the mixed negotiation mechanism would dominate the posted tax one.

Let us find then the parameter values for which the inequality 4.26 is satisfied. By replacing 4.16 into 4.26 and simplifying we get:

$$\frac{s_b(1-p)-s_ap}{(1-2p)}+3s_ap > 3s_b(1-p) \tag{4.27}$$

It is not possible to analytically prove that expression 4.27 is satisfied. Then, in order to prove that the compound strategy can be an equilibrium in the mixed negotiation mechanism we use the following numerical example.

Example 27 *Assume the MNCs of type a and b produce externalities of* $e_a = 74$ *and* $e_b = 0$ *respectively and profits of* $\pi_a = 22$ *and* $\pi_b = 95$ *respectively (i.e.* $s_a = 96$ *and* $s_b = 95$*), and* $p = 0.42$.

Figure 4-1 shows the expected country's welfare and expected regional payoff produced by each of the strategies. It is clear that the equilibrium strategy under the posted tax mechanism is achieved when only the MNC of type b is attracted ($ew_b^p = ez_b^p = 55.10$*). However, under the mixed negotiation mechanism the compound strategy is the equilibrium one (*$ew^{cs,m} = ez^{cs,m} = 1.52$*), which produces a expected country's welfare of*

[7] The same reason given in footnote 6 applies here.

63.11.

Thus, we can summarise section 4.4 results in the following two propositions:

Proposition 28 *The mixed negotiation mechanism weakly dominates the posted tax one.*

However, it is also the case that:

Proposition 29 *In order for the mixed negotiation mechanism to dominate the posted tax one it is necessary that: 1) the parameter values are such that the bargaining mechanism dominates the posted tax one; 2) the MNC of type a produces more externality than profit (i.e. $e_a \geq \pi_a$); 3) the profit produced by an MNC of type b is more than twice the one produced by an MNC of type a (i.e. $\pi_b \geq 2\pi_a$); and 4) $\frac{1}{3} < p < \frac{1}{2}$.*

Proof. See appendix A1. ■

The problem of the result in proposition 28 is that for the compound strategy to be the equilibrium one the central government has to set exactly the tax given in expression 4.16. If it sets a marginally higher one, and given $p < \frac{1}{2}$[8], inequality 4.14 would be satisfied, but not inequality 4.13. Then, it would be optimal for the region to post a subsidy that only attract an MNC of type a and the expected country's welfare would be given by expression 4.6 (equal to 40.32 in the previous numerical example). On the contrary, if it sets a marginally lower one, and given $p < \frac{1}{2}$, inequality 4.13 would be satisfied, but not inequality 4.14. Then, it would be optimal for the region to post a subsidy that only attract an MNC of type b and the expected country's welfare would be given by 4.7 (equal to 55.10 in the previous numerical example).

In fact, as we already said, if the central government tax is marginally lower than the one in expression 4.16, the region would post a subsidy that only attract an MNC of type b. Then, as can be seen in 4-1, the expected country's welfare would be the same in the posted tax and mixed negotiation mechanisms.

However, if the central government tax is marginally higher than the one in expression 4.16, the region would post a subsidy that only attract an MNC of type a. Then,

[8] This is the case because at the point where g is given by expression 4.16, the inequality 4.26 is satisfied what, given $s_b(1-p) - s_a p$, requires $g = \frac{s_b(1-p)-s_a p}{(1-2p)} > 0$.

Bargaining mechanism			
Country's welfare		Regional payoff	
ew_a^b	40.32	ez_a^b	0.00
$ew_{a,b}^b$	95.21	ez_b^b	0.50
Posted tax mechanism			
Country's welfare		Regional payoff	
ew_a^p	40.32	ez_a^p	40.32
ew_b^p	**55.10**	ez_b^p	**55.10**
$ew_{a,b}^p$	53.08	$ez_{a,b}^p$	53.08
Mixed mechanism			
Country's welfare		Regional payoff	
$ew_a^{p,m(c)}$	**40.32**	$ez_a^{p,m}$	1.52
$ew_b^{p,m(c)}$	55.10	$ez_b^{p,m}$	1.52
$ew_{a,b}^{p,m(c)}$	53.08	$ez_{a,b}^{p,m}$	-39.29
$ew_{a,b}^{b,m(c)}$	93.90	$ez_{a,b}^{b,m}$	1.52
$ew^{cs,m}$	**63.11**	$ez^{cs,m}$	**1.52**

Figure 4-1: The compound strategy

we see in figure 4-1 that the expected country's welfare would be higher in the posted tax mechanism (i.e. $ew = 55.10$) than in the mixed one (i.e. $ew = 40.32$).

Thus, a marginal miss-precision in the setting of the central government tax could result in a much lower expected country's welfare than the equilibrium one. Still, as it is clear in proposition 29, the mixed negotiation mechanism dominates the posted tax one only under a very narrow and unlikely range of values.

An implication of proposition 28 appears in the case that the central government can determine the regional negotiation mechanism. The policy recommendation derived from this proposition is that the central government should use this power. A suggestion of how this could be possible will be left for the following section.

4.5 Results

4.5.1 Summary of previous results

Under this section we will give a short summary of the main results of the chapter.

We have found that to only attract the low surplus MNC can be the optimal policy under the mixed negotiation mechanism as well. Considering the result in the previous chapter it would not be a surprise if this is the case for these parameter values where the posted tax mechanism dominates the bargaining one. For, under these parameter values, the posted tax and mixed negotiation mechanisms produce exactly the same results. However, the surprising thing is the fact that this is also the case for these parameter values where the bargaining mechanism dominates the posted tax one. Though, under these parameter values, we already saw that to only attract the MNC of type b is only "probabilistically optimal" under the mixed negotiation mechanism (i.e., when the compound strategy is the country's optimal one).

Furthermore, we saw that under the same range of parameter values where the bargaining mechanism dominates the posted tax one, it also dominates the mixed negotiation mechanism. This implies that, under these particular parameter values, the addition of the ability of posting a tax negotiation tool to a region which is already enjoying the ability of using bargaining reduces the expected country's welfare. It seems striking that the addition of another negotiation tool to the region can result in a lower expected country's welfare. As we have already explained the reason for that is the existence of a conflict of interests between the central government and the region. That is, under some circumstances, it is optimal for the country that the bargaining strategy is used in order to attract both MNCs but not for the region. We already saw that this conflict of interests does not exist in a mechanism where the region can only use one of the negotiation tools.

We also saw that the mixed negotiation mechanism dominates the posted tax one. However, a marginal miss-precision in the setting of the central government tax could result in a much lower expected country's welfare than the equilibrium one. For, it would make the region to choose a strategy that is not optimal for the country. Still, as it is clear in proposition 29, the mixed negotiation mechanism dominates the posted tax one only under a very narrow and not very likely range of values.

4.5.2 Choosing the negotiation mechanism

We have seen in this chapter that the expected country's welfare varies with the regional negotiation mechanism. Then, an interesting question is: Has the central government the power of changing the particular regional negotiation mechanism? It is possible to think of the central government having the ability to add and/or eliminate a specific regional negotiation tool (i.e. bargaining or posted tax capabilities). However, what can the central government do in order to achieve that? To answer this question we need to know the 'fundamentals' that make possible for a region to bargain and/or post a tax. A summary of these fundamentals are pointed out in the following two paragraphs.

Fundamentals that make possible for a region to bargain. 1) The meetings between the MNC managers and the local authority have to be permitted. 2) It could be the case that in order for the bargaining to take place a special "bargaining board" is needed. 3) The regional government needs some degrees of freedom in determining the allocation of capital expenditure. As we already mentioned it is usually the case that the subsidies take the form of capital expenditure, which in one or another way has a positive impact in the MNC's profits.

Fundamentals that make possible for a region to post a tax. One important requisite for a region to post a tax is the possibility of passing laws about MNCs. Among other things these laws could determine the taxes to be paid by the MNCs willing to build a new plant in the region.

Then, if it were the case that a particular mechanism is better than another, it could be optimal for the central government to eliminate (make available) some of these fundamentals in order to limit (create) the regional ability to bargain or post a tax. However, it seems easier for the central government to limit the capability of a regional government from using one of the negotiation tools than creating it. This seems to be particularly the case with the bargaining negotiation tool. For if a region were effectively using bargaining, it would be probably not so difficult to identify which of the fundamentals can be tackled in order to eliminate this way of regional negotiation. However, it seems more difficult to identify the particular fundamentals which prevent a region from bargaining if presently it is not using it.

Another concern takes the form of the following question: Is the fact that the central government can eliminate the regional capability to do bargaining incompatible with our

assumption that the central government cannot see the subsidies given by the regional government? Not necessarily. It could perfectly be the case that the central government has some power in restricting the regional ability to bargain, but once the region is allowed to bargain, it cannot see the subsidy given. Perhaps the reality is somewhere in between. However, our assumption allowed us to keep the model simple.

Nevertheless, it can be sometimes difficult to limit (enable) the regional bargaining capability without also limiting (enabling) the posted tax one and vice versa. Arguably this could be an additional limitation to the central government capability in determining the regional negotiation mechanism. One extreme example is the case of a country having to take a decision of becoming a federal or unitarian one. It is obvious that a mere administrative decentralization would neither be able to bargain nor to post a tax. Then, if this were the only option for a country, it would be equivalent to an option where the country has to choose between the mixed and posted tax mechanisms[9].

Finally, assuming that the central government can choose not only the particular tax to be set on the MNC but also the particular regional negotiation mechanism, we can make the following summary. On the one hand, for those parameter values where the bargaining mechanism strictly dominates the posted tax one, it is the best mechanism. For from proposition 23 we know that it also strictly dominates the mixed one. On the other hand, for those parameter values where the posted tax mechanism dominates the bargaining one, it is not a dominated one. For, from proposition 20 we know that the posted tax mechanism is not dominated by the mixed one. Thus, we can conclude that, for the central government, the mixed negotiation mechanism is not expected country's welfare superior to the possibility of choosing between the bargaining and posted tax mechanisms. That is, if the parameter values were such that the bargaining mechanism strictly dominates the posted tax one, the best thing the central government could do is to choose the bargaining mechanism. On the contrary, if the parameter values were such that the posted tax mechanism dominates the bargaining one, the central government would be indifferent between the posted tax and mixed negotiation mechanisms.

Thus, as it is clear in the previous paragraph, our model not only determines the optimal tax policy in each particular mechanism, but also which is the optimal mechanism

[9]For, given that the central government posts a tax, we know from proposition 5 that a posted tax mechanism can be one where the regional government can neither bargain nor post a tax.

under particular parameter values.

4.6 Conclusion

The present chapter is an extension of the previous one. A new negotiation mechanism was analysed, which is a combination of the two mechanisms considered in the previous chapter. In this new mechanism the region can choose between using bargaining or posting a tax. In fact this is the only difference with the previous chapter. For all the other assumptions of the model remain the same.

We have suggested that this mixed negotiation mechanism could be sometimes the most appropriate one for interpreting how countries negotiate with MNCs.

The main results stem from the comparison between the mix negotiation mechanism and the other two mechanisms. The most important one is that for those parameter values where the bargaining mechanism is welfare superior to the posted tax one, we also find that the addition of the posting tax tool to the regional options not only cannot increase the expected country's welfare, but it reduces it in some cases. It seems striking that the addition of another negotiation tool to the region reduces the expected country's welfare. We have shown that the reason for this result is that the existence of a regional choice between bargaining and posted tax creates a conflict of interests between the region and the central government. That is, it is optimal for the country that the bargaining strategy is used in order to attract both MNCs but not for the region. On the contrary, we saw that this conflict of interests does not exist in the bargaining and posted price mechanisms.

We also saw that the mixed negotiation mechanism dominates the posted tax one. However, a marginal miss-precision in the setting of the central government tax could result in a much lower expected country's welfare than the equilibrium one. For, it would make the region choose a strategy that is not optimal for the country. Still, as it is clear in proposition 29, the mixed negotiation mechanism dominates the posted tax one only under a very narrow and not very likely range of values.

Another interesting characteristic of the present model is that it provides clear policy recommendations. On the one hand it determines the optimal central government tax policy under each of the considered negotiation mechanisms. On the other hand, it also

establishes the optimal negotiation mechanism under specific parameter values. what is useful in the case the central government of the country has some control of it.

However, the following question remains: What is the policy recommendation if the central government only has a limited ability of limiting the region from using one or another negotiation tool. We cannot give an answer to this last question without further developing the present model. In fact this is an interesting question that encourages further research. Last but not least, we recognise that an important limitation of the models of the present and previous chapters is the fact that they can only be applied to a country with only one region. That is, there was no consideration of the effects stemming from the inter-regional competition. The analysis of this competition will be the main aim of the following two chapters.

Chapter 5

Competition between regions under the bargaining mechanism

5.1 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 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].

In the present chapter 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. Indeed, a puzzling stylised fact is 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 spe-

[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.

cial 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 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 chapter 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 expected 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, because of imperfect information or non-verifiability, the central government cannot tax-discriminate the different types of MNCs that are 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

[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.

match between region and MNC. In some situations the achievement of the former target gives rise to a mismatch. This result seems to support the critical view emphasising 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 expected country's welfare maximising policy.

The structure of the chapter is as follows. The basic model is presented in Section 2. The first part of this section assumes 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.

5.2 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 expected country's welfare, which is equal to the local welfare (externality 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. 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 profit, which is equal to the externality produced by the MNC minus the subsidy[4]. 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

[3] As it was the case in chapter 3, whether the central government tax is on the MNC or on the region does not make any difference in terms of the payoff the MNC and the regions get.

[4] As in chapter 3 we are assuming that the regional governments do not consider the central government tax revenue in their own utility function.

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, which is the after-tax surplus it produces in the other region. In other words, the MNC gets half of the winning region after-tax surplus when the outside option is not binding and the value of the outside option when it is binding. Let us show the result of this bargaining in a numerical example

Example 30 *Assume the MNC produces an externality of* 40 *in region* 1 *and one of* 20 *in region* 2. *Then, on the one hand, let's assume that the central government taxes are* 20 *and* 15 *in regions* 1 *and* 2 *respectively. In this case the after-tax surpluses are equal to* 20 *and* 5 *respectively and so region* 1 *would be the winner of the MNC new production plant. Indeed, because the outside option is not binding, region* 1 *and the MNC would equally divide this after-tax surplus and get a payoff equal to* 20 *each.*
On the other hand, if the central government taxes were 20 *and* 5 *in regions* 1 *and* 2 *the after-tax surpluses would be equal to* 20 *and* 15 *respectively. Again, region* 1 *would be the winner of the MNC new production plant but, because the outside option is now binding, it would have to pay the MNC a subsidy of* 15, *which is the value of this outside option. Thus, the payoffs are* 15 *for the MNC and* 5 *for the winning region.*

5.2.1 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.

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 expected 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"[5]. Then, the benefit of the externality is totally appropriated by the country.

In the previous example there was only one type of MNC. However, as we have already justified in chapter 3 it is usually the case that a variety of MNCs are involved in negotiations with the different regions of a country. 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. Indeed, we assume that an MNC of type a shows up with probability p and an MNC of type b does it with probability $1-p$. Furthermore, it is appropriate to think that since the taxes are set in advance, it is difficult for the central government to 'tax-discriminate' between the two types of MNCs. Thus, as before, it can only set the taxes conditional on the region the new plant is built, but not on the MNC's type[6].

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 31 *In the first case we additionally assume that the probability of an MNC*

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

[6] As in the previous chapters the fact that the central government cannot tax discriminate between the two types of MNCs can be justified by assuming that the type of MNC is a non-verifiable variable. However, in the context of the present chapter we can also assume that the central government has imperfect information. That is, it does not know the realisation of the MNC's type and only knows that an MNC of type a shows up with probability p and an MNC of type b does it with probability $1-p$.

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 32 *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 us first obtain the expected 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 (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 us now obtain the expected 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 expected 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 33 *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 dis-*

similar 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 in some situations a symmetric treatment of identical regions is not an optimal policy. The reason for this is straightforward. It is true that setting a tax equal to the externality produced by an MNC of type b in both regions reduces the inter-region competition when this type of MNC shows up. However, this policy is not very effective for an MNC of type a. For it makes the MNC's outside option to bind and consequently increases the subsidy that the winning region has to pay. In other words, the advantage of the asymmetric treatment over the symmetric one when there are two MNC's types is that, in some situations, the former reduces the subsidy competition when the high type MNC shows up, but the later fails in doing so.

5.2.2 Two different regions

Although the explanation of the stylised fact that the central governments give asymmetric treatments to similar regions is the main aim of the chapter, 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).

It is obvious that because of the existence of two types of MNCs and two regions, there will be now twelve different 'economic regimes'. However, because of symmetry it is enough to only consider the following six:

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

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

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

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

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

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

The fact that we only need to look at six economic regimes will significantly simplify our task.

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[7] (i.e. $s_{ij} - g_j \geq s_{ik} - g_k$)[8]. 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 be the winner of the MNC of type i. Then, the equilibrium payoff for the MNC is:

$$y_i = \begin{cases} \max\left(\frac{s_{ij}-g_j}{2};\ s_{ik} - g_k\right) & \text{if } s_{ij} \geq g_j \\ 0 \text{ otherwise} \end{cases} \tag{5.1}$$

When region j is the winner the first line of expression 5.1 applies. Then, because of the results of the Bolton and Winston's bargaining model already explained in page 4, the MNC 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 tax that the winning region must charge is such that, the MNC

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

[8] Furthermore, for simplicity we assume that if the previous weak inequality is satisfied with an equal sign, region j is the superior one.

gets the payoff in expression 5.1. Thus, the equilibrium tax is:

$$t_{ij} = \begin{cases} \max\left((\pi_{ij} - g_j) - \frac{s_{ij}-g_j}{2};\ (\pi_{ij} - g_j) - (s_{ik} - g_k)\right) \text{ if } s_{ij} \geq g_j \\ 0 \text{ otherwise} \end{cases} \tag{5.2}$$

Again, if the central government tax in the superior region is too high the MNC does not come to the country and the tax effectively charged is equal to zero (as it is the case in the second line of expression 5.2). In the first line of expression 5.2 and when the outside option is not binding 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 5.1. This guarantees that the MNC gets the payoff in expression 5.1. A similar reasoning applies when the outside option is binding. It is obvious that the tax in expression 5.2 can be a negative one (i.e., a local subsidy) and in a lot of cases this will be the case[9].

Then, by adding the equilibrium tax to 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:

$$z_{ij} = \begin{cases} \min\left(\frac{s_{ij}-g_j}{2};\ s_{ij} - g_j - (s_{ik} - g_k)\right) \text{ if } s_{ij} \geq g_j \\ 0 \text{ otherwise} \end{cases} \tag{5.3}$$

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, the expected country's welfare is:

$$\begin{aligned} ew \quad = & \left\{ \begin{array}{l} \left(g_j + \min\left(\frac{s_{aj}-g_j}{2};\ s_{aj} - g_j - (s_{ak} - g_k)\right)\right) p \text{ if } s_{aj} \geq g_j \\ 0 \text{ otherwise} \end{array} \right\} \\ + & \left\{ \begin{array}{l} \left(g_j + \min\left(\frac{s_{bj}-g_j}{2};\ s_{bj} - g_j - (s_{bk} - g_k)\right)\right)(1-p) \text{ if } s_{bj} \geq g_j \\ 0 \text{ otherwise} \end{array} \right\} \end{aligned} \tag{5.4}$$

[9] As an example, think of the case where there is no central government tax and no profit (the surplus is just equal to the MNC's externality). Then, for the region to get half of this surplus, it has to give a subsidy to the MNC the MNC.

The previous expression will be useful in order to accomplish our next task, which is to find the optimal central government policy. That is, we need to find the expressions for g_1 and g_2 that maximises the expected country's welfare. It is obvious that this optimal central government policy is conditional on the particular values taken by the parameters (i.e. s_{a1}, s_{a2}, s_{b2}, s_{b1} and p).

Furthermore, given the existence of two MNC types and two different regions there are eight possible matches between regions and MNCs that can be achieved as a result of the central government intervention. That is: a) to attract only one MNC (a or b) to a particular region (1 or 2); b) to attract both MNCs to region 1; c) to attract both MNCs to region 2; d) to attract the MNC of type a to region 1 and the MNC of type b to region 2; and e) to attract the MNC of type b to region 1 and the MNC of type a to region 2. Thus, an easy way of searching for the optimal tax policy is to first obtain the optimal central government set of taxes for each of these matches (conditional optimums). Then, for each specific parameter values, the maximum of these conditional optimums is the unconditional central government optimal policy. The conditional optimums are obtained in the following 6 propositions.

Tax policy 1

Proposition 34 *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* $g_2 = \infty$[10]*).*

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, every region 1 tax that is accepted by an MNC of type b is also

[10] *In fact in order to eliminate region* 2 *from the competition it is enough if* $g_2 \geq s_{b2}$.

accepted by an MNC of type a, what means that both types of MNCs are attracted. 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 5.4 the expected country's welfare is:

$$ew_1 = s_{a1}p \tag{5.5}$$

Tax policy 2

Proposition 35 *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 expected 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 expected country's welfare. ■

By replacing tax policy 2 into expression 5.4 the expected country's welfare is:

$$ew_2 = \left(s_{b1} + \frac{s_{a1} - s_{b1}}{2}\right)p + s_{b1}(1-p) \tag{5.6}$$

Tax policies 3a and 3b

Proposition 36 *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 expected 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 expected country's welfare. ■

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

$$ew_{3a} = \left(s_{b2} + \frac{s_{a2} - s_{b2}}{2}\right) p + s_{b2}(1-p) \text{ if } s_{b2} \leq s_{a2} \tag{5.7}$$

$$ew_{3b} = \left(s_{a2} + \frac{s_{b2} - s_{a2}}{2}\right) p + s_{a2}(1-p) \text{ if } s_{b2} \geq s_{a2} \tag{5.8}$$

Tax policy 4

Proposition 37 *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.

$$s_{a1} - g_1 \geq s_{a2} - g_2 \tag{5.9}$$

$$s_{a1} - g_1 \geq 0 \tag{5.10}$$

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:

$$s_{b2} - g_2 \geq s_{b1} - g_1 \tag{5.11}$$

$$s_{b2} - g_2 \geq 0 \tag{5.12}$$

Then, by replacing 5.9 into 5.11 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:

$$s_{a1} - s_{a2} - s_{b1} + s_{b2} \geq 0 \tag{5.13}$$

On the one hand, it is clear that restriction 5.13 is always satisfied in economic regime I, but this is not always the case in economic regimes II and IV. However, assuming that restriction 5.13 is satisfied, the maximum tax that can be applied in region 1 that is compatible with restrictions 5.9 and 5.10 is,

$$g_1 = \min\left(s_{a1} - s_{a2} + g_2,\ s_{a1}\right) \tag{5.14}$$

but because of restriction 5.12 and that we are assuming $s_{b2} \leq s_{a2}$, this is equivalent to:

$$g_1 = s_{a1} - s_{a2} + g_2 \tag{5.15}$$

On the other hand, because of 5.12 and 5.15 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 expected 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 expected 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 in the expected 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 expected 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 5.4 the expected country's welfare is[11]:

$$ew_4 = \begin{cases} (s_{a1} - (s_{a2} - s_{b2}))\,p + s_{b2}(1-p) \text{ if } s_{b2} \leq s_{a2} \\ s_{b2}(1-p) \text{ if } s_{b2} \geq s_{a2} \end{cases} \tag{5.16}$$

tax policy 5

Proposition 38 *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 5.9, 5.10, 5.11, 5.12 and 5.13 have to be satisfied. However, given that now we assume $s_{b2} \geq s_{a2}$, restriction 5.13 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 5.14. 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 expected 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 expected country's welfare whichever MNC shows up. Then, given that this is the optimal tax in region 2, the expression 5.14 turns into $g_1 = s_{a1}$. ■

Then, by replacing tax policy 5 into expression 5.4 the expected country's welfare is:

$$ew_5 = \begin{cases} s_{a1}p + s_{b2}(1-p) \text{ if } s_{b2} \geq s_{a2} \\ s_{a1}p \text{ if } s_{b2} \leq s_{a2} \end{cases} \tag{5.17}$$

[11] Expression 5.16 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.

It is obvious that when $s_{b2} \leq s_{a2}$ tax policy 5 is a special case of tax policy 1. Indeed, in order to be more precise let's make the following definitions, which will also be useful later on:

Definition 39 *We will define a tax policy as dominated if there are no parameter values for which this tax policy provides the highest expected country's welfare.*

Definition 40 *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 expected country's welfare.*

Then, we can say that tax policy 1 is dominated by tax policy 5. This is the case because when $s_{b2} \leq s_{a2}$ tax policy 5 produces the same expected country's welfare than tax policy 1. However, when $s_{b2} \geq s_{a2}$ tax policy 5 produces a higher welfare.

Hereafter and for the sake of clarity we adopt the following terminology: We refer to tax policy 5 as tax policy 5a when $s_{b2} \geq s_{a2}$ and as tax policy 5b when $s_{b2} \leq s_{a2}$. Indeed, we will ignore tax policy 1 and refer instead to tax policy 5b. Furthermore, it is obvious that 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 5a in economic regimes III, V, and VI). Thus, this tax policy is a dominated one and so can be disregarded.

Then, we continue with proposition 7:

tax policy 6

Proposition 41 *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 37, 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:

$$s_{b2} - g_2 \leq s_{b1} - g_1 \tag{5.18}$$

$$g_1 \leq s_{b1} \tag{5.19}$$

$$s_{a2} - g_2 \geq s_{a1} - g_1 \tag{5.20}$$

$$g_2 \leq s_{a2} \tag{5.21}$$

Then, by replacing 5.18 into 5.20 and rearranging we get the following inequality:

$$s_{a1} - s_{a2} - s_{b1} + s_{b2} \leq 0 \tag{5.22}$$

Thus, the present tax policy is feasible only if restriction 5.22 is satisfied. However, restriction 5.22 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 5.19 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 5.18 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 find out what the expected 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[12]. On the other hand, region 1 will not be a binding outside option for an MNC of type a if the following inequality applies.

$$\frac{s_{a2} - g_2}{2} \geq s_{a1} - g_1 \tag{5.23}$$

Moreover, by replacing $g_1 = s_{b1}$ and $g_2 = s_{b2}$ into 5.23, and rearranging we get the

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

following expression.

$$2s_{a1} - 2s_{b1} + s_{b2} - s_{a2} \leq 0 \tag{5.24}$$

Thus, when inequality 5.24 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 expected country's welfare is:

$$ew = [s_{a2} - s_{b2} - (s_{a1} - s_{b1})]\, p + s_{b1}(1 - p) \tag{5.25}$$

But this is lower than the one in expression 5.5 for every parameter values in economic regimes II and IV where the expression 5.24 is not satisfied. On the contrary, when inequality 5.24 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 expected country's welfare is given by the following expression.

$$ew_6 = \left(\frac{s_{a2} - s_{b2}}{2}\right) p + s_{b1}(1 - p) \tag{5.26}$$

But, in economic regime II and IV this expected country's welfare is lower than the one in expression 5.6. 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. ■

Then, in order to know the precise parameter values for which each of the previous five tax policies is the optimal one, a comparison of the expected country's welfare generated by each of them has to be done. However, in order to prove that tax policies 2, 3a, 4, 5a, and 5b are not dominated ones, in figure 5-1 we provide five numerical examples respectively showing that each of the five tax policies is the optimal one for at least some parameter values.

Furthermore, some of the implications of the previous six propositions are summarised in table 2. 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). Indeed, in column 6 we also list the specific economic regimes for which each tax policy is not 'regime dominated' (the proof is in appendix A2).

Tax policy	Parameter values					Country's welfare under tax policy:				
	s_{a1}	s_{a2}	s_{b1}	s_{b2}	p	2	3a	4	5a	5b
2	40	12	20	5	0.5	**25**	6.75	19		20[a]
3a	40	38	7.6	20	0.5	15.7	**24.5**	21		20[a]
4	40	20	7.6	19	0.5	15.7	19.3	**29**		20[a]
5a	40	5	10	30	0.2	13	27.5	24	**32**[b]	
5b	40	30	10	5	0.5	17.5	11.3	10		**20**[a]

Notes: a) Notice that in this case we have $s_{b2} < s_{a2}$; b) Notice that in this case we have $s_{b2} > s_{a2}$.

Figure 5-1: Numerical examples proving that tax policies 2, 3a, 4, 5a, and 5b are the optimal ones for some specific parameter values

5.3 Results

The first result of this chapter 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 puzzling that in some situations a symmetric treatment of identical regions is not an optimal policy. As we already saw, the reason for the advantage of the asymmetric treatment over the symmetric one when there are two MNC's types is that, in some situations, the former reduces the subsidy competition when the high type MNC shows up, but the later fails in doing so. It is important to notice that this result crucially depends on the fact that the central government does not have perfect information about the type of MNC showing up. For if this were not the case both policies would get the entire surplus produced by both MNCs.

Some other results can be derived from table 5-2. One of them is that depending on the values taken by the parameters, the spectrum of central government optimal tax policies can be reduced to only four. Indeed, in the optimum the following matches between region and MNC are the only possible ones: only a MNC of type a is attracted and it goes to region 1; both MNCs are attracted to region 1 or 2; or the MNC of type a is attracted to region 1 and the one of type b to region 2.

Tax Policy	Tax imposed on each region		MNC that each region gets		Economic Regime
	g_1	g_2	region 1	region 2	
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]
5a	$g_1 = s_{a1}$	$g_2 = s_{b2}$	a	b	III, V[b], and VI
5b	$g_1 = s_{a1}$	$g_2 = \infty$	a		I, II, and IV

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 5-2: Tax policies that are not regime dominated

Another implication is that when one of the regions does not get any MNC it is optimal for the central government to eliminate this region (i.e. in tax policies 2, 3, and 5b). For, in order to increase the expected country's welfare, it is optimal to prevent the loosing region from becoming a binding outside option. However, we should not be tempted to think that this is a general result and conclude that in the optimum the outside option would never be binding. It is evident that this is not the case in tax policy 4. For when this tax policy is the optimal one, region 2 is a binding outside option when an MNC of type a shows up. This is the case because the after tax surplus in region 1, $s_{a1} - g_1 = s_{a1} - (s_{a1} - (s_{a2} - s_{b2})) = s_{a2} - s_{b2}$, is equal to the one in region 2. This is not an obvious result given that the fact that an outside option is binding reduces the expected country's welfare.

We are now in condition to look for the existence of mismatches between regions 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.

Example 42 *Assume that* $s_{a1} = 40$, $s_{a2} = 34$, $s_{b2} = 20$, $s_{b1} = 10$, *and* $p = 0.5$. *In*

this case, tax policy 3a the central government optimal policy, which eliminates region 1 from the competition and attracts both MNCs to region 2.

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 figure 5-2, 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 expected country's welfare and reaching the best match between region and MNC. More specifically, the impossibility of tax-discriminating between the different types of MNCs leaves the central government with only two tools (the taxes in each of the two regions, i.e. g_1 and g_2) 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. g_{a1}, g_{a2}, g_{b1}, and g_{b2}), 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 it is obvious in figure 5-2, 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).

5.4 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 expected 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 chapter.

In our model a central government that cannot tax-discriminate between the different types of MNCs moves first by setting the taxes 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. 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 expected country's welfare. This result seems to justify the widespread existence of the so-called special economic zones or other economic regimes that create asymmetries between the regions of a particular country. Indeed, it is the case that under some particular conditions an asymmetric treatment of similar regions is the only optimal policy. For 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 regions and MNCs. 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 expected country's welfare.

Let us 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 expected country's welfare and reaching the best match between region and MNC. More specifically, the fact of not being able to apply tax-discrimination between the different types of MNCs 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 cannot tax-discriminate between the different MNC types.

Chapter 6

Competition between regions under the mixed negotiation mechanism

6.1 Introduction

In the previous chapter we have seen how the inter region competition works in a setting where the regions can only use bargaining. In this one we work on a model where there are two regions choosing between the bargaining and posting tax strategies. In this respect the present chapter is an extension of the mixed negotiation mechanism of chapter 4 to a case where there is competition between regions.

The structure of the chapter is as follows. Section 1 introduces the model. Section 2 analyses an inter-region competition in a setting with only one type of MNC in a mixed negotiation mechanism without central government intervention. This setting is interesting by itself but also as an intermediate step in order to have a better understanding of the setting where there are two types of MNCs and central government intervention. Under the former setting there are multiple equilibriums, but all these equilibriums are output equivalent. This means that the taxes set by both regions and the payoff obtained by them and the MNC do not change between equilibriums. Moreover, the posting tax strategy is always an equilibrium one and the expected country's welfare is higher under this setting than in one where the two regions can only use the bargaining

strategy.

In section 3 we move on to analyse a mixed negotiation mechanism inter-regional competition in a setting with two MNCs, two identical regions, and central government intervention. In order to get a better understanding, we look first at a case with only one region and go onto a more complex one where there are two identical regions. The main results are that, under certain parameter values, the addition of a second identical region to the country increases the expected country's welfare. The reason for this result is that the existence of a second identical region provides the central government with an additional negotiation tool. That is, the competition from the second region can be used by the central government in order to prevent the first region from using a strategy that is not the optimal one for the country.

Section 4 concludes.

6.2 The model

In the present section we will use a three stage game similar to the one described in chapter 4. However, there will be two regions instead of one. That is, we assume a three-stage game involving the central government, two regions, and a MNC. In the first stage, in order to maximise the expected country's welfare, the central government posts a lump sum tax to be paid by the MNC. In the second stage the regional government choose their optimal taxing strategy. That is, whether or not to post a particular tax to be paid by the MNC in the third stage. Finally, in the third stage an MNC shows up and decides whether to build the new production plant in one of the regions or not to stay in the country at all. Depending on the regions choosing bargaining or posted tax in the second stage we have three different competitive environments in the third stage.

The first competitive environment is when none of the regions posts a tax. In this case the result of the third stage is the one developed by Bolton and Whinston (1993). where a three-player bargaining game is solved. As we already saw in chapter 5 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. surplus 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[1]. A second pair of competitive environments is the two symmetric cases where one region uses bargaining and the other tax posting. Then, on the one hand, if the winning region were the one using a tax posting, the MNC would have to pay the posted tax and get a profit equal to the value of the outside option. On the other hand, if the winning region were the one using bargaining we apply the traditional Rubinstain bargaining model with outside option, where the value of the outside option is equal to what the MNC can get in the other region[2][3]. In fact, the MNC and regions' payoffs under this bargaining are the same as in the Bolton and Whinston (1993) bargaining framework. Finally, when both regions post a tax, the MNC just chooses one region and has to pay this region's posted tax. It should be obvious by now that when tax posting is used the tax paid by an MNC is independent of its type, but this is not the case when bargaining is used.

6.3 One MNC type

In the present section we will consider a very simple model with only one type of MNC. Note that as a consequence of having only one type of MNC this is a perfect information game. This marks a difference with respect to the mixed negotiation mechanism in chapter 4 where there were two MNCs. Hence, we can say that in chapter 4 we had an imperfect-information mixed negotiation mechanism, but the one in the present section is a perfect information one. However, contrary to the case in the previous chapter, in the present section the regions can choose between using bargaining and posting tax.

The main aim of the present section is to find out the equilibrium of the inter-region competition of the second stage of the game for the case when there is only one type of MNC. Because of this and on the sake of simplicity we assume that the central government taxes are $g_1 = g_2 = 0$. This assumption will be relaxed in the next section. Furthermore, following the specification in chapter 5 we know that the surpluses produced by the MNC in regions 1 and 2 are $s_1 = \pi_1 + e_1$ and $s_2 = \pi_2 + e_2$ respectively with $s_1 > s_2$. For simplicity we also assume that $s_1 = 100$ and $s_2 = 20$, but

[1] A more detailed explanation of this bargaining process can be found in chapter 5.

[2] That is, equal to the surplus the MNC produces in this other region minus the central government tax and the other region tax.

[3] A more detailed explanation of the Rubinstain bargaining process in our context was given in chapter 3.

without specifying how these surpluses are divided between profits and externalities.

Because of the previous assumption the result of the game is that the MNC always ends up building the new plant in region 1. Thus, we will refer to 1 and 2 as the winning and loosing regions respectively. Indeed, in order to simplify the analysis let's assume from now on that when an MNC is indifferent between region 1 and 2 it chooses region 1 with probability 1.

We know that there are two possible environment under bargaining: when the outside option is binding and when it is not. Thus, in the next sub-section we analyse the later environment while living the consideration of the former one for section 6.3.2.

6.3.1 The outside option is non-binding

Let us first analyse the case where the outside option is not binding, $\frac{s_1}{2} > s_2$. The question is: What are the equilibrium regional tax strategies and each player's payoff?

Case 1: Assume that region 2 plays bargaining. Then, a bargaining strategy would give region 1 a payoff equal to half of the surplus (i.e. $\frac{s_1}{2} = 50$). However, given that the outside option is not binding, region 1 can do better than that by posting a tax that just leaves the MNC with a payoff[4]

$$y_1 = s_2 = 20 \tag{6.1}$$

which is equal to the value of its outside option.

It is obvious that the tax that the winning region must post is such that, the MNC gets the payoff in expression 6.1. Thus, the optimal regional tax is:

$$t_1 = \pi_1 - s_2 \tag{6.2}$$

In expression 6.2 it is like if the winning region takes the entire gross profit from the MNC (π_1), but then it compensates the MNC by giving back a subsidy equal to the payoff in expression 6.1. Recall that this tax can be a negative one (i.e. a regional subsidy).

Then, by adding the equilibrium tax from 6.2 to the externality in region 1 (i.e. e_1)

[4]This expression is derived from 5.1 for $g_1 = g_2 = 0$ and eliminating the subscript i because we have only one MNC type.

we get the winning region's equilibrium payoff:

$$z_1 = e_1 + (\pi_1 - s_2) = s_1 - s_2 \tag{6.3}$$

Case 2: Assume that region 2 posts a tax. It is obvious that any region 2's tax $t_2 > -e_2$ [5] would not be an equilibrium because region 1 would be able to undercut this tax such that the MNC just marginally prefers region 1 to region 2. But then, it would be optimal for region 2 to also marginally undercut region's 1 tax. This results in both regions subsequently undercutting each other. This competition process would continue until region 2 cannot make any additional tax reduction. Thus, $t_2 = -e_2$ is the only equilibrium posted tax for region 2[6], to which region 1's optimal strategy is to post the tax given in expression 6.2. Again, the winning region and the MNCs' payoffs will be given by expressions 6.1 and 6.3 respectively.

Thus, we can conclude that if the outside option is not binding the winning region optimal strategy is to post a tax (the in expression 6.2) that leaves the MNC with a payoff equal to the value of this outside option. The loosing region has two equally optimal strategies, to use bargaining or post a 'subsidy' equal to the externality the MNC gets in its location ($t_2 = -e_2$). All the possible equilibriums are stated in the following proposition:

Proposition 43 *When there is only one type of MNC, two regions, and the outside option is not binding there are two equilibriums: 1) the winning region posting a tax $t_1 = \pi_1 - s_2$ and the loosing one using bargaining and 2) the winning region posting a tax $t_1 = \pi_1 - s_2$ and the loosing one posting a subsidy equal to the entire externality the MNC produces in its site, $t_2 = -e_2$.*

Still, the existence of the two equilibriums is not a problem because they are outcome equivalent. That is, in both cases the winning region sets the tax in expression 6.2. The MNC and the winning region get the payoffs in expressions 6.1 and 6.3 respectively and the loosing region gets nothing.

[5] Recall that a negative value of t is a subsidy.

[6] For it is obvious that region 2 cannot pre-commit to a tax lower than $t_2 = -e_k$ without having looses.

6.3.2 The outside option is binding

Let us analyse now the case where the outside option is binding, that is $\frac{s_1}{2} < s_2$. Again, the question is: What are the equilibrium regional tax strategies and each player's payoff?

Case 3: Assume that region 2 plays bargaining. In this case the minimum payoff the MNC would accept in region 1 is again the one in expression 6.1 and so the winning region equilibrium tax is the one in expression 6.2. For, a higher tax would produce a lower profit and a lower one would not be accepted by the MNC. However, the winning region can set this tax by using a posted tax or by bargaining and so both strategies would be an equilibrium of the game. Thus, the winning region payoff is the one in expression 6.3 and the loosing one gets nothing.

Case 4: Assume that region 2 posts a tax. As in case 2, it is obvious that region 2's only equilibrium posting tax strategy is $t_2 = -e_2$. The minimum payoff the MNC would accept is the one in 6.1 and so the winning region equilibrium tax is the one in expression 6.2. However, the winning region can set this tax by using a posted tax or bargaining and so both would be equilibrium strategies. Thus, the winning region payoff is the one in expression 6.3 and the loosing one gets nothing.

We have obtained that both, bargaining and tax-posting, are equilibrium strategies for both regions and so the following proposition applies:

Proposition 44 *When there is only one type of MNC, two regions, and the outside option is binding there are four equilibriums: 1) the winning region posting $t_1 = \pi_1 - s_2$ and region 2 using bargaining; 2) the winning region posting $t_1 = \pi_1 - s_2$ and the loosing one posting $t_2 = -e_2$; 3) both regions using bargaining; and 4) region 1 using bargaining and the loosing one posting $t_2 = -e_2$.*

Again, the existence of the four equilibriums is not a problem because they are outcome equivalent. That is, in the four cases the winning region sets the tax in expression 6.2. The MNC and the winning region get the payoffs in expressions 6.1 and 6.3 respectively and the loosing region gets nothing. Indeed, the last two propositions result in the following corollary:

Corollary 45 *When there is only one type of MNC, the posted tax $t_1 = \pi_1 - s_2$ is*

an equilibrium strategy for the advantageous region independently of the outside option being binding or not.

By now we have assumed that there was no central government intervention. However, the introduction of the central government intervention does not produce substantial change in the previous conclusions. In fact the only difference is that in the previous propositions the surplus to be considered in the negotiation process between the MNC and the regions are the ones after the taxes imposed by the central government (after-tax surpluses).

Let us look now then at the differences between the results of this section and the case where the inter region competition framework is one where they can only use bargaining (the one in chapter 5). As it was stated in section 2 of chapter 5 the result of the competition between the regions when they can only use bargaining 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. On the contrary as we have seen in the present section, the result of the competition between the regions when they can choose between bargaining and posted tax is that the MNC's payoff is equal to the outside option given by the 'after-tax surplus' it produces in the loosing region. This is the case whether this outside option is binding or not.

Thus, the results in this section and those in section 2 of chapter 5, allow us to write the following two corollaries:

Corollary 46 *When there is only one type of MNC, two regions, and the outside option is binding the bargaining and mixed negotiation mechanisms produce the same expected country's welfare.*

And

Corollary 47 *When there is only one type of MNC, two regions, and the outside option is non-binding the mixed negotiation mechanism produces a higher expected country's welfare than the bargaining one.*

6.4 Two MNC types and two identical regions

In section 4.3 of chapter 4 we have found that under certain parameter values the addition of commitment power to the only region of the country reduces de expected country's welfare. Thus, the question is, does this result also applies when there are two regions instead of one? At first we would think that the addition of another identical region would create harmful competition and so this result should continue applying or even increase in intensity.

However, in the present section we will show that this is not the case. In other words, in a mixed negotiation mechanism with two MNCs and only one region, the addition of a second identical region increases the expected country's welfare. This is a very interesting result because, at first, it seems more reasonable to expect that the competition created by the addition of a second region would have the inverse effect on welfare.

In this section we continue assuming a three-stage-game involving the central government, one region, in subsection 6.4.1 and two regions (i.e. 1 and 2), in subsection 6.4.1, and two types of MNCs (i.e. a or b). In the first stage, in order to maximise the expected country's welfare the central government posts a different lump sum tax (to be paid by the MNC) in each of the regions. In the second stage each regional government chooses its optimal tax strategy. That is, whether or not to post a particular tax. In this last case the region would have to bargain with the MNC in the third stage. Finally, in the third stage an MNC shows up and 'negotiates' with the two regions according with the strategies chosen by the regions in the second stage. That is, it bargains the regional tax or decides whether to accept or reject the posted regional tax.

We assume that, in the third stage of the game all players have perfect information. This means that the surplus produced by the MNC in each region, the taxes imposed by the central government in the first stage of the game, the tax strategy chosen by the regions in the second stage, 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. On the contrary, both the central government and the regions have imperfect information at the time of posting a tax[7]. This imperfect information is modelled by assuming that

[7] As we already explained in the introduction to the thesis, it would be enough that the MNC type

they know the externality each type of MNC can produce, but they do not know the realization of the MNC type. In particular, they only know that an MNC of type a shows up with probability p and an MNC of type b does it with probability $1-p$.

As we already said, we want to show that in a mixed negotiation mechanism with two MNCs and only one region, the addition of a second identical region increases the expected country's welfare. The best way of showing this result is by a numerical example, where we begin assuming the existence of only one region (region 1).

6.4.1 Numerical example

Only one region

Assume the MNCs of type a and b produce respective profits of $\pi_{1a} = 40$ and $\pi_{1b} = 30$, zero externalities, and the probability of an MNC of type b showing up is high enough as to make it optimal for the country to attract both MNCs under the bargaining mechanism (say $1-p = 0.8$)[8]. Thus, under the 'bargaining mechanism' it is optimal for the central government to charge a tax $g = \pi_{1b} = 30$ and the expected country's welfare is given by expression 3.8. That is, $ew = 35p + 30(1-p) = 31$.

On the contrary, we already saw that if the central government sets this same tax $g = 30$ under the mixed negotiation mechanism, the region would have an incentive to post a tax that only attracts the MNC of type a. That is, it would be optimal for the region to post a tax equal to 10. Thus, the region gets the entire after-tax surplus produced by an MNC of type a, but the MNC of type b does not come to the country[9]. In terms of the expected country's welfare this result is the same as the one achieved by the central government tax policy that only attracts the MNC of type a.

From the previous two paragraphs it is clear that the central government would prefer the region to choose the bargaining strategy, but the later prefers the tax posting one. The conflict of interests is evident.

The existence of this conflict of interest implies that the central government optimal policy is the one inducing the region to implement a posting tax strategy attracting both

is not verifiable.

[8]That is, the country's welfare in expression 4.10 is higher than the ones in expressions 4.6, 4.7, 4.8, and 4.9.

[9]This strategy gives the region a payoff equal to $10p$, which is higher than the payoff obtained under the bargaining one (equal to $(10/2)p$).

MNCs. One way of achieving this optimal policy is by setting $g_1 = 0$, what induces the region to set $t_1 = 30$[10]. This is the central government optimal policy because, from expression 4.11 we get that the 'unconditional maximum expected country's welfare' is achieved by the implementation of this regional strategy. That is, the 'conditional expected country's welfare' provided by this strategy (given in expression 4.8) is higher than the one provided by the other ones (given in expressions 4.6, 4.9, and 4.10)[11]. Thus, the expected regional payoff and expected country's welfare would be given by expression 4.3 and 4.8 respectively.

We have already explained in section 4.3 of chapter 4 that the reason why the bargaining strategy is not implemented in this setting is because it is not enough for the bargaining strategy to be optimal for the country, but it has to be also optimal for the region. However, we will show now that the existence of a second identical region allows the central government to make the bargaining strategy, which is the optimal one for the country, to be the optimal one for the first region as well. This is achieved by reducing the payoff the region 1 gets from the implementation of the tax posting strategy only attracting the MNC of type a. Indeed, in this particular example the addition of the second region does not reduce the expected country's welfare provided by the bargaining strategy. That is, the expected country's welfare will be equal to the one in expression 3.8.

Two identical regions

This section's numerical example consists in adding an identical region to the numerical example of the previous section. Then, the new numerical example is: the MNCs of type a and b produce respective profits of $\pi_{1a} = \pi_{2a} = 40$ and $\pi_{1b} = \pi_{2b} = 30$, zero externalities, and the probability of an MNC of type b showing up is high enough as to make it optimal for the country to attract both MNCs under the bargaining mechanism (say $1 - p = 0.8$).

[10] It is easy to see from expressions 4.1, 4.2, 4.3, 4.4, and 4.5 that a posting tax $t_1 = 30$ is the strategy giving the highest regional payoff.

[11] In the present numerical example the regional tax posting strategy attracting both MNCs provides a country's welfare $w_{a,b}^{p,m(c)} = 30$ while the other strategies generate the following country's welfares: $w_a^{p,m(c)} = 8$, $w_b^{p,m(c)} = 24$, and $w_{a,b}^{b,m(c)} = 16$. Note that expression 4.7 is not and equilibrium in this numerical example because every tax accepted by an MNC of type b would be also accepted by an MNC of type a.

We already know from chapter 5 that the central government can choose between two possible symmetric tax treatments: *symmetric tax treatment 1*. $g_1 = g_2 = 40$; and *symmetric tax treatment 2*, $g_1 = g_2 = 30$. We also know that the central government can treat the regions asymmetrically. In this case the central government eliminates region 2 from the competition by setting a very high tax there and set a tax $g_1 = 30$ in region 1[12]. Let us refer to this as the *asymmetric tax treatment 1*. The *asymmetric tax treatment 2* is introduced bellow. Let us analyse each of them in more detail.

***Symmetric tax treatment 1*:** The first symmetrical tax treatment only attracts the MNC of type a. Region 1[13] gets the MNC and the expected country's welfare is the one in expression 3.7 (i.e., $ew = 40p$).

***Symmetric tax treatment 2*:** The second symmetric tax treatment attracts both MNCs. Region 1 gets both MNCs but, because the competition between the regions is though, the expected country's welfare is the one in the following expression

$$ew_{a,b}^{s,m} = s_b p + s_b (1 - p) = s_b \tag{6.4}$$

It is obvious that this expected country's welfare is lower than the one given by the bargaining mechanism when both MNCs are attracted, (given in expression 3.8).

***Asymmetric tax treatment 1*:** On the contrary, if the central government implements the asymmetric tax treatment 1 it creates the same setting than in section 6.3 where there is only one region. As we already saw a tax $g_1 = 30$ in region 1 results in the bargaining strategy not being implemented by the region. For, it is optimal for region 1 to post a tax $t_1 = \pi_1 - g_1$, which is only accepted by the MNC of type a. As in the *symmetric tax 1* case the country's welfare is $ew = (g_1 + t_1)\,p = (g_1 + \pi_a - g_1)\,p = s_a p = 40p$.[14]

***Asymmetric tax treatment 2*:** We will show now that there is another asymmetric alternative for the central government, which does completely eliminate region 2 from the competition. The optimal taxes under this alternative are $g_1 = \pi_{b1} = 30$ and $g_2 = \frac{\pi_{a1} - \pi_{b1}}{2} = 35$.

[12] In fact it could also set a tax $g_1 = 40$ in region 1. However, this tax policy would give the same country's welfare than the first symmetric tax treatment where $g_1 = g_2 = 40$.

[13] In order to simplify the analysis let's assume that when an MNC is indifferent between region 1 and 2 it chooses region 1 with probability 1.

[14] Because $e_a = 0$.

Then, on the one hand, when an MNC of type b shows up the after tax surpluses it produces are $s_{a1}^{at} = \pi_{b1} - g_1 = 0$ in region 1 and $s_{a2}^{at} = \pi_{b2} - g_2 = -5$ in region 2. It is obvious that region 2 would not be able to profitably attract the MNC of type b. Moreover, we can be certain that a tax $t_1 = 0$ would attract the MNC of type b to region 1. Recall that we are assuming that if indifferent between coming or not to the country, the MNC would choose to come to the country with probability 1. On the other hand, when an MNC of type a shows up the after tax surpluses it produces are $s_{b1}^{at} = \pi_{a1} - g_1 = 10$ in region 1 and $s_{b2}^{at} = \pi_{a2} - g_2 = 5$ in region 2.

It is obvious in the previous paragraph that, given that region 2 cannot attract the MNC of type b, it should only go for the MNC of type a. However, let us take a closer look at the equilibrium of this sub-game.

Case 1: Let us assume first that region 2 chooses the bargaining strategy. Then, the optimal posting tax strategy for region 1 would be to set $t_1 = 5$[15], which provides it an expected payoff $ez_a^{p,m,1} = 5p$. Moreover, region 1 would get exactly the same expected payoff by choosing a bargaining strategy, $ez_{a,b}^{b,m1} = \frac{\pi_{a1}-g_1}{2} = 5p$[16].

Case 2: It should be obvious that in the case that region 2 chooses to post a tax, in equilibrium it would set $t_2 = 0$. Then, region 1's best response is the same as in case 1. That is, a posted tax $t_1 = 5$ or bargaining. Moreover, region's 1 payoff is also the same as in case 1.

Thus, in the present numerical example and given $g_1 = 30$ and $g_2 = 35$, we have the following four second stage equilibriums: 1) region 1 posting $t_1 = 5$ and region 2 posting $t_2 = 0$; 2) region 1 posting $t_1 = 5$ and region 2 using bargaining; 3) region 1 using bargaining and region 2 posting $t_2 = 0$; 4) and region 1 using bargaining and region 2 using bargaining.

However, as before, the existence of multiple equilibriums is not a problem because they are outcome equivalent. That is, in each of the equilibrium region 2 gets nothing and region 1 gets an expected payoff $ez_a^{p,m} = ez_{a,b}^{b,m} = 5p$.

Then, it is obvious that for the bargaining to be the only optimal strategy for region 1 it would be enough for the central government tax in region 1 to be marginally lower

[15] In order to simplify the analysis let's assume that when the MNC of type a is indifferent between region 1 and 2, it chooses region 1 with probability 1.

[16] In fact, the outside option is just binding because half of the after tax surplus produced by the MNC of type a in region 1 $\left(\frac{\pi_{a1}-g_1}{2} = 5p\right)$ is exactly equal to the value of the outside option $(\pi_{a2} - g_2 = 5p)$.

than 30, (say $g_1 = 30 - \epsilon$), where ϵ is very small. However, because the introduction of ϵ would result in a more cumbersome explanation, it is better to assume that whenever a region is indifferent between using bargaining or posting a tax, it uses bargaining with probability 1.

Then, given that region 1 chooses the bargaining strategy the expected country's welfare is

$$ew_{a,b}^{b,m(c)} = \left(g_1 + \frac{\pi_{1a} - g_1}{2}\right) p + g_1 (1 - p) = 35p + 30 (1 - p) \tag{6.5}$$

which is obviously equivalent to the one in expression 4.10[17].

Thus, we can express the previous example findings in the following proposition:

Proposition 48 *In a mixed negotiation mechanism with two MNCs and only one region, the addition of a second identical region can increase the expected country's welfare.*

The reason for the previous result is that the existence of a second region provides the central government with an additional negotiation tool. We have already explained in section 4.3 of chapter 4 that one problem of the mixed negotiation mechanism when there is only one region is that it is not enough for the bargaining strategy to be the optimal one for the country, but it has to be also the optimal one for the region. Hence, the central government can use the competition from the second region in order to prevent the first region to use the posted tax strategy that only attracts the MNC of type a, what under some parameter values provides a lower expected country's welfare than the bargaining strategy. As a result, in the previous numerical example, the region adopts the bargaining strategy, which is the optimal one for the country.

Furthermore, it should be obvious that the previous result does not depend on the second region being identical to the first one. For example, the result would still apply if the MNCs of type a and b produce respective profits of $\pi_{1a} = 40$, $\pi_{2a} = 30$, $\pi_{1b} = 30$, and $\pi_{2b} = 20$, zero externalities, and the probability of an MNC of type b showing up is high enough as to make it optimal for the country to attract both MNCs under the bargaining mechanism (say $1 - p = 0.8$). For in this case the central government taxes $g_1 = 30$ and $g_2 = 25$ would produce exactly the same equilibriums than in the previous

[17] Because $1 - p = 0.8$, the expected country's welfare in (6.5) is higher than the one in the two symmetric tax treatments as well as in the asymmetric tax treatment 1.

numerical example and so they would also produce the same expected country's welfare than in expression 6.5.

6.5 Conclusion

In the present chapter we have worked on a model where there are two regions choosing between the bargaining and posting tax strategies. In the first section we have modelled the inter-regional competition in a setting with only one type of MNC in a mixed negotiation mechanism without central government intervention. There, we have found the existence of output equivalent multiple equilibriums. That is, the taxes set by both regions and the payoff obtained by them and the MNC do not change between equilibriums. Moreover, the posting tax strategy is always an equilibrium one and the expected country's welfare is higher under this setting than in one where the two regions can only use the bargaining strategy.

In the second section of the present chapter we have analysed the same mixed negotiation mechanism, but allowing for inter-regional competition and central government intervention. For simplicity we have assumed two identical regions. We found that under certain parameter values, the addition of a second identical region to the country increases the expected country's welfare. As we already explained, the reason for this result is that the existence of a second identical region provides the central government with an additional negotiation tool which can be used in order to prevent the winning region from using a strategy that is not the optimal one for the country.

Chapter 7

Conclusion

In the present thesis we have analysed the very well known fact of inter-region competition to attract MNCs. In chapters 3 and 4 we have considered a situation where there is only one region in the country. We have justified that this is sometimes the case in reality. Moreover, the consideration of only one region in these chapters was useful in order to understand the more difficult case when there are two regions. This last case was analysed in chapters 5 and 6.

In chapter 3 we have considered the stylized fact that the central government has to set the taxes in advance (tax posting), but depending on the negotiation mechanism, the regional government can either bargain or post a tax, but it cannot choose between the two mechanisms. Furthermore, the MNC has to accept whichever negotiation mechanism is in place and decide whether to establish its new production plant in the country.

Interesting results have been found. In particular, we found that when the region also gets externalities in addition to the levied tax, it is not always the case that the regional bargaining mechanism dominates the tax posting one. However, we also saw that the regional bargaining mechanism is welfare superior to the posted tax one for a very plausible range of parameter values which, as in Wang (1995) but in a different context, includes the case where the MNCs only produce profits and no externalities to the region.

We have shown that the likelihood that the regional bargaining mechanism dominates the posted-tax one is higher the higher is the dispersion of the profits and the lower is the externality of the high surplus MNC with respect to the one produced by the

low surplus one. We have also shown that the composition of the surplus between profits and externalities does not produce any effect on the equilibrium expected country's welfare in the bargaining mechanism. However, it does in the posted tax one.

Other important results were found in chapter 4. They stem from the comparison between the mix negotiation mechanism on the one hand and the bargaining and tax posting ones on the other. The most important one is that for those parameter values where the regional bargaining mechanism is welfare superior to the posted tax one, we also find that the addition of the posting tax strategy to the regional options not only cannot increase the expected country's welfare, but it reduces it in some cases. It seems striking that the addition of another negotiation tool to the region reduces the expected country's welfare. We have shown that the reason for this result is that the existence of a regional choice between bargaining and posted tax creates a 'conflict of interests' between the region and the central government. That is, it is optimal for the country that the bargaining strategy is used in order to attract both MNCs but not for the region. Recall that this conflict of interests does not exist when the region cannot choose between strategies.

Clear policy recommendations are also derived. On the one hand our model determines the optimal central government tax policy under each of the considered negotiation mechanisms. On the other hand, it also establishes the optimal negotiation mechanism under specific ranges of parameter values, what is useful in the case the central government of the country has some control of it.

In chapters 5 and 6 competition was introduced by considering two regions instead of one. In chapter 5 we have assumed that each of the regions can only use bargaining with the MNCs. We have found 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 expected country's welfare. This result seems to justify the widespread existence of the so-called special economic zones or other economic regimes that create asymmetries between the regions of a particular country. Indeed, it is the case that under some particular conditions an asymmetric treatment of similar regions is the only optimal policy. For 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 regions and MNCs. 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 optimal policy.

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 expected country's welfare and achieving the best match between region and MNC. This result is mainly driven by the central government inability of applying tax-discrimination between the different types of MNCs, what leaves it with only two tools to reach four targets.

In chapter 6 we model two competing regions that are able to choose between the bargaining and posting tax strategies. We found that under certain parameter values, the addition of a second identical region to the country increases the expected country's welfare. The reason for this result is that the existence of a second identical region provides the central government with an additional negotiation tool which can be used in order to prevent the winning region from using a strategy that is not the optimal one for the country. That is, the conflict of interests between central and regional government is avoided.

Finally, we should recognise the limitation implied by the section 4 of chapter 6 assumption that the two regions are identical. Consequently, it seems interesting to see if the results of this section still hold in a more general setting. That is, when a mixed negotiation mechanism inter-regional competition process is applied to the twelve economic regimes of chapter 5. It seems to be that this is a worth doing task. One possibility would be to adapt one of the existing models in the "posting price versus bargaining literature" to the inter-regional competition setting. Indeed, this seems an interesting research. However, the complexities involved in developing such a model suggest that this will have to be the task of a future work.

Chapter 8

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Chapter 9

Appendix

A1

From expressions 4.6 and 4.25 we know that $s_b(1-p) > s_a p$, what implies that $3s_b(1-p) > 3s_a p$. Then, for inequality 4.27 to be satisfied it has to be the case that $\frac{s_b(1-p)-s_a p}{(1-2p)} > 0$[1], what requires $p < \frac{1}{2}$.

Then, by multiplying both members of expression 4.25 by $(1-2p)$ and given $p < \frac{1}{2}$ we get:

$$s_a(-6pp+2p) > s_b(6pp-8p+2) \tag{9.1}$$

On the one hand, the probability solving $-6pp+2p=0$ is $p=\frac{1}{3}$ what, given s_a, $s_b > 0$, implies that the bracket in the first member of 9.1 is positive for any $0 < p < \frac{1}{3}$ and negative for any $\frac{1}{3} < p < \frac{1}{2}$[2]. On the other hand, the roots solving $6pp-8p+2=0$ are $p_1, p_2 = 1, \frac{1}{3}$, what implies that the bracket in the second member of 9.1 is positive for any $0 < p < \frac{1}{3}$ and negative for any $\frac{1}{3} < p < \frac{1}{2}$.

Let us assume that both members of expression 9.1 are positive. Then, it is equivalent to:

$$\frac{s_a}{s_b} > \frac{(6pp-8p+2)}{(-6pp+2p)} \tag{9.2}$$

Moreover we know that $s_b(1-p) > s_a p$, what is equivalent to

$$\frac{(1-p)}{p} > \frac{s_a}{s_b} \tag{9.3}$$

[1] This also implies that the optimal central government tax is positive.
[2] We know that it must be $p < \frac{1}{2}$.

Then, from 9.2 and 9.3 we get:

$$\frac{(1-p)}{p} > \frac{(6pp-8p+2)}{(-6pp+2p)} \tag{9.4}$$

By multiplying both members by $(-6pp+2p)$, what we know is positive and rearranging we get that expression 9.4 can only be solved as an equality. That is:

$$\frac{(1-p)}{p} = \frac{(6pp-8p+2)}{(-6pp+2p)} \tag{9.5}$$

Then, from 9.2, 9.3, and 9.5 we get that

$$\frac{(1-p)}{p} = \frac{s_a}{s_b} \tag{9.6}$$

what implies $s_b(1-p) = s_a p$. However, if this is the case, expression 4.25 would be satisfied as equality and so the mixed negotiation mechanism would not dominate the posted tax one. Then, in order for the mixed negotiation mechanism to dominate the posted tax one it is necessary that in expression 9.1 $-6pp+2p < 0$ and $6pp-8p+2 < 0$ what, as we already said, requires that $\frac{1}{3} < p < \frac{1}{2}$.

Furthermore, from expression 3.21 and the fact that $s_a \geq \pi_b$ we get:

$$\frac{e_a}{2e_a+\pi_a} \geq p \tag{9.7}$$

However, we already know that $p > \frac{1}{3}$ and so we get:

$$e_a \geq \pi_a \tag{9.8}$$

Finally, replacing $e_a \geq \pi_a$ into expression 3.21 we get:

$$\pi_b \geq \pi_a \frac{(1+p)}{(1-p)} \tag{9.9}$$

The fact that $\frac{1}{3} < p < \frac{1}{2}$ implies that expression $\frac{(1+p)}{(1-p)}$ varies from 2 to 3. Thus, we can be certain that $\pi_b \geq 2\pi_a$.

A2

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 expected country's welfare provided by every tax policy in every economic regime. The result is as follows:

Tax policy 2 is regime-dominated in economic regimes III and VI (by tax policy 5a). 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 5a). The application of tax policy 4 in economic regimes III, V, and VI does not attract the MNC of type a to the country and so it is regime-dominated (by tax policy 5a). By definition tax policy 5a can only be applied when $s_{b2} \geq s_{a2}$ (i.e. in economic regimes III, V, and VI). Indeed, it is not regime dominated in these particular regimes. In a similar way, tax policy 5b can only be applied when $s_{b2} \leq s_{a2}$ (i.e. in economic regimes I, II, and IV). Indeed, it is not regime dominated in these particular regimes.

A3 Mathematical derivation of the main expressions

A3.1 Derivation of expression 3.9

$$s_a p > \left(s_b + \frac{s_a - s_b}{2}\right) p + s_b(1-p)$$

$$s_a p > \left(\frac{s_a + s_b}{2}\right) p + s_b(1-p)$$

$$\frac{s_a}{2} p > \left(\frac{s_b}{2}\right) p + s_b(1-p)$$

$$\frac{s_a}{2} p > s_b(1 - \frac{p}{2})$$

$$\frac{s_a}{2} > s_b(\frac{1}{p} - \frac{1}{2})$$

$$\frac{s_a}{2} > s_b \frac{2-p}{2p}$$

$$s_a > s_b \frac{2-p}{p}$$

A3.2 Derivation of expression 4.21

$$ew_{b,m} = \left(g + \frac{s_a - g}{2}\right)p + \left(g + \frac{s_b - g}{2}\right)(1-p)$$

$$ew_{b,m} = \left(\frac{s_a + g}{2}\right)p + \left(\frac{s_b + g}{2}\right)(1-p)$$

$$ew_{b,m} = \frac{s_a}{2}p + \frac{s_b}{2}(1-p) + \frac{g}{2}$$

Then, we know that for bargaining to be the optimal strategy under the mixed negotiation mechanism, it must be the case that expression 4.10 is higher than 4.6, what implies:

$$\frac{s_a}{2}p + \frac{s_b}{2}(1-p) + \frac{g}{2} > s_a p$$

$$\frac{s_a}{2}p + \frac{s_b}{2}(1-p) + \frac{g}{2} > s_a p$$

A3.3 Derivation of expression 4.22

$$\frac{s_a}{2}p + \frac{s_b}{2}(1-p) + \frac{g}{2} > s_a p$$

$$\frac{s_a}{2}p + \frac{s_b}{2}(1-p) + \frac{s_b(1-p) - s_a p}{2(1-2p)} > s_a p$$

$$s_a p + s_b(1-p) + \frac{s_b(1-p) - s_a p}{(1-2p)} > 2 s_a p$$

$$s_b(1-p) + \frac{s_b(1-p) - s_a p}{(1-2p)} > s_a p$$

$$s_b(1-p)\,(1-2p) + s_b(1-p) - s_a p > s_a p\,(1-2p)$$

$$s_b(1-p) - 2p s_b(1-p) + s_b(1-p) - s_a p > s_a p\,(1-2p)$$

$$-2p s_b + 2p s_b p + 2 s_b - 2 s_b p - s_a p > s_a p - 2 s_a p p$$

$$-2p s_b + 2p s_b p + 2 s_b - 2 s_b p > 2 s_a p - 2 s_a p p$$

$$s_b pp - 2s_b p + s_b > s_a p - s_a pp$$

$$s_b\,(pp - 2p + 1) > s_a\,(-pp + p)$$

A3.4 The roots after expression 4.22

$$p_1,\ p_2 = \frac{2 \pm \sqrt{2^2 - 4 \cdot 1 \cdot 1}}{2 \cdot 1}$$

$$p_1,\ p_2 = \frac{2 \pm \sqrt{4 - 4}}{2}$$

$$p_1,\ p_2 = \frac{2 \pm 0}{2}$$

$$p_1,\ p_2 = \frac{2 \pm 0}{2} = \begin{matrix} 1 \\ 1 \end{matrix}$$

A3.5 The roots after expression 4.24

$$p_1,\ p_2 = \frac{3 \pm \sqrt{3^2 - 4 \cdot 2 \cdot 1}}{2 \cdot 2}$$

$$p_1,\ p_2 = \frac{3 \pm \sqrt{9 - 8}}{4}$$

$$p_1,\ p_2 = \frac{3 \pm \sqrt{1}}{4}$$

$$p_1,\ p_2 = \frac{3 \pm 1}{4} = \begin{matrix} 1 \\ \frac{1}{2} \end{matrix}$$

A3.6 Derivation of expression 9.1

$$s_b(1-p) - s_a p + 3s_a p(1-2p) > 3s_b(1-p)(1-2p)$$

$$s_b - s_b p - s_a p + 3s_a p - 3s_a p2p > (3s_b - 3s_b p)(1-2p)$$

$$s_b - s_b p + 2s_a p - 6s_a pp > (3s_b - 3s_b p) - 2p(3s_b - 3s_b p)$$

$$s_b - s_b p + 2s_a p - 6s_a pp > 3s_b - 3s_b p - 6ps_b + 6s_b pp$$

$$2s_a p - 6s_a pp > 2s_b - 8s_b p + 6s_b pp$$

$$-6s_a pp + 2s_a p > 6s_b pp - 8s_b p + 2s_b$$

$$s_a(-6pp + 2p) > s_b(6pp - 8p + 2)$$

A3.7 The roots after expression 9.1

$$p_1,\ p_2 = \frac{8 \pm \sqrt{8^2 - 4 \cdot 6 \cdot 2}}{2 \cdot 6}$$

$$p_1,\ p_2 = \frac{8 \pm \sqrt{64 - 48}}{12}$$

$$p_1,\ p_2 = \frac{8 \pm \sqrt{16}}{12}$$

$$p_1,\ p_2 = \frac{8 \pm 4}{12} = \begin{matrix} 1 \\ \frac{1}{3} \end{matrix}$$

A3.8 Derivation of expression 9.5

$$\frac{(1-p)}{p} \geq \frac{(6pp - 8p + 2)}{(-6pp + 2p)}$$

$$(1-p)(-6pp + 2p) \geq p(6pp - 8p + 2)$$

$$(1-p)(-6pp + 2p) \geq p(6pp - 8p + 2)$$

$$(-6pp + 2p) - p(-6pp + 2p) \geq p(6pp - 8p + 2)$$

$$(-6p + 2) - (-6pp + 2p) \geq (6pp - 8p + 2)$$

$$-6p + 2 + 6pp - 2p \geq 6pp - 8p + 2$$

$$-8p \geq -8p$$

A3.9 Derivation of expression 9.7

$$\pi_b(1-p) \geq \pi_a + e_a p$$

$$s_a(1-p) \geq \pi_a + e_a p$$

$$(\pi_a + e_a)(1-p) \geq \pi_a + e_a p$$

$$(\pi_a + e_a) - (\pi_a + e_a)p \geq \pi_a + e_a p$$

$$e_a - (\pi_a + e_a)p \geq e_a p$$

$$e_a - \pi_a p \geq 2e_a p$$

$$e_a \geq 2e_a p + \pi_a p$$

$$e_a \geq p(2e_a + \pi_a)$$

$$\frac{e_a}{2e_a + \pi_a} \geq p$$

A3.10 Derivation of expression 9.8

$$\frac{e_a}{2e_a + \pi_a} \geq \frac{1}{3}$$

$$e_a \geq \frac{1}{3}(2e_a + \pi_a)$$

$$e_a \geq \frac{1}{3}2e_a + \frac{1}{3}\pi_a$$

$$e_a - \frac{2}{3}e_a \geq \frac{1}{3}\pi_a$$

$$\frac{1}{3}e_a \geq \frac{1}{3}\pi_a$$

$$e_a \geq \pi_a$$

A3.11 Derivation of expression 9.9

$$\pi_b\,(1-p) \geq \pi_a + \pi_a p$$

$$\pi_b\,(1-p) \geq \pi_a\,(1+p)$$

$$\pi_b \geq \pi_a \frac{(1+p)}{(1-p)}$$

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