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OLIGOPOLY MODELS

AND COMPETITION

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Ai miei genitori

Contents

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Chapter 1

Introduction

In the past decades game theory has developed several tools which resulted very fruitful in the literature of industrial organization where the strategic interaction among agents is a central element. The game-theoretic viewpoint has shown particularly useful in the study of oligopoly settings where the impact of each firm's choice to her opponents cannot be reasonably neglected.

In this thesis I make use of simple dynamic games and game theoretic notions, basically involving the concept of subgame perfection. However, they are enough to highlight some interesting insights arising from the strategic behaviour of firms in oligopoly industries as well as from their interaction with other agents such as potential buyers and public authorities.

In particular, this approach has been applied to different settings: the issues investigated are related to Foreign Direct Investments' attraction, to the Internal Capital Markets of diversified conglomerates and to buyers' fragmentation. However, a common feature of the three works presented in this thesis is that the analysis pays a particular attention to the competition policy implications.

In this Chapter I shall introduce the questions addressed in each work, anticipate on the main results and comment on the policy implications raised by each study.

1.1 Do conglomerate divisions compete differently than stand-alone firms?

Conglomerate mergers are defined as mergers involving essentially unrelated enterprises. This feature apparently alleviates concerns about increase of concentration and market power abuse. Nonetheless, the impact of conglomeration on competition has been the object of much economic discussion which still lacks of a formal underpinning: is conglomeration conductive to predatory pricing or, in general, does it facilitate behaviours aimed at deterring entry or inducing exit of rivals? Yet, does conglomeration allow an entry pattern different from the one of new born stand alone firms?

In the work presented in Chapter 2, we have tried to understand whether being part of a conglomerate allows divisions to compete differently from stand-alone firms and hence whether and when conglomerate mergers should raise anti-competitive concerns.

In doing this, we have analysed the link between the *financial policy* operated within the conglomerate and its divisions' product market behaviour. In particular, we have characterised the conglomerate Internal Capital Market by its ability to appropriate divisional internal resources and to reallocate them. This reallocation results in the cash flows from monopolistic divisions being partly used to subsidise the divisions facing the more competitive environment, which, in turn, affects the latter's competitive performance.

However, we have assumed that the allocation of internal resources is not observable by rivals (or that it is secretly renegotiable), so that we have *ruled out any strategic role* associated to it. The implication of this is that subsidisation is simply done to alleviate the more severe agency problem of division facing more aggressive rivals, *without a specific commitment and anti-competitive purpose.* Hence, in our model, the difference between a conglomerate division and a stand alone firm does not stems from the former being facilitated to *to commit* to a given behaviour by having a longer purse. In spite of this, being subsidised makes conglomerate divisions peculiar competitors. Moreover, this interplay and the policy implications that can be drawn are less simplicistic than what appears at first sight.

First, being subsidised by the parent company does not necessarily imply that divisions are made tougher competitors than equally profitable stand alone firms. Indeed, if the business group is not financially strong, the infusion of internal resources received by the parent company induces a softer competitive behaviour. Hence, *subsidisation (and conglomeration) cannot be necessarily suspected with an anti-competitive implication.*

Second, being subsidised may facilitate the entry process of a conglomerate division with respect to the one of a stand alone firm. In particular, by increasing a division's value, subsidisation makes more costly for an incumbent firm to commit to an entry deterrence behaviour. Conglomerate divisions are, thus, more protected against rival's entry deterrence commitments and, in this sense *conglomerate mergers may have welfare improving pro-competitive effects.* Moreover being assigned more and more financial resources as the rivals' become more and more aggressive makes the division less reactive to the rivals' behaviour and affects the latter's strategic commitment, in case of accomodated entry. However, this represents an advantage for a financially healthy business group, as it discourages the incumbent's "top dog" strategy, while it may represent a *cost* for a financially weak conglomerate, as it discourages "pro-collusive" commitments.

Finally, a conglomerate merger may *well give rise to anti-competitive concerns* and restrict competition in the markets where the divisions operate, *even if joining a conglomerate does not enable a division to commit to a predatory (entry deterrence) behaviour,* by making its pocket deeper. Again no-strategic subsidisation drives the result. If entry is blockaded in one market, the division operating in the other may be (optimally) subsidised when facing competition. To the extent that this makes it a tougher competitor, entry is made less profitable and in some cases may be deterred also in the second market, in spite of a wider scope for competition. Moreover, subsidisation creates scope for miscoordination of the potential entrants in business group-dominated markets so that the economy may get stuck to an equilibrium where all the markets are monopolised by the incumbent group, while competition would result in both of them with stand alone incumbents. Hence, the financial link created by the ICM between the two otherwise separate markets enables a *financially strong business group* to extend monopolistic conditions from one market to another and correlates the probability of entry in the two.

Note that the impact of conglomeration on product market competition crucially depends on the conglomerate's financial strength. This might give empirical content to the theory.

1.2 Can buyers' fragmentation deter entry?

The work presented in Chapter 3 is related to the discussion on buyers' countervailing power. It has been held that facing one or few buyers instead of many dispersed buyers makes a difference for a seller. The reason is that either in the former case the buyer(s)' bargaining power is stronger and the seller market power is thus limited or sellers' collusion is more difficult to sustain.

We have contributed to this debate, focusing on the impact of buyers' fragmentation on entry. In particular, we have tried to understand whether and when buyers' fragmentation limits the competitive pressure that a more efficient potential entrant exerts on an incumbent firm. Hence, does buyers fragmentation matter in evaluating the anti-competitive impact of mergers, as some recent decisions of the European Commission suggest? Finally, what can be done to facilitate entry when buyers' fragmentation raises such problems?

To answer these questions we have considered a setting where some buyers simultaneously invite tenders to an incumbent firm and a (more efficient) potential entrant. Afterwards, buyers simultaneously decide whose bid to accept. The difference between the incumbent and the potential entrant lies in the latter *not having already incurred a fixed sunk investment which needs time to be carried out*. Hence, when bids are made the potential entrant *cannot credibly commit to enter*: he will only if it is patronised by enough buyers to recover the fixed costs. This lack of commitment creates an *asymmetry* between the potential entrant *from a buyer's point of view*. While by accepting the incumbent's bid one is confident of obtaining the good, accepting the potential entrant's bid is more *risky*. Maybe it gives up from entering so that the buyer must subsequently resort to the incumbent, and presumably pay a high price. This creates the scope for *miscoordination*: when the entrant bids a lower price than the incumbent, it is not obvious that it is addressed by all the buyers. These may get stuck to an equilibrium (less efficient from their perspective) where each buyer chooses to patronize the incumbent and individually nobody has incentive to deviate. For this reason buyers' fragmentation may prevent entry by a more efficient producer and may allow the incumbent to fully exert its market power despite the existence of the potential entrant.

Note that the incumbent does not need to resort to explicit vertical restraints to deter entry; it just exploits the credibility advantage offered by having already sunk the costs. Note also that a similar effect of buyers' fragmentation might arise as a consequence of network externalities or of economies of scope. Finally, this analysis provides some rationale for anything that helps buyers to coordinate, such as centralised buying agencies to which independent buyers delegate their purchasing decision.

In this contest we have also investigated the role of a penalty paid to the unfulfilled buyers by the potential entrant in alleviating the "perverse" effect of fragmentation. If the payment of the penalty is *credible*, it may have two effects. If the penalty it is sufficiently high, it *eliminates* any room for miscoordination and the more efficient producer always enters. In a sense, the penalty makes more costly to give up providing the good and acts as a commitment to enter . Such commitment could not be done through the sunk investment as it takes time to be carried out. If the penalty is not that high, it *reduces* the scope for miscoordination. The intuition is that the penalty reduces the risk of accepting the entrant's better bid, when prices are higher than a threshold: if the entrant should decide not to operate, one receives the penalty. This reduces the cost of resorting to the incumbent in a second step. In other words, if the incumbent bids a price higher than the threshold, buyers find it more profitable to accept the entrant's bid, regardless it enters or not. This does not eliminate equilibria in which entry is prevented, but limits the incumbent's ability to exert market power. Hence the penalty can be effectively used by the potential entrant to favour entry as well as by the social planner.

1.3 Should incentives to attract FDI be banned?

The increasing important of Foreign Direct Investments in developed economies and the emphasis given since the 80's to the benefit of FDI in the host countries (especially in terms of employment creation and technological spillovers) have made FDI's attraction an economic priority in many countries. However, as open policies towards FDI have been adopted in most of the countries, they have lost their effectiveness in attracting FDI. More attention, thus, is being paid to the so called "business facilitation measures", which comprehend financial and fiscal incentives but also promotional and assistance activities. Such measures are not new, but recently they have become more and more sophisticated and targeted to specific sectors and indeed to specific firms. As a result, competition in terms of incentives among countries, regions or indeed local authorities for the location of a specific investment project has become more and more intense, and the amounts offered have reached remarkably high levels. This has risen the question of whether competition is good in this contest, whether all the involved countries would be better off by banning the possibility to offer incentives. This is the issue investigated in the fourth Chapter. Note that the perspective is reversed with respect to the others and the emphasis is not on the impact of some behaviours on competition but on the impact of competition on welfare.

To answer the previous question I have tried to stress a role of subsidy competition which does not always receive the appropriate attention. Competition, by inducing an efficient allocation of the economic activity, *may* lead the investments where they generate the highest benefits and where they would not locate otherwise. When this is the case *standardising or banning incentives* may prevent competition from developing its allocative function. Hence, even if it solves the problems associated to each country or region lacking to internalise the effects of one's offer on the others, *it may generate another problem.* Hence, it is not obvious that every region should gain by banning incentives as well as that the overall welfare of the competing countries should increase.

In the work presented in Chapter 4, I have tried to identify whether and when this argument holds. To do this, I have adopted a different approach from the one generally used by the economic literature dealing with competition for FDI. I have assumed two asymmetric regions, one that benefits more than the other from FDI but that is not the most preferred location of the investing firm. This allows to evaluate the previous trade-off. In this setting it is possible that subsidy competition makes the multinational invest in the region where it generates the highest benefits. This would never happen by banning subsidies and might therefore *decrease the joint welfare of the competing regions.* In particular this is the case when competition takes place between very different regions, for instance a region which suffers from severe unemployment problems and a more prosperous one, and when the positive externality associated to FDI is sufficiently strong.

As an immediate policy implication, *the previous trade-off cannot be solved simply by a ban on subsidies* but requires a more articulated solution. A case by case approach ought to be adopted and typically only "depressed region" should be allowed to offer subsidies when competing with advanced ones. Note that, in principle, the European Regulation in this field seems to follow this logic and a similar approach is gaining importance also at WTO level.

Finally, another important implication of the analysis is that the *actual alternatives available to the multinational* are relevant to evaluate the welfare effects of a ban on incentives. If it is not obvious that the MNE invests in either countries, should subsidies be banned, the welfare conclusions can dramatically change. In particular, it is important to evaluate whether the "outside option" is desirable or not for the competing regions. In the former case the waste of resources associated to subsidy competition may be amplified as the possibility to offer incentives turns one region against the other and makes them dissipate most of the welfare gains associated to the MNE's location; viceversa, in the latter case, the welfare increasing effect of subsidy competition may be emphasised as, regardless who wins the auction, it serves at avoiding an undesirable outcome for both the rival parties.

Chapter 2

Internal Capital Markets and Product Market Competition (joint with Giacinta Cestone)

2.1 Introduction

In this paper we explore how internal capital allocation within a diversified conglomerate, in particular within a holding group, interacts with the product market behaviour of subsidiaries. Conventional wisdom suggests that the possibility of shifting resources through an internal capital market (ICM) allows conglomerate divisions to be stronger competitors in the product market game. We address this issue studying an extension of Aghion-Dewatripont-Rey (1998) model of corporate finance and product market competition.

The theoretical literature on internal capital markets has addressed two main issues. First, the relative merits of internal and external capital markets have been established, in order to assess whether internal markets create value.[1] This requires studying the allocation of resources among divisions of a diversified firm. Other papers[2] have gone further by analysing the optimal size and scope of internal capital markets. In both cases, projects' profitability has been taken as exogenous, or dependent on division managers' effort and incentives. Product

[1]This is the case in Gertner, Scharfstein, Stein (1994), and - more recently - Rajan, Servaes, Zingales (1998).
[2]For instance, Stein (1997).

market competition has never been studied explicitly in these models. Our paper tries to fill this gap, by recognising that the product market performance of divisions crucially depends on resource allocation within the internal capital market.

The product market impact of conglomeration has been the object of much economic discussion. A main policy concern about diversified conglomerates is that cash flow-rich divisions may subsidise divisions competing in other product markets. Since John Rockefeller's Standard Oil Company anti-trust case, this has been meant to imply that conglomeration has anti-competitive effects. As Scherer (1980) reports, "the conventional wisdom, handed down from generation to generation of economists, tells us that Standard cut prices sharply in specific local markets where there was competition while holding prices at much higher levels in markets lacking competition". In other words, within-conglomerate subsidisation is seen as instrumental to predatory pricing.[3] Taking a different perspective, other works have focussed on *conglomerate entry* as a peculiar phenomenon with respect to firm entry. Biggadike (1979) concludes his study of entry strategies and post-entry performances of forty business units of diversifying corporations claiming that "established firms can enter more easily and more effectively than newborn firms", and thus "cross-business subsidisation by established firms has favorable aspects as well as the more commonly expressed unfavorable aspects". Many other empirical studies and informal discussions have pointed at the link between financial phenomena within diversified conglomerates and their product market behaviour. However, a formal analysis of this interaction has not been carried out yet.

We analyse competition in R&D efforts between a subsidiary of an holding group (or business unit) and a stand-alone firm. Both the subsidiary and the stand-alone firm need funds from the external capital market in order to operate. The amount of *internal* funds determines the agency problem with outside investors, and thus the intensity of R&D effort exerted by the firm (subsidiary)'s manager. The subsidiary's internal funds, though, are endogenously determined by the capital allocation decisions of the parent company. The allocation of internal funds to subsidiaries is *not* observed by product market competitors, which rules out the possibility of a

[3]This claim presumes that some capital market imperfection prevents stand-alone firms from getting their predatory activities funded by an external investor, whereas conglomerates - having an easier access to capital - can provide their predatory divisions with a 'deeper pocket'. To our knowledge, there is no *formal* theory linking the financial synergies realised in pure conglomerates and the predatory potential of conglomerate divisions.

strategic allocation of funds. In spite of this assumption, there is still room for ICM decisions to affect subsidiary managers' product market behaviour.

We show that a subsidiary's product market behaviour differs substantially from that of an equally profitable stand-alone firm. This result derives from the fact that, as a subsidiary's rival becomes more aggressive, the subsidiary's incentive problem vis-à-vis external investors is exacerbated, which makes internal funds relatively more valuable to it. As a consequence, *the headquarters is always willing to shift funds to those subsidiaries facing more aggressive competitors.* Through this channel, product market competition affects capital allocation among subsidiaries of an holding group. This in turn has an impact on the subsidiary manager's effort choice, and thus on *its* product market strategy.

However, subsidisation from the parent company does not necessarily spur a business unit's competitiveness. In our model, managers under a tight leash (that is, with large financial needs) are the most likely to compete fiercely: they are ready to pay a high private cost in order to commit to a tough behaviour and get their projects funded. Subsidising a business unit that is struggling to survive has thus a perverse effect: the manager, no longer under the pressure that her project is shut down, "takes it easy" and fights *less aggressively* against competitors. Conversely, a manager with low financial needs knows that her position is safe. Thus, her effort just responds to monetary incentives. When her business unit is subsidised, the manager can keep a higher share of the profits for herself, and therefore competes *more aggressively* so as to increase her monetary returns. These formal results confirm that subsidiaries of an holding groups are peculiar competitors on the product market, but also suggest that many statements about the anti-competitive impact of conglomeration lack a formal underpinning.

Conglomeration affects competition also through the *entry process.* We analyse this issue from two perspectives.

First, we consider the entry problem for a subsidiary of an holding group to study whether it differs from that of a stand-alone firm, as analysed in Fudenberg and Tirole's (1984) seminal paper on entry deterrence and accommodation. For instance, a financially weak *stand-alone* firm can be easily deterred from entering the market if the incumbent rival commits to a high level of R&D effort. Tough competition reduces the firm's value and the income pledgeable to external investors, making it impossible for the firm to get funded and enter the market.[4] Deterring entry of a subsidiary of an holding group is more difficult: faced with a tougher rival, the potential entrant will be 'subsidised' through the parent company's internal capital market. This infusion of internal assets will allow entry in spite of the aggressive strategy of the rival. Anticipating this, the rival is discouraged from adopting such entry deterrence strategies. In this sense, the internal capital market acts as a credit line contract with a bank aimed at deterring predation by long purse rivals.

More generally, a strategic move making the rival more aggressive does not only spur a product market response from the subsidiary manager. It also induces a capital infusion in favour of that subsidiary. This alleviates the impact of the rival's strategic move in two ways. First, the value of the business unit is increased due to the capital infusion, which counteracts the loss in profitability caused by having a tougher rival. This is the "pro-entry" effect described in the previous paragraph. On top of this, the cash infusion makes the manager tougher when it competes in strategic substitutes and softer when it competes in strategic complements. This reduces the subsidiary's responsiveness to the rival's effort choice, i.e. the slope of its reaction function, and thus discourages the incumbent from making any strategic commitment when entry is accommodated.[5] Overall, subsidiaries of an holding company are 'protected' against the rivals' strategic moves. While this is always desirable when these are aimed at deterring entry, when entry is accommodated, conglomerate entry may also bring about some costs with respect to independent entry, as being less responsive to the incumbent's effort choice discourages any pro-collusive strategic move.

Second, we study the entry process in markets where the subsidiaries of a business group are the incumbent firms. We show that capital reallocation operated within the conglomerate creates a link between otherwise separate markets and may enable the business group to extend lack of competition in one market to another market where the scope of competition is, in principle, wider. As a result, conglomeration makes entry less likely in all the markets where its subsidiaries operate and correlates the probabilities of entry in markets completely unrelated

[4]This is simply the idea that a 'short purse' firm is vulnerable to predatory strategies aimed at deterring entry or inducing exit from the market. On this, see Telser (1966) and Bolton and Scharfstein (1990).

[5]As Fudenberg and Tirole (1984) point out, when entry is accommodated, the incumbent's incentives to make strategic commitments depend on the sign and the intensity of the *strategic effect*, which in turn is determined by the slope of the entrant's reaction function.

in any other respect. Note that, in our model, this occurs despite the allocation of internal resources is not observable and cannot be used as a commitment device to deter entry.

This paper contributes to the theoretical research on the interaction between corporate financial decisions and product market competition. Financial policy may affect the market game in several ways. It can make a firm more or less vulnerable to predation (Bolton-Scharfstein, 1990), commit the firm to a particular market strategy (Brander-Lewis, 1986), or convey signals to the firm's competitors (Gertner-Gibbons-Scharfstein, 1988). Financial policy matters also in that it can facilitate collusion among competing firms (Maksimovic, 1988), or create 'financial barriers' to entry in the product market (Cestone-White, 1998). Ours is the first attempt to analyse the effect of *internal* capital market decisions on product market competition.

Our work also brings new policy implications on the competitive impact of conglomerate mergers. Competition policy theorists have focussed mainly on the *real* effects of mergers on competing firms. Conversely, we point at the interplay between a merger's effect on firms' financial conditions and product market behaviour. This interplay, however, operates in a less simplicistic way than the standard view predicts and the impact of conglomerate mergers on competition may be more delicate to assess than what appears at first sight. For instance, even if by becoming part of a business group a firm may benefit from subsidisation from the parent company, it is not necessarily made a tougher product market competitor. Hence, a conglomerate merger ought not to be necessarily suspected with an anti-competitive implication. Indeed, by merging with a financially healthy unit, a new-born firm becomes able to deter the rivals' predatory behaviour. To the extent where this is aimed at deterring entry/inducing exit, the merger will positively impact consumer' surplus. Viceversa, we show that conglomeration may give raise to anticompetitive concerns even if it is assumed out that a richer endowment of financial resources can be used as a commitment to a predatory behaviour. For instance, through subsidisation operated by the Internal Capital Market, conglomerate mergers between established firms may have an anticompetitive impact in the markets where the firms operate, in spite of the fact that these markets are completely unrelated in any other respect. More generally, our analysis implies that merger investigations should carefully take into account the joint effect of mergers on firms' finance and competitiveness.

2.2 Capital allocation within an holding group

2.2.1 The model

In this section we abstract from product market competition, in order to focus on the functioning of internal capital markets. We analyse the optimal allocation of resources within a holding group composed of two subsidiaries (business units) running independent projects.

Each subsidiary is run by a manager,[6] who needs to invest an amount I in order to start a project, and is endowed with an amount of assets $\frac{A}{2}$. These can be thought of as a subsidiary's retained earnings, liquid assets, and any other asset that can be pledged as collateral and help raise funds on the external capital market. The headquarter of the holding group has the control rights on total internal resources A. In other words, the headquarter has the right to appropriate and redistribute subsidiaries' assets: he can seize the subsidiaries' total resources A and allocate A_1 and A_2 to subsidiaries 1 and 2, provided $A_1 + A_2 = A$.

After subsidiary division managers are assigned $A_i \leq I$ by the headquarters, they must resort to outside investors to obtain the additional funds $I - A_i$. Outside investors are completely passive in our model. We just require that they break even in order to be willing to finance a project.

Projects:

Once started, each project is subject to moral hazard. After the project is financed, manager i chooses a level of R&D effort e_i to develop a new product. The level of effort is observed by neither the headquarters nor the external investor. The manager also chooses a *verifiable* action a_i. This variable represents those actions like hiring a monitor or release control rights to investors, that enhance the expected profitability of a project and yet can be contracted upon.[7] With probability $z_i = e_i + a_i$ subsidiary i succeeds in developing a new product and yields the return π_i. With probability $1 - z_i$, the project fails and the return is 0.

Preferences:

All agents are risk-neutral. Each subsidiary manager enjoys a private benefit B from running

[6]The assumption that each subsidiary is run by a different manager rules out any diversification effect à la Diamond (1984), whereby cross-pledging the income of various projects run by the same manager improves the latter's incentives and thus the firm's borrowing capacity.

[7]See footnote 15 later.

a project. Effort e_i has a private cost $C(e_i)$ to the manager. We assume that $C(e_i)$ takes the following form:

$$C(e_i) \equiv \begin{cases} \frac{\beta}{2}(e_i - \widetilde{e})^2 & \text{when } e_i \geq \widetilde{e} \\ 0 & \text{when } e_i < \widetilde{e} \end{cases}$$

with $\frac{\pi}{\beta} < \widetilde{e} < 1$.[8]

The verifiable action also has a private cost γa_i. We assume $\gamma > \frac{\pi_i \beta \widetilde{e}}{\beta \widetilde{e} - \pi_i}$, that is, a is relatively more costly than effort. This assumption ensures that - whenever possible - it is more efficient to increase the expected profitability of a project by inducing a high level of effort through managerial incentives, rather than contracting on a high level of a_i.

Timing:

The timing of events is as follows (see also Figure 2-1):

t=0 (Internal capital market allocation) The headquarters seizes total resources A and allocates A_1 and A_2 to subsidiaries 1 and 2.

t=1 (Financial contracting) Each subsidiary manager raises $I - A_i$ on the external capital market and signs a contract with outside investors.

t=2 Returns are realised and outside investors are paid according to the financial contracts.

Financial contracts:

The modelling of the financial contracting sub-game follows Aghion-Dewatripont-Rey (1998). Each manager raises funds $I - A_i$ on the external capital market and contracts on the outside investor's share of returns (α_i) and on the verifiable action a_i.

To derive the optimal allocation of total internal resources we solve the game backward. Hence, we first study the managers' financial contracting problem for any given level of internal funds. Then, we analyse how internal funds should be assigned to subsidiary managers in order to maximise the holding group's value.

[8] $\widetilde{e}$ can be interpreted as the minimum level of effort under which managerial moral hazard is detected. Obviously, the optimal level of effort will always lie above $\widetilde{e}$.

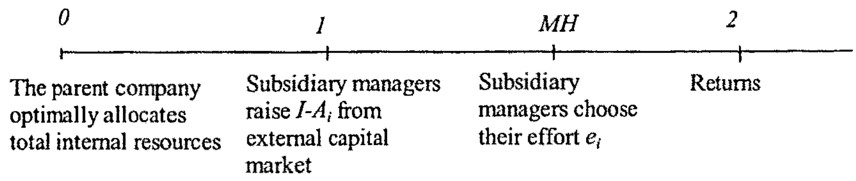

Figure 2-1: *Time – line*

2.2.2 Discussion: What is an internal capital market?

In our model, an internal capital market is characterised by headquarters' control over subsidiaries' assets.[9] This feature has already been emphasised in previous theoretical work on ICMs (Gertner, Scharfstein and Stein, 1994, Stein, 1997, and Matsusaka-Nanda, 1999). Standalone firms seek funds on the external market using their own assets as collateral. As the amount of internal assets determines the financial contract with outside investors (and thus the firm's incentives), the value of each firm depends solely on *that firm*'s cash and collateralisable assets. Conversely, in an internal capital market, the headquarters has the authority to shift resources across business units, so that subsidiaries' values are jointly determined. For instance, "headquarters can draw on the collateral value of project 1 to obtain funds, but then pass these funds to project 2" (Stein, 1997). This authority marks the difference between corporate headquarters and a common outside lender.

An important question is then why should individual firms decide to commit their resources to a common party. Our paper cannot give an answer to this question, as the merger stage is not modelled explicitly.[10] Let us simply point out that firms may bear some ex-ante uncertainty about the profitability of their projects, their R&D costs, or the strength of product market rivals, and thus be willing to share risk. Creating an holding group by putting all assets under

[9] We do not assume, neither endogenously derive, stronger monitoring incentives for headquarters. Consequently, the latter has no informational advantage with respect to outside investors.

[10] Our focus is on the product market behaviour of an already established holding group, not on the incentives to carry out a conglomerate merger. Obviously, the analysis indirectly sheds light on some benefits and costs of mergers that have not been studied so far.

the same roof is then a way to implement a risk-sharing contract between firms that is unlikely to be enforceable in reality. Credit line contracts are an alternative way to share risk among different firms. However, credit lines are usually not contingent on firms' ex-post conditions, whereas in our model the headquarters' optimal allocation rule does depend on parameters such as the degree of competition in each respective market.

Our model assumes that subsidiary managers are assigned assets A_1 and A_2 by corporate headquarters, and then raise additional funds on the external market. This setting well describes the functioning of a *holding group*, an organisational structure adopted by many diversified conglomerates. Within a holding group, different business units (or *subsidiaries*) have the formal authority to sign financial contracts with outside investors. Yet, the parent company, holding a majority of shares, has control on the subsidiaries' assets, which allows a consistent reallocation of resources to take place within the group. This suggests that holding groups, as well as multidivisional firms, are an important example of internal capital markets.[11]

Modelling the internal capital market also requires to define the headquarters' objectives. We assume that the headquarters maximises the subsidiaries' total value (that is, the NPV plus the benefit from running the project). The assumption that the headquarters internalises subsidiary managers' private benefits may seem questionable. We motivate this assumption on two grounds. First, if we view conglomeration as a risk-sharing contract among entrepreneurs, then the latter will design the common party's incentives so as to *internalise* the private benefits from running their projects. Second, the assumption captures the idea that headquarters also enjoys *its own* private benefit from having one more subsidiary under control.[12] This idea is confirmed by the observation that headquarters, differently from external investors, have a bias towards continuation of projects that take a long time to show positive profits.[13]

[11]For instance, Houston et al.(1997) and Houston and James (1998) find that, in bank holding companies, "subsidiary loan growth is more closely tied to the cash flow and capital position of its holding company than it is to the bank's own cash flow and capital position. This evidence suggests that multiple bank holding companies establish internal capital markets to allocate scarce capital within the organisation."

[12]Stein (1997) assumes that control rights allow the headquarters to appropriate a fraction ϕ of the private benefits associated with any project it oversees.

[13]For instance, Biggadike (p. 209) argues that "the established firm does provide an environment in which .... early mistakes can be tolerated; some extra time to make good provided. Capital markets do not provide this environment." The headquarters' bias for continuation can then result by the design of headquarters' incentives (as suggested in the first point), or rather be a side-product of the top management career concerns, as subsidisation of unprofitable projects may 'cover up' early mistakes in project selection.

2.2.3 The subsidiary manager's fund raising problem

At date 1, for a given level of A_i, subsidiary manager i offers outside investors a contract $\{\alpha_i, a_i\}$ that solves:

$$\max_{e_i, a_i, \alpha_i} \quad [(1-\alpha_i)(e_i+a_i)\pi_i - C(e_i) - \gamma a_i + B - A_i]$$

$$\begin{aligned} &\text{s.t. } 0 \leq \alpha_i \leq 1, \quad e_i \geq 0, \quad a_i \geq 0, \qquad e_i + a_i \leq 1 \\ &\alpha_i (e_i + a_i)\pi_i \geq I - A_i \qquad (IR) \\ &e_i \in \arg\max_{\widehat{e}} \ (1-\alpha_i)(\widehat{e}_i + a_i)\pi_i - C(a_i, \widehat{e}_i) \quad (IC) \end{aligned}$$

where B is the private benefit from running the project[14]. The constraint (IR) ensures that outside investors are willing to finance the project. (IC) is the manager's incentive constraint.

As proved in the ADR model, the solution to this problem depends on the amount of internal financial resources available to the manager. This is stated in the following lemma:

Lemma 2 *The solution to the subsidiary manager's financial contracting problem is characterised as follows:*

- if $A_i \geq \widetilde{A_i} \equiv I - \widetilde{e}\pi_i$ **(shirking region)**:

  $\alpha_i^* \leq 1, \ \ a_i^* = 0$, and e_i^* is the largest solution to the equation:

  $$e_i[\pi_i - \beta(e_i - \widetilde{e})] = I - A_i$$

- if $A_i < \widetilde{A_i}$ **(bonding region)**

  $\alpha_i^* = 1, \ \ a_i^* = \frac{I-A_i}{\pi_i} - \widetilde{e}$, and $e_i^* = \widetilde{e}$

Proof. See Aghion, Dewatripont, Rey (1998) ■

[14] We assume that the private benefit is high enough for the manager to be always willing to undertake the project (as long as she can convince outside investors to finance it). More formally, we require that $B \geq \gamma\left[\frac{I}{\pi} - \widetilde{e}\right]$.

The intuition for this result is the following: as the verifiable action a_i is very costly, the manager avoids to resort to it unless external financial needs $(I - A_i)$ are very large. Managers that do not need outside finance at all set a_i and e_i so as to maximise the project's net present value. As $\gamma > \pi_i$, Net Present Value maximisation requires that $a_i = 0$. When external financial needs are small (*shirking region*), the firm can still obtain funding without resorting to costly commitments. Thus, the optimal contract sets $a_i = 0$ as in the first best. In this region, when the external financial needs increase slightly, the firm gives investors a higher share of returns α_i (which reduces the manager's incentives and hence e_i^*), but does not contract on a higher level of the costly action. Conversely, when external financial needs are large (*bonding region*), the firm leaves all the monetary returns to investors. Thus, the manager is obliged to take the costly but verifiable action a_i in order to increase the investor's expected repayment and obtain additional funds.[15]

From the above solution, we obtain the value of each business unit as a function of internal resources A_i:

$$V_i(A_i) \equiv \begin{cases} \left(\frac{\gamma}{\pi_i} - 1\right) A_i - \frac{\gamma}{\pi_i} I + \gamma \widetilde{e} + B & \text{if } A_i < \widetilde{A_i} \\ e_i^*(A_i, \pi_i)\, \pi_i - \frac{\beta}{2}\left(e_i^*(A_i, \pi_i) - \widetilde{e}\right)^2 - I + B & \text{if } \widetilde{A_i} \leq A_i < I \end{cases}$$

As expected, $V_i(A_i)$ is increasing in the amount of internal resources. Internal resources alleviate the manager's fund raising problem by reducing her reliance on outside finance. In particular, in the *bonding region*, the larger is A_i (the smaller the external financial needs), the lower is the level of the costly action a_i^* necessary to obtain outside funds. In the *shirking region*, a larger A_i allows to reduce the share of profits α_i to be left to outside investors and thus to improve managerial incentives. In both cases, the increase in A_i raises the business unit's value.

[15]This illustrates a more general principle in corporate finance that weak entrepreneurs may be obliged to take inefficient actions in order to get their projects funded. These are actions that reduce the firm's net present value but increase its repayment capacity, and thus the availability of external funds. For instance, hiring a monitor may alleviate agency problems and thus increase the income pleadgeable to investors, but it also imposes an extra cost on the firm. Thus, only firms with large financial needs hire a monitor (i.e. borrow from a bank), while well-capitalised firms typically borrow from uninformed investors. For this result, see Holmström-Tirole (1997). Relinquishing control rights to investors is another way of increasing the pledgeable income, though imposing a private cost on the entrepreneur. Indeed, only young and badly capitalised firms leave much control to investors (venture capital contracts are an example).

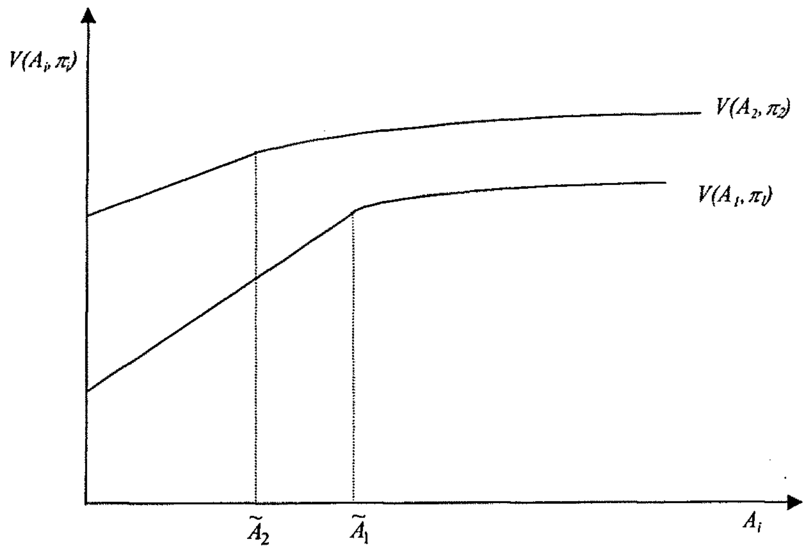

Figure 2-2: $\pi_1 < \pi_2$.

The objective of next subsection is to analyse how internal funds should be allocated between two subsidiary managers with different projects. To do so, we will assume that the two projects differ in their profitability π_i, and ask whether *additional internal assets* are more valuable to more or less profitable business unit. Our results are based on the following Lemma (see also figure 2-2).

Lemma 3 *Suppose the two subsidiaries have different profitability levels:* $\pi_1 < \pi_2$. *For the less profitable subsidiary:*

- *the bonding region is wider:* $\widetilde{A}_1 > \widetilde{A}_2$
- *the value function is shifted downwards.*
- *the value function is uniformly steeper.*

Proof.

- From the definition $\widetilde{A_i} \equiv I - \widetilde{e}\pi_i$, it follows immediately that $\frac{\partial \widetilde{A}}{\partial \pi} < 0$. Outside investors are less willing to finance less profitable projects. Thus, for worse projects, the threshold level of internal finance below which the manager must resort to action a_i is higher.

- In the *shirking region:* $\frac{\partial V}{\partial \pi_i} = \frac{\partial NPV_i}{\partial \pi_i} + \frac{\partial e^*}{\partial \pi_i}\left[\frac{\partial NPV_i}{\partial e_i}\right] = e_i^* + \frac{\partial e^*}{\partial \pi_i}\left[\pi_i - \beta(e_i^* - \widetilde{e})\right] > 0$

  This is always true, as:

  e_i^*solution to $e_i^*\left[\pi_i - \beta(e_i^* - \widetilde{e})\right] = I - A_i$ implies: $\left[\pi_i - \beta(e_i^* - \widetilde{e})\right] \geq 0$, and $\beta e^* > \beta\widetilde{e} > \pi$ implies: $\frac{\partial e^*}{\partial \pi_i} = \frac{e^*}{2\beta e^* - \beta\widetilde{e} - \pi} > 0$. Note that a decrease in project profitability has a direct impact on the subsidiary's NPV, and an indirect impact through reduced incentives.

  In the *bonding region:*

  $$\frac{\partial V}{\partial \pi_i} = \frac{\gamma}{(\pi_i)^2}(I - A_i) > 0$$

  A decrease in π_i makes it more difficult to raise funds. Thus, the subsidiary manager must choose a higher level of a_i. This allows the project to be funded but reduces its NPV. Finally, in $A_i = \widetilde{A_i}$ the derivative $\frac{\partial V}{\partial \pi_i}$ does not exist, but it can easily be checked that $V(\pi_1) < V(\pi_2)\ \forall \pi_1 < \pi_2$ in these kinks.

- In the *shirking region:*

  $$\begin{aligned}\frac{\partial^2 V}{\partial A_i \partial \pi_i} &= \frac{\partial^2 e_i^*}{\partial A_i \partial \pi_i}\left[\frac{\partial NPV_i}{\partial e_i}\right] + \frac{\partial e_i^*}{\partial A_i}\left[\frac{\partial^2 NPV_i}{\partial e_i \partial \pi_i}\right] = \\ &\frac{\partial^2 e_i^*}{\partial A_i \partial \pi_i}\left[\pi_i - \beta(e_i^* - \widetilde{e})\right] + \frac{\partial e_i^*}{\partial A_i}\left[1 - \beta\frac{\partial e_i^*}{\partial \pi_i}\right]\end{aligned}$$

  which is strictly smaller than zero. A decrease in π_i has two effects on the slope of the value function. The first term in the above expression is the *incentive effect*: the smaller π_i, the more serious the incentive problem, the higher the positive impact of additional internal resources on effort $\left(\frac{\partial^2 e_i^*}{\partial A_i \partial \pi_i} < 0\right)$ and hence on net present value $\left(\frac{\partial NPV}{\partial e_i} > 0\right)$. On top of this, for a smaller π_i, the increase in effort due to more internal resources $\left(\frac{\partial e_i^*}{\partial A_i}\right)$ has a stronger impact on net present value $\frac{\partial^2 NPV}{\partial e_i \partial \pi_i} < 0$ *(convexity effect).*

In the *bonding region:*

$$\frac{\partial^2 V}{\partial A_i \partial \pi_i} = -\frac{\gamma}{(\pi_i)^2} < 0$$

An increase in internal resources allows the manager to commit to a lower level of the costly action. This effect is more beneficial the more she is desperate for funds, that is the lower is π_i.[16]

■

Lemma 3 implies that *internal funds are more valuable to less profitable business units.* The intuition for this result is quite simple. Internal financial resources are valuable in that they alleviate the subsidiary manager's agency problem vis à vis external investors. Less profitable subsidiaries suffer more serious agency problems; thus, for these business units, the marginal benefit associated with an increase in internal resources is higher. We now turn to the optimal allocation of resources within the holding group.

2.2.4 The Headquarter's problem

At date 0, the headquarters allocates A_1 and A_2 to each subsidiary in order to maximize the sum of their expected surplus, given the amount of total internal resources A it is endowed with:

$$\max_{A_1, A_2} V(A_1, \pi_1) + V(A_2, \pi_2)$$

$$s.t. \quad A_1 + A_2 = A$$

From Lemma 3, it follows immediately that the optimal allocation of internal resources is as stated below:

Proposition 4 *Within an internal capital market the optimal allocation rule is such that internal resources always flow from more profitable to less profitable subsidiaries.*

Proof. See Appendix B for a detailed solution. ■

[16]See Appendix A for a more formal proof.

Internal financial resources matter because they reduce the managers' agency problem vis à vis external investors. This problem is exacerbated for a less profitable business unit, which makes additional internal resources more valuable to it. This justifies weak business units' subsidisation in holding groups. Our result is consistent with previous empirical work showing that resource allocation in diversified firms seems to ignore traditional market indicators of the value of investment such as Tobin's q.[17]

In our simple setting, the internal capital market creates value as it minimises total agency costs *by smoothing incentive problems across business units.* We assumed out any informational advantage of conglomerate headquarters with respect to external investors. Yet, the ICM has still a valuable role, due to its control right over subsidiary assets.[18] Stand alone firms cannot implement the "robin hood" allocation rule stated above, as ex-post rich entrepreneurs would never relinquish their assets in order to help weaker firms. They can commit to do so ex-ante, by giving the property right on their assets to a common party. This, in our view, is a main consequence of conglomerate mergers.[19]

One important caveat is that the allocation of total financial resources follows criteria which are different from the ones driving the allocation of internal assets. Obviously, headquarters will never subsidise, but rather will shut down business units with a negative value. One may then argue that if the private benefit B was not included in the headquarters' objective function, the headquarters would also shut down subsidiaries in the bonding regime (as in this regime, the NPV is always negative), and channel funds to new projects. Thus, the assumption that a subsidiary's value to the headquarters includes the manager's private benefit seems to play a crucial role. We motivated this assumption in section 2.2.2. Moreover, even if headquarters only cared about subsidiaries' NPV, 'bonding' business units would not exist but the rest of our analysis would still hold for the shirking case.

[17] Lamont (1997) finds that that when oil companies' profits were hurt by the 1986 oil crisis, investment was cut not only in oil-related divisions but also in nonoil-related divisions. This suggests that the cash flow generated by more profitable oil segments was partly transferred to non-oil segments, that is, poor-divisions subsidisation did take place.

[18] Control rights over assets also mark the difference between internal and external capital markets in Gertner-Scharfstein-Stein (1994). In their model, though, the headquarters' control rights create value by improving the headquarters' monitoring incentives, and thus endogenously generating an informational advantage over outside (common) lenders.

[19] On this, see the discussion in section 2.2.2.

The solution to the headquarters' optimization problem is presented in detail in Appendix B. Here we just point out that the optimal allocation changes according to the total amount of internal resources. Roughly speaking, if A is sufficiently high, total resources will be allocated so that both business units remain in the shirking region, but the weaker subsidiary receives relatively more ($A_1^* > A_2^*$). If A is not too high, it is optimal to transfer internal resources to the less profitable subsidiary until this is pushed to the boundary between the bonding and the shirking region ($A_1^* = \widetilde{A}_1$), and assign the residual resources to the more profitable business unit. The intuition is that lying in the bonding region is very costly, in particular for the less profitable subsidiary; hence it is always optimal to avoid this to be the case. Finally, if A is very low, the weaker business unit is pushed as close as possible to the bonding-shirking threshold, by receiving all internal resources ($A_1^* = A$).

2.3 Capital allocation and product market behaviour

We now turn to analyse how internal capital allocation interacts with subsidiary managers' product market behaviour. Our objective is to explore whether business units of an holding group do enjoy a competitive advantage with respect to stand-alone firms, as conventional wisdom suggests.

The timing is the same as in the basic model presented in section 2.2, except that now business units compete on the product market. At date 0 the headquarters allocates A_1 and A_2 to each subsidiary. At date 1 each manager writes a contract $\{\alpha_i, a_i\}$ with outside investors to raise the amount $I - A_i$ from the external capital market and chooses her level of unverifiable effort e_i. At date 2 competition takes place and returns are realised.

Product market competition

Subsidiary 1 and subsidiary 2 operate in separate product markets. Thus, they differ in that they may be faced with more or less aggressive competitors. To simplify the analysis, we assume that subsidiary 1 competes in a duopolistic market while subsidiary 2 is a monopolist in its own market (assuming that subsidiary 2 just operates in a less competitive oligopolistic market would not add much insight to the analysis). We denote with R subsidiary 1's rival. Competition between firm R and subsidiary 1 is modelled following Aghion-Dewatripont-Rey (1998): a firm (subsidiary) receives the return π only if its project succeeds and the rival's project does not. This is the case, for instance, when R&D for a new product is being carried out, and Bertrand competition takes place between successful innovators. Under this assumption, firm i's project (with $i = 1, R$) generates a positive return with probability $z_i(1 - z_j)$ with $i \neq j$ and $z_i = a_i + e_i$.

Simultaneous financial contracting

We assume that firms (subsidiaries)' managers *simultaneously* write their contracts with external investors and pick their R&D effort. As in Aghion-Dewatripont-Rey, this rules out any commitment effect associated with the choice of contracts: "the firms' choices of contracts and levels of effort are based on their expectation regarding the other firms' contracts and efforts...the contract actually signed by one firm cannot affect its rival's strategic choice and the firm will not try to manipulate its rivals' strategies when determining the terms of its own contract."[20] Moreover, we assume that internal capital market allocations are not observable by product market rivals (or equivalently that the headquarter cannot credibly commit to a given allocation of internal funds). This second assumption rules out the possibility of a strategic allocation of internal funds. In spite of this, we will show that capital reallocation within the conglomerate allows subsidiaries to compete in a different way than stand-alone firms.

We solve the game backward, starting with the managers' financial contracting problem. We focus on subsidiary 1 (the competing subsidiary) since the problem for subsidiary 2 is the same as in the previous section.

2.3.1 The competing managers' fund raising problem

For simplicity, we assume that firm R has internal resources equal to I. In other words, firm R does not need to resort to outside investors to develop its project. Therefore, at date 1, for a given value of subsidiary 1's effort z_1, firm R picks the first best levels of verifiable and unverifiable effort so as to maximise:

[20]This is equivalent to assuming that contracts are observable but can be secretly renegotiated. This is a main difference between our view of the product market effects of financial contracts, and Brander-Lewis' (1986) argument that financial contracts are credible commitments.

$$\max_{a_R, e_R} \quad \left[(e_R + a_R)(1 - z_1)\pi - C(e_R) - \gamma a_R + B - I\right]$$

$$\text{s.t.} \quad e_R \geq 0, \quad a_R \geq 0, \quad e_R + a_R \leq 1$$

The solution is:

$$a_R = a^{FB} \equiv 0 \qquad e_R = e^{FB} \equiv \widetilde{e} + \frac{\pi(1 - z_1)}{\beta}$$

which characterises firm R's best reply function as: $z_R(z_1) = \widetilde{e} + \frac{\pi(1-z_1)}{\beta}$.

Subsidiary 1's manager, for any level of internal funds A_1 and for any level of the rival's effort z_R, offers outside investors a contract $\{\alpha_1, a_1\}$ that solves:[21]

$$\max_{a_1, \alpha_1, e_1} \quad \left[(1 - \alpha_1)(e_1 + a_1)(1 - z_R)\pi - C(e_1) - \gamma a_1 + B - A_1\right]$$

$$\begin{aligned} &\text{s.t. } 0 \leq \alpha_1 \leq 1, \quad e_1 \geq 0, \quad a_1 \geq 0, \quad e_1 + a_1 \leq 1 \\ &\alpha_1 (e_1 + a_1) \pi_1 (1 - z_R) \geq I - A_1 \qquad (IR) \\ &e_1 \in \arg\max_{\widehat{e}_1} \ (1 - \alpha_1)(\widehat{e}_1 + a_1)\pi_1(1 - z_R) - C(a_1, \widehat{e}_1) \qquad (IC) \end{aligned}$$

This programme is analogous to the one analyzed in section 2.2, where π must be replaced with $\pi(1 - z_R)$. Therefore, the solution follows Lemma 2, with $\pi(1 - z_R)$ substituting π:

Lemma 2-bis (Aghion-Dewatripont-Rey,1998) *The solution to the competing subsidiary's programme is the following:*

- if $A_1 \geq \widetilde{A_1} \equiv I - \widetilde{e}\pi(1 - z_R)$ *(shirking region):*

$\alpha_1^* \leq 1, \ a_1^* = 0, \ e_1^*(A_1, \widetilde{z}_R)$ is the largest solution to:

$$e_1 \left[\pi(1 - z_R) - \beta(e_1 - \widetilde{e})\right] = I - A_1$$

[21] As competition reduces firm's NPVs, the private benefit B must satisfy the stricter condition: $B \geq \gamma \left[\frac{I}{\pi\left(1 - \widetilde{e} - \frac{\pi(1-\widetilde{e})}{\beta}\right)} - \widetilde{e}\right]$ to ensure that the project's social value is positive.

- if $A_1 < \widetilde{A_1}$ *(bonding region):*

$\alpha^* = 1 \quad a_1^* = \frac{I - A_1}{\pi(1-z_R)} - \widetilde{e} \quad e_1^* = \widetilde{e}$

Note that an increase in the rival firm's effort z_R has the same impact on subsidiary 1 as a decrease in profit π, since z_R and π are relevant to subsidiary 1 only through its perceived profit $(1 - z_R)\pi$. This solution allows us to obtain the value function of subsidiary 1 for any level of the rival's effort z_R (the value function of subsidiary 2 is the same as in section 2.2.3, assuming $\pi_2 = \pi$):

$$V(A_1, z_R) \equiv \begin{cases} \left(\frac{\gamma}{\pi(1-z_R)} - 1\right) A_1 - \frac{\gamma}{\pi(1-z_R)} I + \gamma\widetilde{e} + B & \text{if } A_1 < \widetilde{A_1}(z_R) \\ e_1^*(A_1, z_R)(1 - z_R)\pi - \frac{\beta}{2}(e_1^*(A_1, z_R) - \widetilde{e})^2 - I + B & \text{if } \widetilde{A_1}(z_R) \le A_1 < I \end{cases}$$

From Lemma 3, one can immediately argue that an increase in the rival's effort z_R (a decrease in perceived profit $(1 - z_R)\pi$) shifts the value function downwards and makes it steeper. The latter is stated in the following:

Lemma 5 *Product market competition reduces a subsidiary's value and makes it more heavily dependent on the availability of internal assets. Subsidiaries facing more aggressive competitors then have a higher shadow value of assets.*

Proof. Increasing z_R is equivalent to reducing π in the model of section 2.2. Thus, from Lemma 3 it follows that: $\frac{\partial^2 V}{\partial A \partial z_R} > 0$. ■

2.3.2 How conglomeration affects competition

Since we assumed that the internal allocation of assets is not observable, the headquarters chooses A_1 and A_2 taking z_R as given. Hence, at date 0, for each possible level of z_R, the headquarter maximizes the joint value of the two business units:

$$\max_{A_1, A_2} V(A_1, z_R) + V(A_2)$$

$$s.t. \quad A_1 + A_2 = A$$

The solution to this problem gives rise to an optimal allocation of assets, $A_1^*(z_R)$, for any possible level of the rival's effort z_R. From Lemma 5, the following Proposition can be proved to hold:

Proposition 6 *Within an holding group, subsidiaries operating in a more competitive environment are assigned relatively more assets by corporate headquarters: $A_1(z_R) > A_2$ for any $z_R > 0$. Moreover, as a subsidiary's rival gets tougher (z_R is increased), more assets are assigned to that subsidiary (A_1^* is increased).*

The above result confirms the conventional wisdom about diversified conglomerates that *cash flows from monopolistic divisions are partly used to subsidise divisions competing in the product market.* In much economic literature, this statement has been meant to imply that such subsidisation has anti-competitive effects.[22] Our analysis shows that this is not necessarily the case.

Let us now compare the product market behaviour of subsidiary 1 to the behaviour of a stand-alone firm headed by an independent entrepreneur, endowed with the same project (with profitability π) and the same *initial* amount of assets ($\frac{A}{2}$). In both cases, the amount of internal assets determines the manager's incentives and thus the intensity of R&D effort exerted. The subsidiary's resources, though, are endogenously determined by the capital allocation decisions of the parent company. By Proposition 6, we know that subsidiary 1 receives internal assets from subsidiary 2. Thus, at date 1 it is endowed with an amount of assets $A_1^*(z_R)$, which is larger than its initial assets $\frac{A}{2}$ for any $z_R > 0$. *Will this make subsidiary 1 a tougher competitor than a stand-alone firm?* The following proposition shows that the answer crucially depends on the level of initial assets $\frac{A}{2}$.

Proposition 7 *For any level of the rival's effort z_R, there exists a threshold level of assets $\overline{A}(z_R)$ such that a stand-alone firm endowed with $\frac{A}{2} \geq \frac{\overline{A}(z_R)}{2}$ $\left(\frac{A}{2} < \frac{\overline{A}(z_R)}{2}\right)$ will compete more softly (toughly) than a business unit of an holding group being subsidised by the parent company.*

Proof. See Appendix C. ∎

[22] For instance, it has been maintained that "conglomerate size is especially conductive to predatory pricing" as a division may "subsidise its predatory operations with profits from other markets" (Scherer, pp. 335-336).

Subsidisation does not always spur a business unit's competitiveness. In our model, managers under a tight leash (that is, in the *bonding regime*) are the most likely to compete fiercely: they are ready to pay a high private cost in order to commit to a tough behaviour and get their projects funded. Subsidising a business unit in the bonding regime has thus a perverse effect: the manager, no longer under the pressure that her project is shut down, "takes it easy" and fights *less aggressively* against competitors. Conversely, a manager in the *shirking regime* knows that her position is safe. Thus, her effort just responds to monetary incentives. When her business unit is subsidised, the manager can keep a higher share of the profits for herself, and therefore competes *more aggressively* so as to increase her monetary returns.

These results show that the product market behaviour of a business unit of an holding group differs substantially from that of a stand-alone firm, but they also suggest that the traditional view on the anti-competitive impact of conglomeration is too simplistic. Conglomeration affects competition also through the entry process. Thus, before proceeding to a policy analysis, we study the entry problem for a subsidiary of an holding group.

2.4 Application 1: Conglomerate entry

A complete analysis of the competitive effects of conglomeration must take into account the effectiveness of conglomerate entry into new markets. The idea that "entry is much freer, and presumably more effective than we had believed while thinking in terms of new-firm entry only" dates back to the late 50s.[23] In his analysis of entry into the computer industry, Brock (1975) maintains that "the only method of entry is... by subsidisation of the computer effort from other activities of the corporation (as RCA and General Electric did before their withdrawal)". And in a recent empirical study, Dunne, Roberts and Samuelson (1988) find that the patterns of entry, growth and exit for new firms differ substantially from the ones of conglomerates that diversify by entering into a new industry. All these works stress "the need for a theory of entry that includes diversification by already existing firms" (Biggadike, 1979).

Economic intuition suggests that subsidisation of the entrant business unit by the parent company should make life easier for the former. Indeed, we can show that - owing to the

[23] See Hines (1958), p. 133.

capital reallocation process within the ICM - subsidiaries of holding groups are 'protected' against incumbents' strategic moves aimed at deterring entry. To this purpose, we modify our model to include an initial entry stage. At this stage, the incumbent firm R can credibly commit to a product market behaviour different from the ex-post optimal one. After observing this commitment, the holding group plans whether to enter or not in the industry by promoting subsidiary 1's activity. The rest of the timing is the same.

To see why the entry problem for a business unit is peculiar, consider the case of an incumbent playing a "Top Dog" strategy,[24] that is, committing to a tough product market behaviour. A strategic move making the incumbent more aggressive does not only spur a product market response from the subsidiary manager. It also induces a capital infusion in favour of that subsidiary. This alleviates the impact of the incumbent's strategic move in two ways. First, the value of the subsidiary is increased due to the capital infusion, which counteracts the loss in profitability caused by having a tougher rival. Second, the cash infusion makes the manager tougher when it competes in strategic substitutes and softer when it competes in strategic complements. This reduces the subsidiary's responsiveness to the rival's effort choice, i.e. the slope of its reaction function. Owing to the above effects, the entry problem for a business unit of an holding group differs from that of a stand-alone firm, as analysed in Fudenberg and Tirole's (1984) analysis of entry deterrence and accommodation.

2.4.1 The incumbent's strategic incentives

Entry deterrence

Let us first analyse the incumbent's incentives to deter entry. Before entry takes place, the incumbent can credibly commit to a higher level of z_R (i.e. shift its own reaction function upward) by overinvesting in verifiable R&D activities. In other words, he can choose $a_R > 0$ and pay a private cost γa_R.[25] This may decrease the entrant's value until it cannot get its project funded.

A financially weak *stand-alone* firm (say, firm F) can be easily deterred from entering the

[24] For this terminology, see Fudenberg-Tirole (1984).

[25] Remember that the post-entry optimal level of a_R for the incumbent is zero, as he has no external financial needs.

market. Tough competition reduces the firm's value and the income pledgeable to external investors, making it impossible for the firm to get funded and enter the market.[26] For instance, assuming the new firm has no internal funds ($\frac{A}{2} = 0$), entry is deterred if a_R is chosen such that:

$$V_F(z_F^*(a_R), z_R^*(a_R), 0) \leq 0$$

where $z_F^*(a_R)$ and $z_R^*(a_R)$ are date-2 equilibrium R&D levels if F enters, and $z_R^*(a_R) = e_R^* + a_R$. Clearly, the optimal entry-deterrence action a_R^* is such that $V_F(z_F^*(a_R^*), z_R^*(a_R^*), 0) = 0$. The cost of deterring entry is thus γa_R^*.

Deterring entry of a business unit of an holding group is more difficult. To see this, note that the incumbent's overinvestment has a smaller impact on subsidiary 1's post-entry value $V_1(z_1^*(a_R^*), z_R^*(a_R^*), A_1(a_R^*))$:

$$\begin{aligned}\frac{\partial V_1}{\partial a_R} &= \frac{\partial V_1}{\partial z_R}\frac{dz_R}{da_R} + \frac{\partial V_1}{\partial A_1}\frac{\partial A_1}{\partial z_R}\frac{dz_R}{da_R} = \\ &\underset{(-)}{\frac{\partial V_1}{\partial z_R}} + \underset{(+)}{\frac{\partial V_1}{\partial A_1}\frac{\partial A_1}{\partial z_R}}\end{aligned}$$

the first term is the entry-deterrence effect for a stand-alone firm: a tougher rival reduces the firm's value and makes entry less profitable. This effect is alleviated for a business unit: faced with a tougher rival, the potential entrant will be 'subsidised' through the parent company's internal capital market (by Proposition 6, $\frac{\partial A_1}{\partial z_R} > 0$). As a consequence, deterring entry of subsidiary 1 requires picking $a_R > a_R^*$ and thus imposes a higher cost on the incumbent.[27] Anticipating this, the incumbent may be discouraged from adopting such entry deterrence strategy. In this sense, the internal capital market acts as a credit line contract with a bank

[26]This is simply the idea that a 'short purse' firm is vulnerable to predatory strategies aimed at deterring entry or inducing exit from the market. On this, see Telser (1966) and Bolton and Scharfstein (1990).

[27]In our model, the benefit from deterring entry of a *financially weak* stand-alone firm is also higher. Being subsidised by the parent company ($A_1^* > 0$), the business unit manager chooses a lower effort level than the stand-alone entrepreneur (see Proposition 11). Thus, the stand-alone firm is perceived as a more dangerous rival, which encourages the incumbent's entry deterrence behaviour.

aimed at deterring predation by long purse rivals.

Entry accommodation

Things are more complex when the established competitor is willing to accommodate entry. In the first stage of the game, by choosing an appropriate level of a_R, the incumbent can commit to higher or lower levels of z_R, in order to enjoy strategic gains and earns higher profits. As is well known, in case of accommodated entry the incumbent's strategic incentives depend on the nature of competition, that is on the slope of the entrant's best reply function.

In our model (as in Aghion-Dewatripont-Rey), the nature of product market competition is endogenously determined by the firms' financial conditions. A business unit with a high level of internal resources (i.e., in the shirking regime) will compete in strategic substitutes. If z_R is increased, the perceived profitability $\pi(1 - z_R)$ is decreased. In order to attract external funds, the outside investor's share of returns must be increased, weakening the manager's incentive to exert effort. Conversely, a financially weak business unit (bonding regime) will compete in strategic complements. When external financial needs are large, being confronted with a tough competitor makes it difficult to get funded. Thus, as the rival increases its R&D effort, the firm is obliged - in order to obtain external finance - to invest more in verifiable R&D activities (raise a_i) and thus increases its effort z_i.

When competition is in strategic substitutes, an incumbent firm will typically *overinvest* in verifiable R&D activities in order to make the entrant softer and increase *its own* profits. This strategic commitment is more valuable for the incumbent the larger is the *strategic effect*, i.e. the reduction in the entrant's effort following the increase in its own effort.[28] To evaluate this strategic effect, let us compute the slope of the division's best reply function. Plugging $A_1^*(z_R)$ in the solution to the manager's programme $z_1^*(z_R) = e_1^*(A_1^*(z_R), z_R)$ we obtain the *modified best response function* $z_1^r(z_R)$. Internal resources' reallocation does not only shift the best response function, as implied by Proposition 7, but also affects its slope:

[28] See Fudenberg-Tirole (1984).

$$\frac{dz_1^r(z_R)}{dz_R} = \underset{(-)}{\frac{\partial e_1^*(z_R)}{\partial z_R}} + \underset{(+)}{\frac{\partial e_1^*(z_R)}{\partial A_1}\frac{\partial A_1^*(z_R)}{\partial z_R}} < 0$$

The first term is the slope of the best reply function for a stand-alone firm, which is negative. The second term captures the *reallocation effect.* If the rival gets tougher, the headquarters subsidises the competing business unit $\left(\frac{\partial A_1^*(z_R)}{\partial z_R} > 0\right)$. The additional internal resources alleviate the manager's incentive problem and induce a higher effort. The reallocation effect partially compensates the first effect so that the "modified best reply function" is flatter than the best reply function of a stand-alone firm. *A business unit of an holding group, having a flatter reaction function, discourages the incumbent from overinvest in R&D activities, and thus is better-off.*

When instead competition is in strategic complements, an incumbent firm is willing to *underinvest* in verifiable R&D activities in order to induce a softer behaviour by the entrant. Again, this strategic commitment is less effective, as the business unit has a flatter reaction function than a stand-alone firm. In the bonding region, $z_1^*(z_R) = a_1^*(A_1^*(z_R), z_R) + \tilde{e} = \frac{I - A_1^*}{\pi(1-z_R)}$. The slope of the best-reply function is then:

$$\frac{dz_1^r(z_R)}{dz_R} = \underset{(+)}{\frac{I - A_1^*}{\pi(1-z_R)^2}} + \underset{(-)}{\left[-\frac{1}{\pi(1-z_R)}\frac{\partial A_1^*(z_R)}{\partial z_R}\right]} \geq 0$$

The *reallocation effect* is negative: since the business unit receives more resources as z_R increases, the manager has less need to increase a_1 (and therefore z_1) to raise funds. This compensates the first effect, making the subsidiary's best reply function flatter than that of a stand-alone firm. *Being less responsive to the rival's effort reduction, the business unit of an holding group discourages any pro-collusive strategic move.* When entry is accommodated and competition is in strategic complements, this may make independent entry more profitable than conglomerate entry.

We summarize these results in Figure 2-3.

		Incumbent	
		Entry accomodation	**Entry deterrence**
Business Unit 1	*Shirking region*	Less incentive to be tough	More difficult to deter entry
	Bonding region	Less (no) incentive to be soft	

Figure 2-3: *Incumbent's strategic moves*

2.5 Application 2: Endogenous Entry

In this section we assume that two subsidiaries of a business group are the incumbent firms in two independent markets, and we endogenise entry in those markets. We keep our assumption that the internal capital allocation is not observable, and thus cannot be used as a commitment device[29]. For the moment we focus only on the shirking regime. More formally, we assume that $\gamma \longrightarrow \infty$.[30]

To model the entry game we assume the following:

Potential Entrants:

There is a potential entrant for each market (denoted by R_i), whose post-entry characteristics are as described in section 2.3.1. of the paper: after entering market i, the rival competes in R&D efforts with subsidiary i. However, market i-entrant's initial investment (the entry cost) is no longer equal to I. Rather, we assume there is a continuum of potential entrants with entry costs K_i ranging from 0 to $\overline{K}$, distributed according to a cumulative function $F(K_i \mid \theta_i)$.

[29]If the internal allocation was observable, it clearly would be used as a commitment device to deter entry. Then, the subsidiary facing the more dangerous threat of entry should be subsidised in the shirking regime, and deprived of internal assets in the bonding regime. This would be an example of how entry can be deterred by "showing a long purse" to potential rivals. As this would be a straight forward application of Aghion-Dewatripont-Rey's results, we leave it aside and focus on the richer and more realistic non-commitment case.

[30]Extending the analysis to the case where one or both subsidiaries may end up lying in the bonding regime will only make the analysis richer. Along the paper, we will try to anticipate how the results will change when the bonding case is analysed.

K_1 and K_2 are independent random variables. The parameter θ_i completely characterises the cumulative function for K_i. We assume the following:

$$\forall\ \theta_{i1} < \theta_{i2} \qquad F(K_i \mid \theta_{i1}) < F(K_i \mid \theta_{i2})$$

A higher θ_i thus corresponds to a lower expected entry cost in market i. Therefore, θ is a proxy for the degree of competitiveness of a market.

As in the former part of the paper, we assume that the entrant's wealth is equal to the entry cost K_i. This implies that he always chooses his first-best R&D level. His reaction function is thus: $z_{Ri} = \widetilde{e} + \frac{\pi(1-z_i)}{\beta}$.[31]

Timing:

The timing of events in the new game is as follows (see also Figure 2-4):

t=0 Entry costs K_1 and K_2 are realised and observed by each potential entrant.

t=1 (Entry stage) Rival 1 and 2 independently choose whether to enter or not in each respective market. This decision is observed by the incumbent business group.

t=2 (Internal capital market allocation) The parent company allocates the group's internal resources to subsidiaries 1 and 2. That is, A_1 and A_2 are chosen such that $A_1 + A_2 = A$. This allocation is not observed by entrants.

t=3 (Financial contracting and product market competition) Each subsidiary manager raises $I - A_i$ on the external capital market and signs a contract with outside investors. If at t=0 entry occurred in a market, competition in R&D efforts takes place. Then, returns are realised and distributed according to financial contracts.

In what follows, we solve the game backward and describe the entry equilibria for all possible realisations of the entry costs.

[31]This assumption may be questioned, as one would expect that entrant firms are more likely to be financially constrained than incumbents are. However, the assumption is irrelevant to our results and widely simplifies the analysis, allowing us to leave aside the entrant's agency problem while focussing on the incumbent's incentives. Moreover, as it will be clear later, having a credit-constrained potential entrant would simply reinforce the logics of our results.

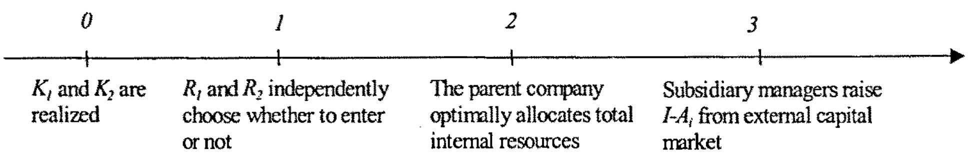

Figure 2-4: *Time − line*

2.5.1 Last stage payoffs and ICM allocation

We denote with $z_i^*(A_i)$ and $z_{R_i}^*(A_i)$ the equilibrium levels of effort exerted by subsidiary i and its rival in the last stage of the game, given that entry occurred in market i and that subsidiary i was assigned assets A_i. $V_i^C(A_i)$ and $V_{R_i}(A_i, K_i)$ are the incumbent and the entrant's values, net of agency costs. When entry did not occur at t=0, the value of the monopolistic business unit is denoted by $V_i^M(A_i)$.

The following lemma illustrates a useful and intuitive preliminary result.

Lemma 8 *The equilibrium value of a potential entrant is lower when the incumbent business unit has more internal resources:* $\frac{\partial V_{Ri}}{\partial A_I} < 0$.

Proof. The value function for entrant i is:

$$V_{R_i}(A_i, K_i) = z_R^*(A_i)\left[1 - z_i^*(A_i)\right]\pi - \frac{\beta}{2}\left[z_R^*(A_i) - \widetilde{e}\right]^2 + B - K_i$$

By the envelope theorem the derivative with respect to A_i is:

$$\frac{\partial V_{Ri}}{\partial A_i} = -z_R^*(A_i)\frac{\partial z_i^*}{\partial A_i}\pi$$

which is negative as $\frac{\partial z_i^*}{\partial A_i} > 0$. ■

Notice that we are restraining our analysis to the shirking regime. In this regime, when a subsidiary is assigned more resources, its reaction function is shifted upwards. In other words, the incumbent becomes a tougher competitor in the R&D game, which reduces the entrant's profitability.[32]

We now need to describe the optimal allocation of resources within the business group. Notice that the continuation game from t=2 onwards is the one analysed in Section 2.3. Thus, we can refer to Proposition 6, and state that, for all levels of z_{R_1} and z_{R_2}, more assets will be assigned to the business unit facing the more aggressive entrant in its own market (i.e. the higher z_{R_i}).[33] It is then straight forward to describe the ICM allocations following any entry configuration. As the entrants are identical (except for entry costs), the continuation equilibrium following entry in both markets is perfectly symmetric, with each subsidiary being assigned the same amount of internal resources $\left(A_1^* = A_2^* = \frac{A}{2}\right)$. The same holds if no entry occurs in both market 1 and 2. Conversely, if entry occurs only in market i, the continuation equilibrium is such that the business unit which has to compete is assigned relatively more resources by the parent company $\left(A_i^* > \frac{A}{2} > A_j^*\right)$.

2.5.2 Entry strategies

At stage 1, after observing the realization of K_i and anticipating the "financial reaction" of the business group, each entrant independently decides whether to enter or not its market.

Anticipating the results, if entry costs are either prohibitive or very low a firm will decide on entry independently of the other entrant's behaviour. However, for intermediate entry costs, a firm will find it profitable to enter only if entry occurs in the other market. The intuition is that an entrant keeps into account that he is competing with a business group operating in more than one market. When no firm enters the other market(s), the incumbent business unit will be subsidised, which will make entry barely profitable in its market. Conversely, when entry occurs in the other market(s), the incumbent business unit will not be subsidised and entry will be profitable for higher levels of entry costs.

It is interesting to note that even if the two markets are unrelated, firms entering each market exert a *positive externality* on each other. This externality arises because internal

[32] On the other hand, if the incumbent business unit lay in the bonding region, increasing its internal resources would soften its behaviour, thus increasing the entrant's profitability.

[33] Remember that the parent company cannot commit to an ICM allocation that is not ex-post optimal. Technically, this implies that the only credible allocation maximises the business group's value *for any given pair of the entrants' efforts* (z_{R1}, z_{R2}).

capital market decisions within the incumbent business group create a financial link between two otherwise independent markets.

Notice that the above results crucially depend on the assumption that firms lie in the shirking regime. We would get opposite results if the incumbent business units lay in the bonding regime. In such case, knowing that entry is taking place in industry j makes entry *more* profitable in market i, as the incumbent business unit is expected to be a *softer* competitor once it is subsidised by its monopolistic affiliate. Then, a firm entering market j would exert a *negative externality* on market i's potential entrants.

The following Lemma describes the entry strategies.

Lemma 9 *There exist two levels of the entry costs K^H and K^L, with $K^H > K^L$ such that the entry strategy of firm i is the following:*

- *when $K_i \leq K^L$, firm i always enters;*
- *when $K_i \in (K^L, K^H]$, firm i enters iff also firm j does;*
- *when $K_i > K^H$, firm i never enters.*

Proof. At stage 1 the potential entrant anticipates its payoff following any continuation game. If firm i decides not to enter, $V_{R_i} = 0$. Firm i's profitability from entry depends on the business group's financial reaction, and thus on the entry decision in the other market.

If firm j enters, firm i anticipates that, if he enters as well, each subsidiary will be assigned the same amount of internal resources $\frac{A}{2}$. Then its value will be: $V_{R_i}\left(\frac{A}{2}, K_i\right) = \widetilde{e}\left[1 - e_i^*\left(\frac{A}{2}\right)\right]\pi + \frac{\pi}{2}\left[1 - e_i^*\left(\frac{A}{2}\right)\right]^2 + B - K_i$. Denote with K^H the entry cost level such that $V_{R_i}\left(\frac{A}{2}, K^H\right) = 0$: given that firm j enters, firm i will find profitable to enter iff $K_i \leq K^H$.

If firm j decides not to enter, and firm i enters: market j business unit is a monopolist and thus subsidises market i business unit $\left(A_i^* > \frac{A}{2}\right)$. By Lemma 8, this reduces the equilibrium value of entrant i : $V_{R_i}\left(A_i^*, K_i\right) < V_{R_i}\left(\frac{A}{2}, K_i\right)$. Consequently, the level of entry costs K^L, such that $V_{R_i}\left(A_i^*, K^L\right) = 0$, is lower than K^H. Given that firm j stays out of its market, firm i will decide to enter iff $K_i \leq K^L$.

Overall, if $K_i \leq K^L$, "enter" is a dominant strategy for firm i; if $K_i > K^H$, "not enter" is a dominant strategy. When $K_i \in (K^L, K^H]$, firm i enters if and only if the other potential entrant does so. ■

2.5.3 The benchmark case: stand-alone incumbents

Before analysing the overall equilibria of the game, we summarise in the following lemma the equilibria of the entry game when incumbents are stand-alone firms. This benchmark case helps emphasise the effects of financial links on entry in two unrelated markets.

Lemma 10 *If the incumbents are stand-alone firms, each one endowed with an amount of assets $\frac{A}{2}$, in equilibrium entry occurs in a market if and only if entry costs in that market are lower than K^H.*

Obviously, if the incumbents are stand-alone firms no subsidisation takes place, and each incumbent is endowed with $\frac{A}{2}$. The entrant's profitability is $V_{R_i}\left(\frac{A}{2}, K_i\right)$ irrespective of whether entry takes place in the other market. Hence, entry is a dominant strategy iff $K_i \leq K^H$. In other words, each market develops independently and in equilibrium entry occurs whenever entry costs are low or intermediate.

2.5.4 Equilibria of the entry game

We now characterise the equilibria of the entry game when incumbent firms belong to a business group. As competitive externalities arise when *at least one market has intermediate entry costs,* the following proposition focuses on this case. A complete description of all possible equilibria is provided in the proof.

Proposition 11 *The allocation of internal resources operated within a business group creates a financial link between apparently unrelated markets. In particular, two interesting phenomena may take place:*

- Anti-competitive spillovers

  The fact that one market is poorly competitive $\left(K_j > K^H\right)$ prevents entry also in the second market where there is more potential for competition $\left(K_i \in \left(K^L, K^H\right]\right)$.

- Entrants' miscoordination

  When potential entrants in both markets have intermediate entry costs ($K_i \in \left(K^L, K^H\right]$ with $i = 1, 2$), one of two equilibria may arise: a "good equilibrium" in which entry occurs in both markets; and a "bad equilibrium" in which both markets stay monopolised..

Proof. According to the realizations of entry costs in the two markets, the following cases may arise:

1. $K_1 \leq K^L$, $K_2 \leq K^L$.

   In this case entry occurs in both markets and the amount of assets assigned to each business unit is $\frac{A}{2}$. The business group's value is $V_1^C\left(\frac{A}{2}\right) = V_2^C\left(\frac{A}{2}\right)$.

2. $K_1 > K^H$, $K_2 > K^H$.

   In this case, for both entrants "not enter" is the dominant strategy. Again, each business unit is assigned $\frac{A}{2}$ but, since there is no competition, their values are $V_1^M\left(\frac{A}{2}\right) = V_2^M\left(\frac{A}{2}\right) > V_2^C\left(\frac{A}{2}\right)$.

   Note that when entry costs are either very low or prohibitive in both markets, no subsidisation is operated by the parent company and the equilibria of the entry game are the same as in the case of stand-alone incumbents.

3. $K_i \leq K^L$, $K_j \in \left(K^L, K^H\right]$ with $i \neq j = 1, 2$.

   Entry is a dominant strategy in market i. Given that firm i enters, the incumbent in market j cannot be subsidised, which makes entry also profitable for firm j. Note that for these values of entry costs the equilibrium outcome is the same as with stand-alone incumbents, whereas equilibrium entry strategies are not. With stand-alone incumbents, a firm's entry strategy does not depend on entry in the other market: whenever $K_i \leq K^H$, entry is a dominant strategy and competition arises in both markets. Instead, when the incumbents belong to a business group, it is entry in market i which allows entry in the market j, where there is less potential for competition. As already emphasised, by entering firm i exerts a *positive externality* on the potential entrant in the second market.

4. $K_i \leq K^L$, $K_j > K^H$ with $i \neq j = 1, 2$.

   "Enter" is a dominant strategy in market i while "not enter" dominates in market j. Hence, the entry outcome is the same as in the case of stand-alone incumbents: market j is monopolised while competition arises in market i. However, note that the parent company optimally assigns more assets to the subsidiary operating in the more competitive sector $\left(A_i^* > \frac{A}{2}\right)$; hence this subsidiary will be a tougher competitor than a stand-alone incumbent and its value will be higher $\left(V_i^C\left(A_i^*\right) > V_i^C\left(\frac{A}{2}\right)\right)$; the opposite holds for the business unit active in the monopolistic sector which is assigned $A_j^* < \frac{A}{2}$.

5. $K_i \in \left(K^L, K^H\right], K_j > K^H$ with $i \neq j = 1, 2$.

   In this case entry in market i would be profitable if the other firm entered market j, as this would avoid subsidisation in favour of the business unit competing with firm i. However this does not occur, as entry costs in market j are prohibitive. As a result, both markets end up being monopolised.

6. $K_i \in \left(K^L, K^H\right], K_j \in \left(K^L, K^H\right]$ with $i \neq j = 1, 2$.

   Given the entry strategies described in lemma 13, two equilibria arise in this case. In one, both firms enter their respective markets, in the other no firm does. Both entrants are better off in this first equilibrium. The problem is that they do not internalise the positive externality they exert on each other by entering the market: if they fail to coordinate, the "bad equilibrium" may arise, where no entry takes place. When this is the case, nobody has the incentive to deviate: if the other firm stays out, by entering one should face a competitor made tougher by subsidisation and it is better off staying out as well. In this case resource reallocation within the business group creates scope for competitors' *miscoordination*. Of course, miscoordination is not an issue with stand-alone incumbents: for this realization of entry costs, entry is a dominant strategy for each firm and the equilibrium unique.

■

Proposition 11 points to some competitive effects of diversified business groups, that have not been formalised yet. First, due to financial links between the diversified business group, lack of competition in market j *spills over* to market i, where the scope for competition is wider (note that with stand-alone incumbents, entry would occur in market i). The internal capital market creates a *link* between two otherwise unrelated markets and enables the business group to *extend its monopoly power* across the markets where it operates. Second, if potential entrants in business group-dominated markets do not coordinate (for instance, by also joining under the same roof), then the economy may get stuck in an uncompetitive equilibrium where all the markets are monopolised by the incumbent group.

The main implication of our analysis is that - due to the financial links within incumbent business groups - the probabilities of entry in unrelated industries end up being correlated. In case of stand-alone incumbents, the probability of entry in a market is just the probability that entry costs are lower than K^H:

$$P(\text{Entry in market } i) = F\left(K^H \mid \theta_i\right) \tag{2.1}$$

Conversely, when incumbent firms belongs to a business group, the probability of entry in market i is given by:

$$P(\text{Entry in market } i) = F\left(K^L \mid \theta_i\right) + \left[F\left(K^H \mid \theta_i\right) - F\left(K^L \mid \theta_i\right)\right] F\left(K^L \mid \theta_j\right) \tag{2.2}$$

if it is assumed that the "bad equilibrium" occurs for intermediate entry costs, and:

$$P(\text{Entry in market } i) = F\left(K^L \mid \theta_i\right) + \left[F\left(K^H \mid \theta_i\right) - F\left(K^L \mid \theta_i\right)\right] F\left(K^H \mid \theta_j\right) \tag{2.3}$$

if it is assumed that the "good equilibrium" occurs for intermediate entry costs.

Comparing 2.1 with 2.2 and 2.3 two main results emerge. First, the business group's ability to shift 'financial muscle' across markets reduces the probability of entry in all markets where it operates. Second, as resource shifting creates scope for anti-competitive spillovers, expected entry in one market is higher the more likely is entry in the *other* market. This latter insight is summarised in the following corollary:

Corollary 12 *The probability of entry in market i is positively related to the degree of competitiveness in market j.*

Proof. Consider the case in which, for intermediate entry costs, entrants coordinate on the "bad equilibrium". Then:

$\frac{\partial P(\text{Entry } i)}{\partial \theta_j} = \left[F\left(K^H \mid \theta_i\right) - F\left(K^L \mid \theta_i\right)\right] \frac{\partial F\left(K^L \mid \theta_j\right)}{\partial \theta_j} > 0$, which is positive by the assumption of first order stochastic dominance. The case in which the "good equilibrium" arises is analogous. ■

An immediate implication of this result is that all actions or events that reduce competition in one market may also limit competition in the other market. This suggests that competition authorities evaluating the effects of horizontal mergers should always take into account whether one of the merging units belongs itself to a diversified business groups, in which case the anti-competitive impact of the merger may invest more than one market.

Another implication is that in countries with large financial-industrial groups (ex.: banks and telecom companies), if the financial sector is not competitive, banks will subsidise their affiliated industrial firms, monopolising the industrial sectors. This is the same prediction as in Cestone-White (1998), but operating through a different mechanism.

Of course, we will extend the analysis to the bonding regime and we plan to make some comparative statics on A. That is, we would check whether the link between the two industries where the business group operates is reinforced or loosened when the group's internal assets A increase. In other words, we inquire whether a financially strong business group is more or less likely to generate (anti)competitive spillovers among industries.

2.6 Policy implications and conclusion

Many industrialised nations are experiencing a significant increase in merger activity, especially in the financial sector. In this new merger wave, pure conglomerate mergers[34] play a relevant role. Scherer (1980) suggests that the increase in pure conglomerate mergers corresponds to a reduction in horizontal and vertical mergers: "the U.S. merger laws have evolved into a potent deterrent against sizeable horizontal and vertical mergers... channelling companies' urge to merge in directions less likely to provoke an antitrust challenge". But if no *direct* competitive advantage is realised, where does this urge to merge come from? A widespread idea is that merging firms are trying to build *financial muscle*, as "being bigger" matters in product market competition. Unfortunately, there exists no rigorous study of how financial phenomena within conglomerates may impact product market competition. Our paper is a first step in this direction.

Three main policy conclusions emerge from our work, all of them having to do with business

[34]The Federal Trade Commission divides mergers into five cathegories: horizontal, vertical, product extension, market extension, and pure conglomerates, involving essentially unrelated enterprises.

units' subsidisation within an holding group. In our model, subsidisation of business units facing competition does not respond to explicit strategic objectives: a competing business unit optimally receives more assets in the ICM allocation process, just because it faces more serious agency problems. The subsidy is not intended to 'scare' product market rivals, as it is not observable. Obviously, as a consequence of subsidisation, business units compete differently than stand-alone firms, but this is just a side-product of an optimal, non-strategic capital allocation in the ICM. The lesson for anti-trust policy is then that competing divisions' subsidisation within conglomerates cannot be condemned *per se*. While the ICM allocation is not observable, the organisational form is. Thus, the decision to merge or stay focussed does represent a strategic variable, as it commits the firm to a different product market behaviour. However, our model does not necessarily predict that merging with a financially healthy unit (and thus gaining financial muscle) commits to a *tougher* product market behaviour. This result challenges the view that conglomerate divisions are always more able to deter entry/induce exit of rivals, and implies that the anti-competitive effects of mergers, if any, operate in a more complex way than standard predation arguments predict. The second conclusion has to do with conglomerate entry. Taking a different perspective, we show that conglomeration may well have pro-competitive effects in those markets where the only feasible way of entry is by subsidisation from the internal capital market. Finally, our analysis shows the conglomeration may indeed have anticompetitive effects, but these are not generated by using internal resources reallocation as a commitment devise. Actually, subsidisation operated by the Internal Capital Market creates a link between otherwise separate markets and may enable the business group to extend lack of competition in one market to another market where the scope of competition is, in principle, wider.

The idea that internal capital markets interact with product market competition is new to the literature. To our knowledge, Matsusaka and Nanda (1999) is the only work hinting at this possibility. They develop a theory of mergers and divestitures trading off costs and benefits of internal capital markets. In their model, though, the flexibility generated by an internal capital market has a commitment *cost*: as internal resources are easily reallocated, a conglomerate division cannot credibly commit to over-invest in order to deter entry of new rivals, and thus is more vulnerable to the threat of entry. Thus, product market considerations should discourage mergers and favour divestiture. Conversely, our model, starting from the same assumption that headquarters cannot commit to a given internal capital allocation, shows that opting for a conglomerate form represents *per se* a credible commitment to a given product market behaviour. This commitment represents a potential benefit of internal capital markets.

Finally, let us discuss some directions for future research. In our model, we do not endogenise the headquarters' objectives. It would be interesting to analyse the optimal design of the headquarters' incentives, keeping into account the product market effects of internal capital market allocations. This would require studying a merger stage where separate business units write a grand-contract with a common third party, and relinquish the latter the control rights on internal resources. So far our work just pointed the product market effects of ICMs, thus delineating some new costs and benefits of pure conglomerates. In future work, we plan to analyse more explicitly what are the incentives to merge for firms competing in oligopolistic product markets.

2.7 Appendix

Appendix A: Proof of Lemma 3

We need to prove that, for a given amount of assets $A_1 = A_2 = A_i$, $\frac{\partial V_1}{\partial A_1} > \frac{\partial V_2}{\partial A_2}$ $\forall \pi_1 < \pi_2$.
We know that:

$$\frac{\partial V_i}{\partial A_i} = \begin{cases} \frac{\gamma - \pi}{\pi} & if\ A_i < \widetilde{A}_i \\ \frac{\pi - \beta(e^* - \widetilde{e})}{2\beta e^* - \beta\widetilde{e} - \pi} & if\ A_i > \widetilde{A}_i \end{cases}$$

In $A_i = \widetilde{A}_i$ the derivative does not exist. However, there exist $\lim_{h \to 0^+} \frac{V(\widetilde{A}+h)}{h} = \frac{\pi}{\beta\widetilde{e} - \pi} \equiv V^+$ and $\lim_{h \to 0^-} \frac{V(\widetilde{A}+h)}{h} = \frac{\gamma - \pi}{\pi} \equiv V^-$.

Note first that the value function is concave. It is linear if $A_i < \widetilde{A}_i$. If $A_i > \widetilde{A}_i$, $\frac{\partial^2 V_i}{\partial^2 A_i} = \frac{\partial^2 e_i^*(A_i)}{\partial^2 A_i}\left[\pi_i - \beta\left(e_i^*(A_i) - \widetilde{e}\right)\right] - \beta\left(\frac{\partial e_i^*}{\partial A_i}\right)^2 < 0$. Finally, in $A_i = \widetilde{A}_i$, $V^- > V^+$ (by the assumption $\gamma > \frac{\pi_i}{1 - \frac{\pi_i}{\beta\widetilde{e}}}$).

Let us compare $\frac{\partial V_1}{\partial A_1}$ and $\frac{\partial V_2}{\partial A_2}$ for any level of A_i. As shown in the text, $\widetilde{A}_1 > \widetilde{A}_2$.

- When $A_i \in \left(0, \widetilde{A}_2\right)$, both value functions lie in the bonding region. In this case, V_1 is steeper than V_2 since $\frac{\partial^2 V_i}{\partial A_i \partial \pi_i} = -\frac{\gamma}{(\pi_i)^2} < 0$.

- When $A_i = \widetilde{A}_2$, V_1 lies in the bonding region. Therefore, as $\pi_1 < \pi_2$:

  $\frac{\partial V_1}{\partial A_1} = \frac{\gamma-\pi_1}{\pi_1} > \frac{\gamma-\pi_2}{\pi_2} = V_2^- > V_2^+$.

- When $A_i \in \left(\widetilde{A}_2, \widetilde{A}_1\right)$, V_1 lies in the bonding region, while V_2 lies in the shirking region $\left(\text{where } \frac{\partial V_2}{\partial A_2} < \frac{\gamma-\pi_2}{\pi_2}, \text{ by concavity}\right)$. Then:

  $\frac{\partial V_1}{\partial A_1} = \frac{\gamma-\pi_1}{\pi_1} > \frac{\gamma-\pi_2}{\pi_2} > \frac{\partial V_2}{\partial A_2}$.

- When $A_i = \widetilde{A}_1$, V_2 lies in the shirking region. Therefore, $\frac{\partial^2 V_2}{\partial A_2 \partial \pi_2} < 0$ and $\frac{\partial V_2}{\partial A_2} < V_1^+ < V_1^-$.

- When $A_i \in \left(\widetilde{A}_1, I\right]$, both value functions lie in the shirking region and $\frac{\partial V_1}{\partial A_1} > \frac{\partial V_2}{\partial A_2}$ since $\frac{\partial^2 V_i}{\partial A_i \partial \pi_i} < 0$.

Appendix B: Detailed solution to the headquarters' programme

Consider $\pi_1 < \pi_2$. The optimal allocation of internal resources depends on the amount A of total internal resources available:

- *if $A < \widetilde{A}_1$, then: $A_1^* = A$ and $A_2^* = 0$.*
- *if $\widetilde{A}_1 \leq A \leq \widetilde{A}_1 + \widehat{A}$, then: $A_1^* = \widetilde{A}_1$ and $A_2^* = A - \widetilde{A}_1$.*
- *if $A > \widetilde{A}_1 + \widehat{A}$, then: $A_1^* > \widetilde{A}_1$ and it is such that $\frac{\partial V_1}{\partial A_1}(A_1^*) = \frac{\partial V_2}{\partial A_2}(A - A_1^*)$*

The proof is as follows:

- Consider first $A < \widetilde{A}_1$. In this case, for any feasible allocation subsidiary 1 will lie in the bonding region, where $\frac{\partial V_1}{\partial A_1} = \frac{\gamma-\pi_1}{\pi_1}$. Since $\frac{\gamma-\pi_1}{\pi_1} > \frac{\gamma-\pi_2}{\pi_2}$ and V_2 is concave, for any feasible allocation $(A_1,\ A - A_1)$, $\frac{\partial V_1}{\partial A_1}(A_1) > \frac{\partial V_2}{\partial A_2}(A - A_1)$. Hence, it is optimal to assign all internal resources to subsidiary 1.

- Consider now the case $\widetilde{A}_1 < A \leq \widetilde{A}_1 + \widehat{A}$, where we denote with $\widehat{A}$ the amount of internal resources such that $\frac{\partial V_2}{\partial A}\left(\widehat{A}\right) = V_1^+$. (By definition of $\widehat{A}$, it is: $\frac{\partial V_2}{\partial A_2} > V_1^+$ if $A < \widehat{A}$ and $\widehat{A} \in (\widetilde{A}_2, \widetilde{A}_1)$).

  From the previous point, any allocation such that $A_1 < \widetilde{A}_1$ is not optimal. Assume then $A_1 = \widetilde{A}_1$, which implies that $A_2 = A - \widetilde{A}_1 < \widehat{A}$. By the definition of $\widehat{A}$, $V_1^+ \leq$

$\frac{\partial V_2}{\partial A_2}\left(A-\widetilde{A}_1\right)$. Therefore, it is not optimal to increase A_1 further, and the optimal allocation is $A_1^*=\widetilde{A}_1$, $A_2^*=A-\widetilde{A}_1$.

- Finally, when $A>\widetilde{A}_1+\widehat{A}$, if $A_1=\widetilde{A}_1$, obviously $A_2>\widehat{A}$, and thus: $V_1^+>\frac{\partial V_2}{\partial A_2}\left(A-\widetilde{A}_1\right)$. It is then optimal to increase A_1 above $\widetilde{A}_1$ until $\frac{\partial V_1}{\partial A_1}(A_1^*)=\frac{\partial V_2}{\partial A_2}(A-A_1^*)$. Note that, in this case, both subsidiaries are in the shirking region.

Appendix C: Proof of Proposition 7

We compare the product market behaviour of a stand-alone firm endowed with assets $\frac{A}{2}$ and of subsidiary 1. Note that - as specified in the model - subsidiary 1 also contributes assets $\frac{A}{2}$ to the holding group, but at t=0 it is subsidised by the headquarters, so that $A_1^*(z_R)>\frac{A}{2}$ (see Proposition 6).

- If $\frac{A}{2}$ is very low $\left(\frac{A}{2}<\frac{\widetilde{A}_1(z_R)+\widehat{A}(z_R)}{2}<\widetilde{A}_1(z_R)\right)$, both the stand-alone firm and subsidiary 1 lie in the bonding regime. Then, for any given z_R, the subsidiary's total effort $z_1=\frac{I-A_1^*(z_R)}{\pi(1-z_R)}$ is lower than the stand-alone firm's effort $z_F=\frac{I-\frac{A}{2}}{\pi(1-z_R)}$, since $A^*(z_R)>\frac{A}{2}$.
- If instead $\frac{A}{2}$ is very high $\left(\frac{A}{2}>\widetilde{A}_1(z_R)\right)$ both the stand-alone firm and subsidiary 1 are in the shirking regime. From Lemma 2-bis, $z_F=e_F$ with e_F solving the equation $e_F[\pi(1-z_R)-\beta(e_F-\widetilde{e})]=I-\frac{A}{2}$, whereas, for subsidiary 1, $z_1=e_1$ solves $e_1[\pi(1-z_R)-\beta(e_1-\widetilde{e})]=I-A^*(z_R)$. Since $A^*(z_R)>\frac{A}{2}$, and $\frac{\partial e}{\partial A}>0$, it follows that $z_1>z_F$ for any given z_R.
- If $\frac{A}{2}$ lies in the interval $\left[\frac{\widetilde{A}_1(z_R)+\widehat{A}(z_R)}{2};\widetilde{A}_1(z_R)\right]$, the stand alone firm lies in the bonding region, while - after being subsidised - the business unit is pushed to the shirking region or at least at the limit between the bonding and the shirking region. Therefore, it is not obvious which one is tougher. Note, however, that as $\frac{A}{2}$ is increased from $\frac{\widetilde{A}_1(z_R)+\widehat{A}(z_R)}{2}$ to $\widetilde{A}_1(z_R)$, z_F decreases from $\frac{I-\frac{\widetilde{A}_1(z_R)+\widehat{A}(z_R)}{2}}{\pi(1-z_R)}$ to $\widetilde{e}$, while z_1 increases from $\widetilde{e}$ to a strictly higher value. By continuity, there exists then a threshold $\frac{\overline{A}(z_R)}{2}$ such that $z_1>z_F$ iff $\frac{A}{2}>\frac{\overline{A}(z_R)}{2}$.

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Chapter 3

Buyers' coordination and entry (joint with Massimo Motta)

3.1 Introduction

In a recent case, the European Commission approved the merger of Enso and Stora, two firms producing Liquid Packaging Board (LPB), used for the packaging of milk and fruit juice. In this market, the merging firms would have a market share between 50% and 70%. Other industry characteristics, such as high barriers to entry, strongly suggested anti-competitive concerns of the operation. Yet, the merger was approved on the grounds that buyer power in this industry was so large (Tetrapak alone buys 60-80% of total sales) that the merging firms would have been unlikely to exercise market power. One of the arguments used by the Commission to justify this finding was that the main buyer, Tetrapak, "would have the option of developing new capacity with other existing or new suppliers, should the parties attempt to exercise market power".[1] In a comment to the decision, it has been noted that:

> "Irrecoverable investments, or sunk costs, that would be considered too risky if the suppliers faced a fragmented demand side are made much less risky when they can be made in effective collaboration with a large customer."[2]

The European Commission also relied heavily on buyers' concentration in the analysis of a joint venture between the rail technology subsidiaries of Asea Brown Boveri (ABB) and Daimler-

[1] Enso/Stora, IV/M.1225, Official Journal of the EC, L254 (1999), paragraph 91.
[2] "Buyer power and the Enso/Stora decision", NERA Competition Brief (November 1999), page 2.

Benz in Germany.[3] The joint venture was declared compatible with the common market in the national trains market but not in the local train and systems market. The relevant markets shared most of the basic features (technology, demand, supply conditions), but they were very different in terms of the bargaining power of buyers. While the only client for mainline trains was the national railways company Deutsche Bahn, there were a number of customers for local trains and systems: the Commission had identified 58 German municipal transport companies which purchased trams and metro systems. According to the Commission, if Deutsche Bahn decided to group orders in such a way to invite tenders for very large single orders, it would be able to attract the interest of foreign groups not active in Germany, such as GEC-Alsthom. Facing very large orders, foreign firms would be willing to incur the fixed costs of changing their product specifications to meet the German technical standards. Instead, individual municipal companies have orders of a much smaller size and are therefore less attractive to foreign potential entrants, for which the fixed costs of adapting to German specifications would not be worth incurring.

These cases suggest that because of coordination problems, entry into the sellers' industry by new firms can be easier when buyers are concentrated.

In this paper, we provide a formalisation of the idea that miscoordination of buyers might prevent entry from an efficient potential entrant. We assume that there exist an incumbent and a more efficient potential entrant, the latter having to make a sunk investment to be able to operate in the industry. In this setting, it may be costly for a buyer to select a firm which will not eventually enter the industry. If buyers are dispersed, winning orders from a few buyers might not be enough to justify the fixed investment, and as a result entry might not occur (even though the entrant is more efficient than the incumbent). Because buyers are not coordinating their decisions, they might end up with having the monopolist as only seller in the industry, and hence face higher bills than if entry had occurred. When instead there is just a single buyer (or all the buyers coordinate), then it will give its order to the entrant and this will be able to enter the industry.

Besides the formalisation of the idea that buyers' miscoordination might pre-empt efficient entry, the other main result of the paper is that we identify a scheme which helps alleviate the miscoordination problem. Indeed, we show that if the potential entrant could credibly offer to pay a penalty for unfulfilled orders should it not enter, exclusion of the efficient entrant due to buyers' miscoordination is less likely to occur. Further, even when exclusion of the entrant occurs at equilibrium, the price that the incumbent monopolist will set is the lower the higher the penalty offered by the potential entrant to buyers.

[3] Case ABB/Daimler Benz, IV/M.580, 18.10.1996.

Our paper is related to at least two different strands of literature. The first one deals with buyer power. Galbraith (1952) is probably the first author who has argued that countervailing power of buyers can considerably restrain the market power of sellers. A firm can better exercise market power if it faces a large number of dispersed consumers or buyers than if it faces one or few strong buyers. A strong buyer can make use of its bargaining power to stimulate competition among the sellers, either by threatening to withdraw orders from one seller to give them to another, or by threatening to start upstream production itself.[4] Innes and Sexton (1993) have modelled the process by which buyers countervailing power forms and have studied the seller's optimal reaction to this. To avoid that buyers costly form a coalition to bargain with the seller or to enter production, the incumbent optimally adopts price discrimination: he bribes some buyers with price discounts keeping them out of any possible coalition. This diminishes the benefits of the remaining buyers from forming coalition so that the seller can charge them the monopoly price without risking the coalition formation. However, the threat of buyers' coordination and competition is shown to exert a powerful procompetitive effect on the incumbent firm. Several empirical works have also tried to test the countervailing power hypothesis, and there appears to be some evidence that buyer concentration negatively affects profitability of the sellers.[5]

Other recent works have been concerned with the question of whether final consumers also benefit from buying power, or if buyers are the only ones who gain from it. Consumers benefit from countervailing power if there exists enough competition among the buyers themselves. This argument has been formalised first by von Ungern-Sternberg (1996) and refined by Dobson and Waterson (1997), whose model shows that welfare rises with buyer concentration only when buyers are selling services (or products) which fiercely compete on the product market (or which are close substitutes). When the buyer-retailer market is characterised by strong competition conditions (e.g. because product differentiation is lower) price discounts obtained from sellers-manufacturers would be passed on to final consumers.

Buyer power might also have an effect on the likelihood of collusion among the sellers. When sellers face few buyers, these are likely to use their bargaining power and use an aggressive procurement strategy. By unifying their orders they can extract better conditions from suppliers, which would be more willing to offer price reductions (and therefore deviate from a collusive strategy) if the size of the contract is large enough. If instead buyers were fragmented, each order would be small and sellers would be less likely to undercut each other. An implication

[4]See Scherer and Ross (1990, chapter 14) for a discussion and a number of examples.

[5]See Scherer and Ross (1990, pp.533-35) for a review of this literature, initiated by Lustgarten (1975). Among more recent work, Schumacher (1991) also supports the countervailing power hypothesis in a study based on US manufacturing industries, whereas Connor, Rogers and Bhagavan (1996) find no evidence of countervailing power in the US food manufacturing industries.

of this is also that buyers might want to behave in a strategic way and group orders together instead of buying in regular small amounts. Snyder (1996) shows that by accumulating a backlog of unfilled orders a buyer can mimic a demand boom and force sellers to collude on lower prices.

This paper departs from the aforementioned recent works in that we focus on the effect of buyer power upon entry, while we abstract from the possibility that it affects collusion and we do not consider competition in the buyers market, implicitly assuming that buyers are the final consumers.

The analysis developed in this paper is closely related to that proposed by Rasmusen, Ramseyer and Wiley (1991), hence-forth RRW, and Segal and Whinston (1996). In their paper Segal and Whiston put on a firmer foundation the RRW argument that an incumbent may be able to profitably deter entry using contracts which commits the buyer to purchasing only from the incumbent. Exclusionary contracts may thus deter otherwise desirable entry and reduce economic welfare. This challenges the view held by some "Chicago School" scholars that exclusionary contracts must be efficient or they would not be signed by buyers.[6] For some aspects the reader will find a strong similarity between our paper and those. Indeed, to facilitate comparison of results, we have tried to follow Segal and Whinston's notation whenever possible. However, some differences should be noted. First, the *timing of the game* is different. In particular, Segal and Whinston assume that in the first stage the incumbent offers exclusionary contracts, in the second one the potential entrant decides on entry and finally active firms name prices. We assume, instead, that first all buyers solicit bids from the two firms; then each of them decides from which seller to buy and finally, after observing how many buyers have accepted its bid, the entrant decides on entry. The different focuses of the papers motivate these different timings. The analysis of Segal and Whinston (and of RRW) is addressed to the *role*

[6] Aghion and Bolton (1987) as well analyse the use of optimal contracts between buyers and sellers to deter efficient entry. They consider *partially exclusionary* contracts in which the buyer must pay *liquidated damages* to the incumbent if trading with the entrant. They study the one seller-one buyer case where the optimal exclusionary contract represents a coalition between the two in order to extract rent from the entrant *when entry occurs*. This reduces the entrant profits from entry and makes entry (inefficiently) less likely. Yet entry is not completely precluded: because of the liquidated damages the incumbent gains the additional payment in all states of nature in which entry occurs so that by signing a contract that completely deters entry it would enjoy a lower expected payoff. Aghion and Bolton also discuss the two-buyer version of the model. In this case when one buyer signs a contract with the incumbent imposes a negative externality on the other one; this externality is exploited by the incumbent to extract more surplus out of each buyer.

Innes and Sexton (1994) extend the Aghion and Bolton's model allowing the buyer to behave strategically and to form a *coalition with the entrant*. Since this coalition internalizes the consumer surplus gains from avoiding monopoly pricing, the benefits from entry to the coalition will typically exceed the benefits accruing to an ordinary outside entrant. Hence, the coalition will have incentive to elicit entry even when such entry is socially inefficient. Innes and Sexton show that exclusionary contracts deter such inefficient entry without harming the buyer, while they do not deter efficient entry. Hence, differently from the aforementioned models, exclusionary contracts are shown to be efficient.

of exclusionary contracts in entry deterrence when there exists a multiplicity of buyers. So, in their paper the pricing behaviour of the entrant is less relevant: it simply sets a price equal to the incumbent's marginal cost when entry is feasible. Moreover, their analysis clarifies that the incumbent's ability to exclude may have different sources. When the incumbent simultaneously offers uniform contracts to all the buyers, exclusion arises because it exploits the buyers' *lack of coordination* on their most preferred continuation equilibrium. However, the incumbent does not need to rely on miscoordination if it can offer *discriminatory terms* to different buyers. In this case, it can *turn the buyers against the other*: if enough buyers accept the exclusionary contracts bribed with an advantageous deal, they impose the externality of no entry on the remaining buyers.[7] This externality is exacerbated in the case of sequential offers when the incumbent may indeed exclude at no cost. Instead, the timing that we have chosen implies that the analysis of the pricing behaviour of the two firms is more articulated and we end up with a richer set of equilibrium solutions. More importantly, it reveals that we are not concerned with vertical restraints but with the effects of buyers' fragmentation on entry and on market power *without the incumbent having an active role in exclusion.* In a sense, in our model the incumbent is passive, it does not implement a devise to keep the rival out of the market. It is the mere fact of having already incurred the sunk investment that allows it to benefit from the buyers' miscoordination and to fully exercise its market power despite the existence of a more efficient potential entrant. In this contest, we are thus interested in studying whether *the entrant can use an instrument (the penalty) which alleviates the miscoordination of the buyers and makes entry more likely to occur.* We also study the level of the penalty which would be optimally chosen by the entrant, as well as by a hypotethical social planner.

3.2 The Model

Two firms compete for the provision of a homogenous good. One of them, I, is an incumbent in the industry and has already paid the fixed sunk entry costs necessary to provide the good. The other firm, E, is a potential entrant. If it actually enters the industry, it will have to pay the fixed sunk cost f. We assume that there are constant marginal costs of production and that

[7] A similar "divide and conquer" strategy is adopted by the incumbent in the model of Innes and Sexton (1994). Differently from the previous works, they assume active buyers who can form coalition that can, in turn, contract with the potential entrant. In this setting the incumbent uses *discriminatory contracts* and selectively offers high payoff to some buyer (as to eliminate their incentive to join coalitions) and poorer contract terms to the remaining ones. This allows the incumbent to capture some of the buyers' entry rents. As a result, differently from the one buyer-one seller case, exclusionary agreements have *two offsetting welfare effects, deterring both inefficient entry and some efficient entry.* However, if price discrimination is prohibited, exclusionary contracts just deter inefficient entry that would occur without them.

the potential entrant has lower cost than the incumbent: $c_E < c_I$. We also assume that there exist N identical buyers whose demand is given by $q(p_i) = 1$ for $p_i \leq p^M$, and $q(p_i) = 0$ for $p_i > p^M$, where p_i is the price set by firm $i = I, E$. All buyers simultaneously solicit bids from the two firms. We must also assume that the market is viable for the entrant, if it obtains a large enough number of buyers. A necessary condition is therefore that the entrant's average cost if all buyers patronise it, $\overline{c}_E$, is lower than the incumbent's marginal cost: $\overline{c}_E \equiv c_E + \frac{f}{N} < c_I$.

The timing of the game is as follows (see *Figure 3-1* for an illustration). At time t_o, firms take part in the (simultaneous) auctions. Firms cannot price discriminate among buyers, i.e., they will offer the same conditions to each buyer. Firm I's bid consists of the price p_I at which it is willing to provide the good. Firm E's action is given by the pair (p_E, D), where $D \in \{0, 1\}$. If $D = 0$, firm E does not make any bid (i.e., it is not willing to supply the good at any price). If $D = 1$, firm E is willing to supply the good at a price p_E. At time t_1, each buyer decides from which seller to buy, after having observed the bids. We assume that the agreement between a buyer and the seller at t_1 is binding; in particular, once decided to patronize the incumbent, a buyer cannot change her decision in the following periods when she realizes whether the potential entrant actually provides the good.[8] Call S the number of buyers who choose the bid of the incumbent. At time t_2, firm E decides, on the basis of the number of buyers $N - S$ who accepted its bid, whether it wants to pay the entry cost and provide the good to those buyers or not. If it decides not to enter, it will have to pay a penalty t to the buyers whose demand has not been satisfied. If it decides to enter, it satisfies the demand at the price indicated in its bid.

Since firm I has already sunk its entry cost, it will always be able to provide the good independently of the number of buyers which will address it. Therefore, it will satisfy all the buyers who have chosen to patronise it, at the price p_I.

At time t_3, all buyers whose demand has been unfulfilled by firm E will be able to buy the good from the monopolist at the price p^M. Note that their net expenditure will be $p^M - t$, since firm E will refund them for the unfulfilled contract of the penalty t. We look for the subgame perfect Nash equilibrium in pure strategies of this game, and we solve it by backward induction.

[8] Suppose the number of buyers who accepted the bid of the more efficient entrant has not made entry profitable. Still, if the buyers' decision were reversible, the entrant would enter the market anyhow, because it knows that by entering all the buyers who addressed the incumbent at t_1 would break the contrant and would switch to it.

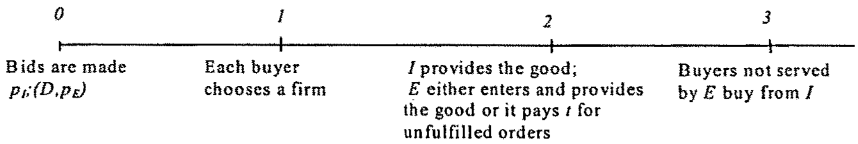

Figure 3-1: *Time – line*

3.3 The entry decision

At time t_2, conditional on having taken part in the auction ($D = 1$) and having bid a price p_E, firm E observes the number of bids that it has won and decides on entry. Entry will occur if the following condition is satisfied:

$$(N - S)(p_E - c_E) - f > -t(N - S). \tag{3.1}$$

This condition simply compares the net profit from entry with the total amount of the penalty it has to pay in the case where firm E decides not to satisfy buyers who preferred its bid.

Following Segal and Whinston (1996), we define N^* as the smallest number of buyers who accept the incumbent's offer in order for firm E not to find entry profitable. Formally, denoting as $\lceil z \rceil$ the smallest integer greater than or equal to z, firm E does not enter if $S \geq N^*$, where:

$$N^* \equiv \left\lceil N - \frac{f}{(p_E - c_E) + t} \right\rceil. \tag{3.2}$$

Note that N^* is (weakly) increasing in the price-cost margin $(p_E - c_E)$ that firm E receives and (weakly) decreasing in the fixed entry cost f.

More importantly, note that N^* is (weakly) increasing in the penalty t that firm E has to pay. This is because the higher the penalty the more costly for firm E not to fulfill the orders it has won. In particular, a very high penalty has the effect of making $E's$ entry profitable even if patronised by a single buyer. This is the case if t is so high that $N - \frac{f}{(p_E - c_E) + t} > N - 1$ and N^* amounts to N : only if no buyer accepts its bid, firm E gives up entering. As it will become clearer in what follows, this prevents miscoordination problems to arise. Given t, we denote with $p^{ex}(t)$ the price such that $\frac{f}{(p^{ex}(t) - c_E) + t} = 1$. If $p_E > p^{ex}(t) \equiv c_E + f - t$, firm E

enters even if its bid has been accepted by a single buyer; hence $p^{ex}(t)$ is the maximum price for which miscoordination can arise[9].

3.4 The buyers' decision

At time t_1, buyers decide on which bid to accept. We now characterise the equilibrium choice of the buyers for given prices quoted by the two firms. (See *Figure 3-2* for an illustration which summarises the following Lemma.)

Lemma 13 *For given p_I and (D, p_E) the equilibrium number of buyers, S, accepting the incumbent's offer is given by:*

- *If $D = 0$, for any p_I, $S = N$.*
- *If $D = 1$ and $p_E > p^{ex}(t)$ buyers' fragmentation is not an issue. Therefore, $S = N$ whenever $p_E > p_I$ and $S = 0$ whenever $p_E \leq p_I$.*
- *If $D = 1$ and $p_E \leq p^{ex}(t)$ the following cases may arise:*
    1. *If $p_E > p_I > p^M - t$, $S = N^*(p_E)$.*
    2. *If $p_E > p_I = p^M - t$, $S \geq N^*(p_E)$.*
    3. *If $p_E > p_I$ and $p_I < p^M - t$, $S = N$.*
    4. *If $p_E = p_I > p^M - t$, $S \leq N^*(p_E)$.*
    5. *If $p_E = p_I = p^M - t$, any S is an equilibrium.*
    6. *If $p_E = p_I < p^M - t$, $S = N$ or $S \leq N^*(p_E) - 1$.*
    7. *If $p_E < p_I$ and $p_I > p^M - t$, $S = 0$.*
    8. *If $p_E < p_I = p^M - t$, $S \geq N^*(p_E) + 1$ or $S = 0$.*
    9. *If $p_E < p_I < p^M - t$, $S = N$ or $S = 0$.*

Proof. When buyers' fragmentation is not an issue ($p_E > p^{ex}(t)$) the buyers' decision is trivial. Note that we adopt the tie-breaking convention that all the buyers address the entrant when it charges the same price as the incumbent.

The analysis is more articulated when $p_E \leq p^{ex}(t)$.

[9] To make the problem interesting, we shall assume that $f > 2(p^M - c_E)$. It is sufficient (but not necessary) for buyers' fragmentation being an issue up to the value $p^M - c_E - \frac{f}{N} (\equiv t^{**})$ of the penalty. In particular, this assumption ensures that $p^{ex}(t^{**}) > p^M$, so that up to t^{**}, a single buyer is not enough to make entry profitable for any $p_E \leq p^M$.

Let us consider the case where $p_E > p_I$. $S < N^*(p_E)$ cannot be an equilibrium: instead of patronising the entrant (who has enough buyers to enter) and paying p_E, a buyer prefers to deviate and demand the good from the incumbent. Further cases must be distinguished according to the level of p_I :

1. If $p_I > p^M - t$, $S > N^*(p_E)$ cannot be an equilibrium. Consider a buyer accepting the incumbent's bid and paying p_I; deviating and demanding the good from the (potential) entrant, she would have to pay $p^M - t$, as the addition of the deviant to the number of buyers demanding the good from E would not be enough for the latter to enter. The deviant would then receive the penalty t but will pay p^M in the next period. Since $p^M - t < p_I$, this buyer would have incentive to deviate.

Overall, if $p_E > p_I > p^M - t$ only $S = N^*(p_E)$ is an equilibrium. A buyer who addresses the entrant has no incentive to deviate as it would have to pay p_I instead of $p^M - t$. A buyer who addresses the incumbent does not have any incentive to deviate as, by switching to the entrant, it makes the latter enter and provide the good. Therefore, this deviant buyer would have to pay $p_E > p_I$.

2. If $p_I = p^M - t$, $S > N^*(p_E)$ is an equilibrium, because a buyer buying from the incumbent would not (strictly) improve its payoff by turning to the entrant, as the latter would not provide the good and the buyer would then pay $p^M - t = p_I$. Indifference also explains why the buyer who selects the entrant does not increase its payoff by turning to the incumbent.

Similarly to 1., if $p_E > p_I = p^M - t$, $S = N^*(p_E)$ is an equilibrium. Overall, in this case, the equilibrium number of buyers accepting the incumbent offer is $S \geq N^*(p_E)$.

3. If $p_I < p^M - t$, no equilibrium exists where $N^*(p_E) \leq S < N$, since any buyer who addresses the (potential) entrant, paying $p^M - t$ when she turns to the incumbent after the entrant has defaulted, could instead buy from the incumbent (immediately) at the lower price p_I. Instead, if $S = N$ no one has incentive to deviate. The deviation would not allow entry and would imply the payment of the higher price $p^M - t$.

Hence, if $p_E > p_I$ and $p_I < p^M - t$ the only equilibrium is the one where $S = N$.

Let us turn to the case where $p_E = p_I$. $S < N^*(p_E)$ is now an equilibrium because buyers choosing to patronize the entrant (which operates) are indifferent between paying p_E and p_I. The same indifference condition holds for the buyers choosing to patronize the incumbent.

4. Similarly to 1., if $p_E = p_I > p^M - t$, $S = N^*(p_E)$ is an equilibrium. Recalling that when $p_I > p^M - t$, $S > N^*(p_E)$ cannot be an equilibrium, overall, in this case the number of buyers patronizing the incumbent is $S \leq N^*(p_E)$.

5. The case where $p_E = p_I = p^M - t$ is trivial. Buyers are completely indifferent among the sellers, and any S is an equilibrium.

6. Recalling 3., if $p_E = p_I < p^M - t$, $S < N^*(p_E)$ and $S = N$ are equilibria.

Finally, let us consider the case where $p_E < p_I$. No equilibrium arises for $0 < S < N^*(p_E)$ because a buyer would always prefer to switch to the entrant (which will provide the good) paying $p_E < p_I$. Hence, only if all the buyers accept the entrant's bid, there exists no profitable deviation and $S = 0$ is an equilibrium.

7. Recalling 1., if $p_E < p_I$ and $p_I > p^M - t$ the only equilibrium is $S = 0$.

8. Recalling 2., if $p_E < p_I = p^M - t$ the equilibrium number of buyers accepting the incumbent's offer are either $S = 0$ or $S > N^*(p_E)$.

9. Recalling 3. if $p_E < p_I < p^M - t$, the only equilibria arise with $S = 0$ and $S = N$. If $S = 0$, nobody would like to deviate and pay a higher price to the incumbent than the entrant (which operates). If $S = N$, nobody wants to deviate and choose the entrant, as the latter would not enter, resulting in the price $p^M - t > p_I$ to be paid. In the intermediate cases, either a buyer choosing the entrant (if $S \geq N^*$) or a buyer choosing the incumbent (if $S < N^*$) would have incentive to deviate. ■

The proof required checking all the possible deviations in each of the cases identified. It is simple but long to follow. What can be noted, however, is the mechanism which is behind the different equilibrium solutions.

The case where $p_E \leq p^{ex}(t)$ is the most interesting. As one expects, the potential entrant will not win enough bids to enter if it charges a price which is higher than the one set by the incumbent (shaded area in *Figure* 3-2). However, if $p_E < p_I$ with the latter being below or equal to $p^M - t$, *miscoordination* of the buyers might lead to the situation in which the entrant's bid is not accepted by enough buyers to enter even if the price quoted is lower than the incumbent's (lined area in *Figure* 3-2). To see the intuition, imagine that all the buyers have accepted the incumbent's offer. A single buyer knows that she is not enough to make *E's* entry profitable so that, should she deviate choosing the entrant, her order would remain unfulfilled and she would have to turn to the incumbent in the following period, paying a (weakly) higher price. This eliminates any incentive to deviate. Instead, when $p_E < p_I$ but $p_I > p^M - t$, an entrant setting lower prices will always be addressed by enough buyers to enter, even if a single one does not suffice to make entry profitable (white area in *Figure* 3-2). This is due to the existence of the penalty: when the incumbent sets a price above $p^M - t$, a buyer always prefers to address the entrant first. If entry occurs she will obtain the good at a lower price; if the entrant does not provide the good, the buyer will still be better off, as she will end up with paying $p^M - t$ instead of the higher p_I. This gives a single buyer the incentive to deviate from $S = N$ and prevents the miscoordination problem to arise. It is therefore important to note the crucial role played by the penalty, which acts as a sort of "insurance" against the possibility that the entrant will not operate. Of course, for this mechanism to work it is indispensable that the

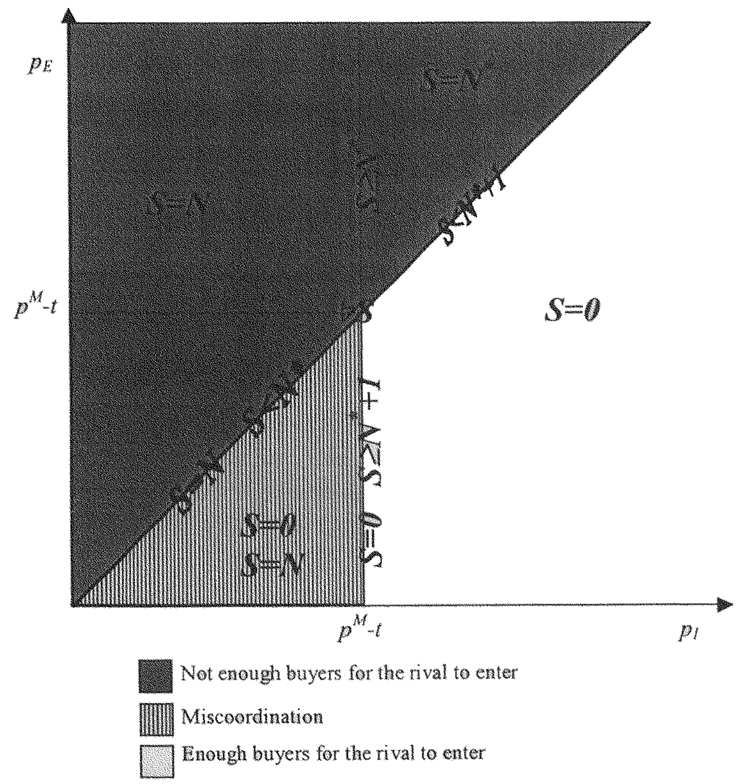

Figure 3-2: Buyers' equilibria

potential entrant's ability to pay the penalty is credible (see more below).

The case where $p_E > p^{ex}(t)$ is the standard one. All the buyers accept the offer of the firm quoting the lowest price. In particular, if $p_E < p_I$, the entrant is always addressed by enough buyers to enter. The reason is that a single buyer is enough to make $E's$ entry profitable so that an equilibrium in which all the buyers accept the incumbent's offer cannot be supported and no miscoordination problem arises.

Perfectly Coalition Proof Nash Equilibria The previous Lemma shows that when the entrant charges a price which is lower than the incumbent's, it may be unable to capture enough demand to profitably enter the market. This is entirely due to *lack of coordination* among the buyers and would not occur if they could agree to jointly address their demand to the entrant, for instance being organized in a centralized purchasing agency[10].

This idea can be developed more formally adopting the concept of *Coalition-Proof Nash Equilibria*.[11] More precisely, an equilibrium is coalition-proof if no coalition of any size can deviate in a way that increases the payoffs of all its members. Note that the coalitional deviations must be Nash Equilibria of the game among the deviating players, holding the strategies of the others fixed.

Applying this concept to our model, $S = N$ is not a coalition-proof Nash Equilibrium following $p_E < p_I < p^M - t$. A joint deviation in which every buyer rejects the incumbent's offer would allow the entrant to provide the good and the buyers to obtain it at a lower price. Obviously, no buyer has incentive to deviate from such a coalitional deviation. Viceversa, no subset of buyers has incentive to jointly deviate from $S = 0$ as they would be charged a higher price. This equilibrium is coalition-proof. Similarly, if $p_E < p_I = p^M - t$ the equilibria in which $S \geq N^*(p_E) + 1$ are not coalition-proof. The buyers accepting the incumbent's offer have the incentive to jointly deviate in order to pay less for the good. $S = 0$ is, instead, coalition-proof.

3.5 The firms' decision

In this section we develop the analysis assuming that the penalty is exogenously determined. We will show that when the penalty is low enough it is not obvious that in equilibrium the most efficient producer succeeds in entering the market. Instead, for high enough penalties, entry will always occur.

[10]Similarly, no miscoordination problem would arise if all the demand was concentrated in a single buyer. However, in such a case, a monopoly inefficiency would arise, if the buyer in turn served a downstream market, and no clear conclusion on the derirability of such configuration could be drawn. This can be avoided assuming that the demand is still fragmented but that the buyers are able to coordinate.

[11]See Bernheim, Peleg and Whinston (1987).

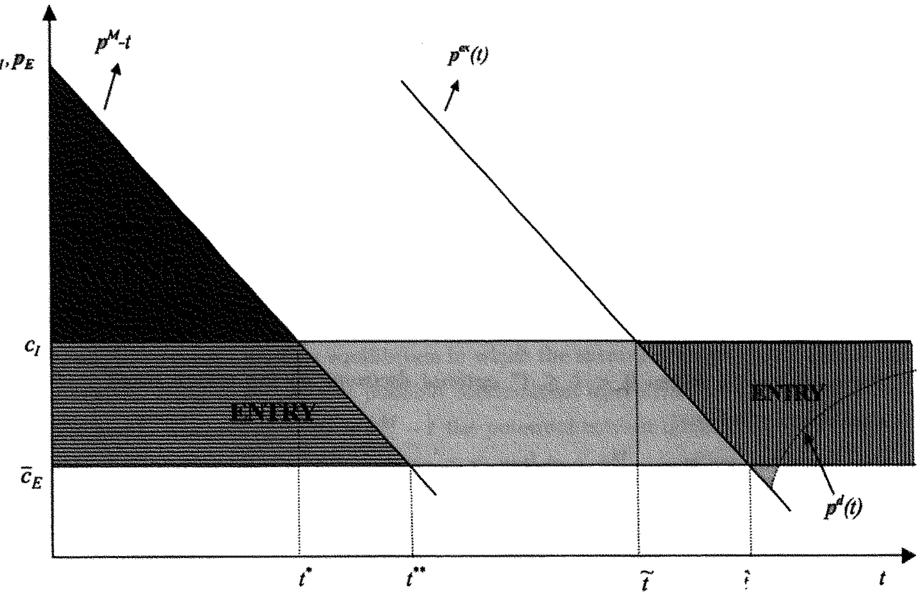

Figure 3-3: $Price - Equilibria : N < \widehat{N}$.

3.5.1 Low penalty: both kind of equilibria arise

Let us consider, first, the case in which the penalty t is sufficiently low. More precisely, we analyse the case where:

$$t \leq p^M - c_I \equiv t^* \tag{3.3}$$

In other words, the threshold $p^M - t$ is weakly higher than c_I.

Two kinds of equilibria exist in this case, illustrated in the following Proposition and *Figure 3-3,3-4,3-5*. There are equilibria *(entry equilibria)* in which the entrant charges a price weakly lower than the incumbent's marginal cost and it is addressed by enough buyers to profitably provide the good. However, due to the miscoordination problem, there are also equilibria *(no-entry equilibria)* in which all the buyers address the incumbent despite the fact that the entrant makes an offer which is more appealing (or, at worse, equal).

Note, however, that the higher the penalty the lower the maximum price that the incumbent can sustain in an exclusionary equilibrium. More precisely, in this setting where the penalty is lower than the threshold t^*, it does not have the role of completely eliminating the miscoordination problem and of avoiding that the no-entry equilibria occur. Nonetheless, its existence limits the incumbent's monopoly power even when it does not suffer the potential entrant's competitive pressure. The reason is that, as illustrated in Lemma 13, if the incumbent should set a price higher than $p^M - t$, the potential entrant could capture all the buyers by slightly undercutting the rival. This is due to the fact that, in this case, the possibility that the entrant might not provide the good does not lead the buyers to accept the incumbent's higher price: they know that if this event should occur they would receive the penalty and hence they are better off accepting the entrant's offer regardless the entrant actually enters or not. In other words, the penalty avoids the miscoordination problem in all the cases where $p_I > p^M - t$ and discourages the incumbent from setting a price higher than this level.[12]

Proposition 14 *When $0 < t \leq t^*$ optimal decisions by the sellers result in two types of equilibrium solutions:*

1. ***No-entry equilibria,***

   where $S = N$ and the two firms make the following choices:

   $p_I^* \in \left[c_I, p^M - t\right]; \qquad D^* = 1, \quad p_E^* \in [0, p_I^*].$

2. ***Entry equilibria,***

   where $S = 0$, and the two firms choose:

   $D^* = 1,\ p_E^* \in \left[\bar{c}_E, c_I\right]; \qquad p_I^* \in \left[p_E^*, p^M - t\right]$

   or where $S \in (0, N^*)$ and the two firms choose:

   $D^* = 1,\ p_E^* = c_I; \qquad p_I^* = c_I$

Proof. First, equilibria where $D = 0$ can be excluded if the penalty is strictly positive. To see this, consider that the incumbent's best reply to $D = 0$ is the monopoly price. However, $\left(D = 0,\ p_I = p^M\right)$ cannot be an equilibrium because $p^M > p^M - t$ and, according to Lemma 13, the entrant could obtain all the buyers choosing $D = 1$ and $p_E < p_I$.

Second, note that there cannot exist an equilibrium in which the incumbent charges a price higher than $p^M - t$. If it does, either the incumbent itself or the entrant (or both of them) has incentive to deviate. To see this, imagine that $p_I > p^M - t$ and that the potential entrant charges a price lower than p_I; according to Lemma 1 the latter obtains all the buyers. Thus,

[12] Note that in equilibrium the penalty is not paid but its mere existence succeeds in limiting the incumbent's monopoly power. However, for the penalty to be effective, it is crucial that the buyers trust to receive it when the entrant gives up entering. For the moment we take as given that the payment of the penalty is credible but we will investigate more deeply this issue in the last Section.

this cannot be an equilibrium as either the incumbent has incentive to deviate by undercutting the potential entrant and deterring its entry or the entrant could deviate by increasing its price. If the entrant charges the same price as the incumbent, two continuation equilibria can arise: either $S < N^*(p_E)$ and the entrant provides the good, or $S = N^*(p_E)$ and entry is not profitable. In the former case, the incumbent has incentive to deviate, by undercutting the rival firm; in the latter case, the entrant has incentive to deviate by undercutting the incumbent and capturing all the buyers. Finally, if the potential entrant charges a price higher than the incumbent's, the continuation equilibrium is $S = N^*(p_E)$. Obviously, this cannot be an equilibrium as the entrant has incentive to undercut the incumbent to be patronized by all the buyers.

Moreover, there cannot exist an equilibrium in which the entrant charges a price higher than the incumbent's. If $p_E > p_I$, in any possible continuation equilibrium the entrant does not provide the good. Hence if $p_E > p_I > p^M - t$ the potential entrant could profitably undercut the incumbent capturing all the buyers. If $p_E > p_I$ and $p_I \leq p^M - t$, either the incumbent or the entrant (or both of them) would have incentive to deviate.

Finally, when $p_I \leq p^M - t$ there exist two possible types of equilibria: equilibria in which the potential entrant remains out of the market even if it is more efficient than the incumbent, and equilibria in which entry occurs. Which one emerges depends upon the continuation equilibria following the bids in which the entrant charges a price lower or equal than the incumbent's.

1. No-entry equilibria.

It is easy to check that $\left(p_I = p^M - t,\ D = 1,\ p_E \leq p^M - t\right)$ can be sustained as an equilibrium by having the continuation equilibria following any bid with $p_E \leq p_I$ such that all the buyers address the incumbent. In this case, the incumbent cannot profitably increase the price because all the buyers would switch to the potential entrant. In turn, the entrant would never succeed in obtaining a number of buyers sufficiently high by charging a price different from p_E. Note that $\left(p_I = p^M - t,\ D = 1,\ p_E \leq p^M - t\right)$ cannot be sustained as an equilibrium when the continuation equilibria following it are such that $S \in [N^*(p_E) + 1, N)$. The potential entrant would be addressed by some buyers, yet not enough to allow it to profitably provide the good. Therefore, it should pay the penalty to the unsatisfied buyers and would have incentive to deviate by choosing not to make any bid $(D = 0)$.

There also exist "no-entry equilibria" in which the incumbent charges a price p lower than $p^M - t$. They are sustained by having all the continuation equilibria following any bid $(p_I = p,\ D = 1,\ p_E \leq p)$ such that $S = N$, while the ones following any bid $(p_I > p,\ D = 1,\ p_E \leq p_I)$ such that all the buyers demand the good from the entrant. When this is the case, the incumbent has no incentive to deviate by charging a price higher than p because it would lose all the buyers; the entrant has no incentive to change its price because this would not allow it to enter.

2. Entry Equilibria.

Note first that there cannot exist an "entry equilibrium" in which the potential entrant charges a price strictly higher than the rival's marginal cost c_I as the incumbent could profitably undercut and obtain all the buyers.

Second, there exist equilibria in which the entrant charges a price between $\overline{c}_E$ and the rival's marginal cost such that all the buyers address it: $(D = 1,\ p_E \in [\overline{c}_E, c_I],\ p_I = p_E)$ with $S = 0$. They are sustained if the continuation equilibria following any bid in which the entrant charges a price strictly lower than the incumbent's (both being $\leq p_I^M - t$) are such that it is addressed by all the buyers. In this case, the entrant cannot deviate by setting a price higher than the rival's as it would lose all the buyers. In turn, the incumbent is indifferent between p_I and any higher price because no buyer would patronize it in any case; instead, it captures all the buyers by decreasing its price (the deviation price is strictly lower than $p^M - t$ and thus $S = N$) but it would not break even as the deviation price is also lower than its marginal cost.

Note that, with the described continuation equilibria, $(D = 1,\ p_E = c_I,\ p_I = c_I)$ and $S \in (0, N^*)$ cannot be an equilibrium because by decreasing slightly the price the potential entrant could capture all the buyers. However, it is sustained in equilibrium by having $S = N$ following any pair of prices such that $p_E < p_I = c_I$ and $S = 0$ following $p_E \leq p_I$ with $p_I > c_I$. This implies that the entrant has no incentive to deviate by decreasing the price because it would lose all the buyers; in turn, the incumbent breaks even either selling at the price c_I to S buyers or increasing its price and losing all the buyers; finally, it would earn negative profits by decreasing its price. Instead, $(D = 1,\ p_E \in [\overline{c}_E, c_I),\ p_I = p_E)$ and $S \in (0, N^*)$ can never be an equilibrium because the incumbent makes negative profits by selling to some buyers at a price lower than its marginal cost and has incentive to deviate to a price sufficiently high to make all the buyers address the entrant.

Finally, there exist also "entry equilibria" in which the incumbent charges a price higher than the entrant's: $\left(D = 1,\ p_E = p \in [\overline{c}_E, c_I],\ p_I \in (p, p^M - t]\right)$. They are sustained by continuation equilibria such that $S = 0$ follows any bid in which the entrant sets a price lower or equal than the incumbent's and lower or equal than p while $S = N$ follows any bid in which the entrant offers a price lower or equal than the incumbent's but higher than p (both being $\leq p^M - t$). In this case, the potential entrant cannot increase its payoff by increasing the price and setting it equal or lower than the incumbent's because it would lose all the buyers. Again the incumbent cannot profitably deviate because, by undercutting, she would earn negative profits. ■

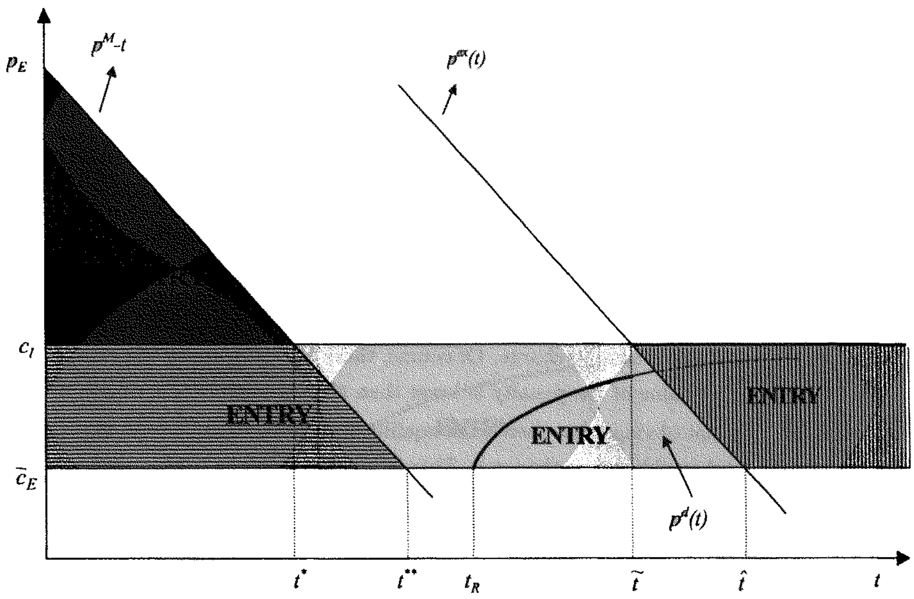

Figure 3-4: *Price – Equilibria* : $N \in \left[\widehat{N}, N^{**}\right)$

3.5.2 High penalty: only "entry equilibria" exist

In this section we consider values of the penalty higher then the threshold $t^* \equiv p^M - c_I$. This implies that the incumbent makes negative profits when it sells to all the buyers charging the maximum price $p^M - t$ and, even if in principle buyers' fragmentation is still an issue[13], equilibria in which the potential entrant is kept out of the market do not arise. This result is illustrated in Proposition 15.

As for the *"entry equilibria"*, the level of the penalty affects the prices that can be charged by the entrant (see Proposition 16). In particular, the higher the penalty the less severe is buyers' fragmentation (i.e. the higher $N^*(p_E)$). Hence, if the penalty is sufficiently high $\left(t > \tilde{t}\right)$, the demand of a single buyer is enough for the entrant to profitably provide the good charging any price higher than $p^{ex}(t)$, with the latter being lower than c_I. Thus, buyers' fragmentation does not play any role when the entrant chooses $p_E \in (p^{ex}(t), c_I]$ and a standard argument applies

[13]Recall that we assumed that a single buyer is not enough to make entry profitable for any $p_E \leq p^M$ up to the value t^{**} of the penalty, with $t^{**} > t^*$.

to show that these prices emerge in the "entry equilibria". Note that, as the value of the penalty increases, the range of prices that can be sustained in equilibrium extends. In particular, as *Figures 3-3,3-4,3-5* make clear, when $t > \hat{t}$ entry is profitable regardless the number of buyers for all the prices weakly higher than $\bar{c}_E$, and the standard equilibria arise.

For lower values of the penalty, miscoordination drives the results. More precisely, given the appropriate continuation equilibria, all the prices between $\bar{c}_E$ and the threshold $p^M - t$ (which now is lower than c_I) are sustainable in equilibrium. The intuition is that the incumbent has no incentive to undercut the potential entrant: it would obtain all the buyers (the deviation price would be strictly lower than $p^M - t$) but its profits would be negative (the deviation price is lower than its marginal cost). Note that the penalty, in this contest, limits the maximum price that the entrant is able to charge. Of course, these equilibria exist as long as $p^M - t \geq \bar{c}_E$ (i.e. as long as the value of the penalty is lower than t^{**} as shown by *Figures 3-3,3-4,3-5*).

Instead, it is not obvious that there exist equilibria where the entrant charges a price higher than $p^M - t$ (and weakly lower than c_I). This implies that it is not also obvious that "entry equilibria" exist at all when $p^M - t < \bar{c}_E$, that is when the penalty is strictly higher than t^{**}. The argument is similar to the one developed for the "no entry" equilibria. In that case, the incumbent was prevented from charging a price above $p^M - t$ by the potential of the entrant to profitably undercut. Now, the entrant maybe prevented from charging a price above $p^M - t$ by the potential of the incumbent to profitably undercut, in spite of the price being below its marginal cost. To see this, assume that $p_E = c_I$.[14] By undercutting slightly the rival, the incumbent would be patronised by $N^*(p_E)$ buyers and would suffer losses selling to them at a price below its marginal cost. Yet, since the entrant would be kept out of the market, the incumbent could compensate these losses with the revenues obtained by selling to the remaining $N - N^*$ buyers at the monopoly price. When $p_E = c_I$ the losses are negligible and the equilibrium does not exist. However, when the entrant charges a lower price (still higher than $p^M - t$) the losses are more relevant and the equilibrium may exist. In *Figures 3-4 and 3-5* the prices above $p^M - t$ that can be sustained in equilibrium are those delimited by the $p^d(t)$ line. Note that these equilibria are more likely to arise the higher the number of buyers. The intuition is that as N increases, N^* increases by the same amount , hence keeping $N - N^*$ constant. This implies that the incumbent's losses by selling to the N^* buyers increase and it is less likely that they can be compensated by selling at the monopoly price to the remaining $N - N^*$ buyers. Similarly, these equilibria are more likely to arise the higher the value of the penalty. Overall, when the number of buyers is sufficiently low $\left(N < \hat{N}\right)$ for all the values of the penalty for which buyers' fragmentation is an issue, these equilibria do not exist (*Figure 3-*

[14] Recall that $c_I > p^M - t$ as we are considering values of the penalty higher than t^*.

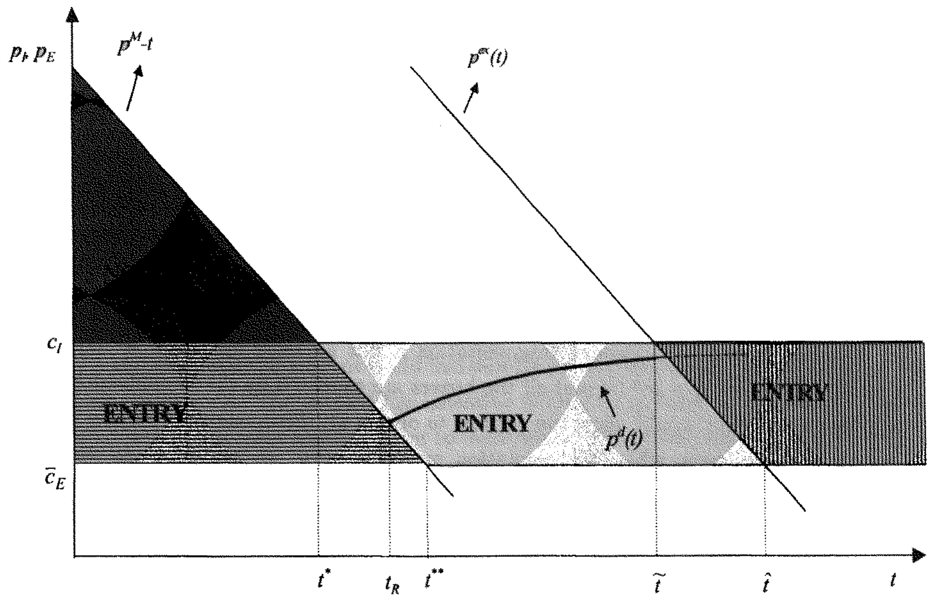

Figure 3-5: *Price Equilibria* : $N \geq N^{**}$.

3). Viceversa, when the number of buyers is higher than the previous threshold, these equilibria exist provided that the penalty is sufficiently high $(t > t_R)$. Note that the threshold t_R moves leftward as N increases (see *Figures 3-4 and 3-5*). In particular, if $N > N^{**}$, $t_R < t^{**}$.[15]

Overall, unless the penalty is so high that entry is credible whatever the number of buyers, fragmentation of the latter creates two sort of problems to the entrant. Either its entry is prevented because buyers stuck on the wrong equilibrium or it is forced to charge prices sometimes significantly below c_I ; indeed maybe that no price above the entrant's average cost can be sustained in equilibrium. In this case the problem is not lack of coordination but the uncertainty about the ability of the entrant to provide the good makes it possible for the incumbent to undercut prices below its marginal costs and prevents the entrant to charge such prices.

Proposition 15 *When $t > t^*$, "**no-entry equilibria**" do not exist.*

Proof. Consider $t \in (t^*, \bar{t}]$ where $\bar{t} \equiv f - (p^M - c_E)$ is such that $p^{ex}(\bar{t}) = p^M$. When the

[15]In the Appendix we provide the formal analysis concerning the critical values $\widehat{N}$ and N^{**}.

value of the penalty belongs to this interval, buyers' fragmentation is an issue for any $p_E \leq p^M$.

Also in this case there cannot exist equilibria where $D = 0$. Moreover, there cannot exist a "no-entry equilibrium" where $p_I \geq c_I$. The reason is that the incumbent's price would be higher than $p^M - t$ and the potential entrant could obtain all the demand by slightly undercutting. Finally, there cannot exist a "no-entry equilibrium" where $p_I < c_I$ as the incumbent would have incentive to deviate. To see this recall that, in order to be an equilibrium, S could not be lower than N (the entrant would deviate to $D = 0$ if its entry was deterred but it should pay the penalty to some unfulfilled buyers). Hence, the incumbent would sell to all the buyers at a price lower than its marginal cost and would not break even. Overall, a "no-entry equilibrium" does not exist.

Consider now $t > \bar{t}$. Buyers' fragmentation is not an issue for $p_E > p^{ex}(t)$. Hence, an equilibrium where $p_I > p^{ex}(t)$ and all the buyers are captured by the incumbent cannot exist, as a slight undercut would allow the entrant to obtain all the demand. Applying the previous argument to the cases where fragmentation problems arise, we can conclude that "no-entry equilibria" do not exist. ■

Proposition 16 *When $t > t^*$ there exist different types of "**entry equilibria**":*

1. *If $t > \widetilde{t}$, there exist equilibria where $S = 0$ and the two firms choose:*

   $D^* = 1,\ p_E^* \in (p^{ex}(t), c_I], \qquad p_I^* = p_E^*.$

2. *If $t^* < t \leq t^{**}$ there exist equilibria where $S = 0$ and the two firms choose:*

   $D^* = 1,\ p_E^* \in [\overline{c}_E, p^M - t], \qquad p_I^* \in [p_E^*, p^M - t].$

3. *If the number of buyers and the penalty are sufficiently high$\left(N \geq \widehat{N} \text{ and } t > t_R\right)$, there exist also equilibria where $S = 0$ and which support some prices above $p^M - t$:*

   $D^* = 1,\ p_E^* \in [\max\{p^M - t, \overline{c}_E\}, \min\{p^d(t), p^{ex}(t)\}], \qquad p_I^* = p_E^*.$

Proof. Obviously, also in this case there cannot exist an "entry equilibrium" in which $p_E > c_I$ as the incumbent could undercut the entrant making entry unfeasible.

1. Denote with $\widetilde{t}$ the value of the penalty such that $p^{ex}(\widetilde{t}) = c_I$ and consider $t > \widetilde{t}$. For all the prices $p_E \in (p^{ex}(t), c_I]$ miscoordination is not an issue and, by the previous Lemma, the incumbent would obtain all the buyers by undercutting. Since the deviation price would be lower than c_I, such deviation would not be profitable and $(D = 1, p_E \in (p^{ex}(t), c_I], p_I = p_E)$ are equilibria. Note that $\widehat{t} \equiv f\frac{N-1}{N}$ is the value of the penalty such that $p^{ex}(\widehat{t}) = \overline{c}_E$. Hence, when $t > \widehat{t}$ all the prices $p_E \in [\overline{c}_E, c_I]$ are sustainable in equilibrium.

2. Proposition 14 (part 2) already shows that $(D=1, p_E \in [\bar{c}_E, p^M - t], p_I \in [p_E, p^M - t])$ with $S=0$ are equilibria. Obviously, these equilibria exist as long as $p^M - t \geq \bar{c}_E$, that is, as long as $t \in (t^*, t^{**}]$ where $t^{**} \equiv p^M - \bar{c}_E$.

3. The case where $p_E > p^M - t$ is more tricky. First, differently from case 1. there cannot exist an equilibrium where $p_I > p_E$. The reason is that this p_I is higher than $p^M - t$ and no miscoordination problem arises if the potential entrant increases her price (keeping it below p_I): she would obtain all the buyers and the deviation would be profitable. Hence, the candidate equilibria are $(D=1,\ p_E = p,\ p_I = p)$ with $p \in (p^M - t, c_I]$ when $p^M - t$ is higher than $\bar{c}_E$ (i.e. when $t \in (t^*, t^{**}]$, and with $p \in [\bar{c}_E, c_I]$ when $t > t^{**}$.

Let us consider $(D=1, p_E = c_I,\ p_I = c_I)$ with $S=0$. (Note that $S \in (0, N^*)$ is excluded as $c_I > p^M - t$ and the potential entrant could increase its profits decreasing slightly its price and capturing all the buyers). The entrant has incentive neither to increase the candidate equilibrium price (it would not enter anymore) nor to decrease it. The incumbent has no incentive to increase the price as it would be higher than $p^M - t$ and no buyer would address it. However, it has incentive to slightly decrease the price. Imagine the incumbent chooses p_I slightly lower than c_I and still above $p^M - t$. In this case the continuation equilibrium is $S = N^*(c_I)$. Hence, the incumbent deters entry and sells to N^* buyers at $p_I < c_I$ but can compensate the present losses by selling to the remaining buyers (unfulfilled by the entrant) at the monopoly price. Therefore, its deviation profits amount to $\pi_I = (c_I - \epsilon - c_I) N^*(c_I, t) + (p^M - c_I)(N - N^*(c_I, t))$[16]. The first term is negative but the second one is positive and if ϵ is sufficiently small $\pi_I > 0$ so that the incumbent can profitably deviate. Hence, $(D=1, p_E = c_I,\ p_I = c_I)$ with $S=0$ is not an equilibrium. Note that this result is due to the fact that $c_I > p^M - t$. The argument does not work when c_I or p_E are smaller than or equal to $p^M - t$ as, when the incumbent undercuts, the continuation equilibrium is $S = N$ and its deviation profits would be negative.

Let us consider now $(D=1,\ p_E = p,\ p_I = p)$ with $S=0$ and $p < c_I$; the incumbent's deviation profits, when she decreases slightly her price (such that $p_I < p$ but it is still higher than $p^M - t$) are given by:

$$\pi_I(p,t) = (p - \epsilon - c_I) N^*(p,t) + (p^M - c_I)(N - N^*(p,t))$$

The lower p the higher the present per-buyer loss of the incumbent. However, the lower p the (weakly) lower N^*. This tends to decrease the aggregate present losses and to increase the gain from selling to the unfulfilled buyers.

To get some insight about the sign of the function $\pi_I(p,t)$, in the Appendix we have studied

[16]For simplicity we assume that the discount factor is equal to 1.

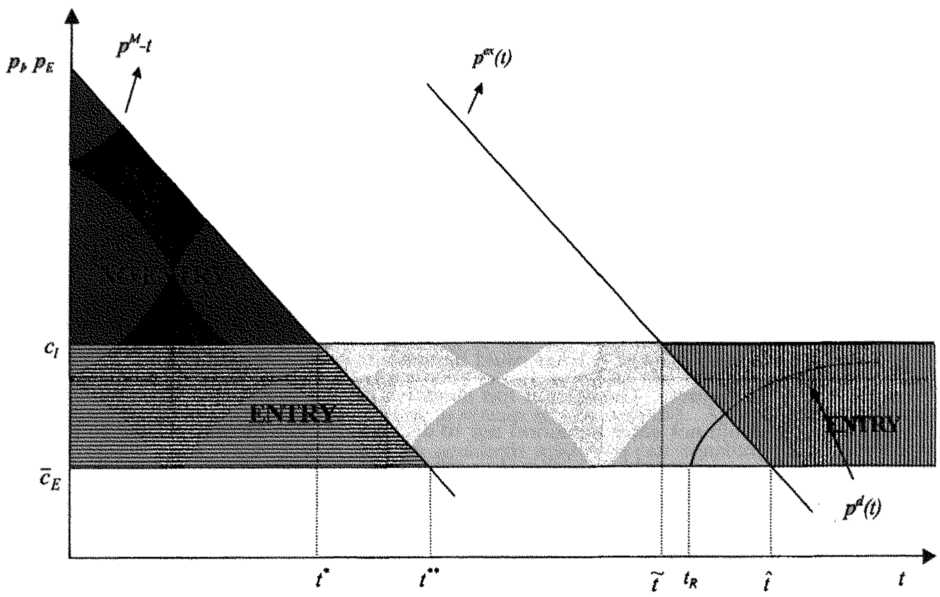

Figure 3-6: *Price – Equilibria* : $N < \widetilde{N}$.

the function $\pi_I^{'}(p,t)$ which approximates $\pi_I(p,t)$ for the case where $N^*(p,t)$ is continuous rather than discrete. ■

3.6 Selection of the equilibria

When multiple equilibria arise, we choose to select the price equilibrium which represents a Pareto-Optimum.

Hence, among the "no-entry equilibria" Pareto-dominance selects the one where $p_I^* = p_E^* = p^M - t$.

If the number of buyers is sufficiently low $\left(N < \widetilde{N}\right)$[17], among the "entry equilibria" Pareto-dominance selects the one where $p_E^* = p_I^* = c_I$ when $t \leq t^*$ and $t > \widetilde{t}$ and the one where $p_E^* = p_I^* = p^M - t$ when $t \in (t^*, t^{**}]$ (See *Figure 3-3 and 3-6*).

When the number of buyers is higher $\left(N \geq \widetilde{N}\right)$, besides the equilibrium where $p_E^* = p_I^* = c_I$

[17] $\widetilde{N}$ is the number of buyers such that $t_R > \widetilde{t}$ when $N < \widetilde{N}$. See the Appendix for more details.

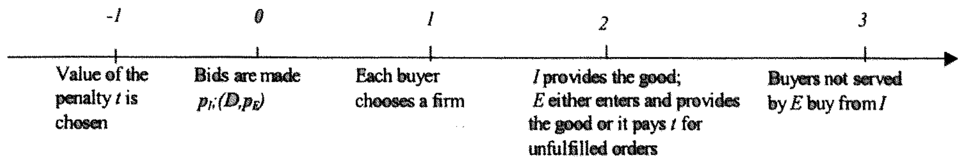

Figure 3-7: *Time – line*

when $t \leq t^*$ and $t > \widetilde{t}$, Pareto-dominance selects $p_E^* = p_I^* = p^M - t$ when $t \in (t^*, \min\{t^{**}, t_R\}]$ and $p_E^* = p_I^* = p^d(t)$ when $t \in (t_R, \widetilde{t}]$ [18] (See *Figures 3-4 and 3-5*).

3.7 The optimal penalty's choice

Sofar, we have considered the case where the penalty t is exogenously given. In this section, we briefly analyse the case where the penalty is endogenous. In terms of our model, this means that there exists a period before the proper game where the penalty is chosen (see *Figure 3-7* with the new timeline) respectively by the social planner and by the potential entrant.

3.7.1 The social planner's choice

Suppose the social planner is maximising a social welfare function which attaches a higher weight to the consumer surplus than to profits, so that she is willing to implement the lowest possible price.[19] Looking at *Figures 3-3,3-4,3-5*, it is clear that the optimal penalty depends upon the number of buyers. Moreover, the optimal penalty implements a price equal to $\overline{c}_E$ when the number of buyers is sufficiently low $(N \leq N^{**})$, with the implemented price decreasing as N increases. Instead, the implemented price increases with N , when the number of buyers is higher than N^{**}.

[18] t_R belongs to the set if $N < N^{**}$.

[19] We need this assumption because we have assumed, for simplicity, that demand is completely inelastic. However, it can be proved that the same qualitative results hold in the case where demand is elastic and the social planner maximizes a standard social welfare function. Since the calculations with elastic demand are more lenghty and cumbersome, we omit them here for shortness. Details are available from the authors upon request.

Low number of buyers ($N \leq N^{**}$)

When $N \leq N^{**}$, by choosing a penalty which amounts to t^{**} the only equilibrium is such that the more efficient producer enters the market, selling to all the buyers at a price equal to its average cost. (See *Figures 3-3 and 3-4*) Note, however, that this price is higher the lower the number of buyers, as fewer buyers imply a smaller total demand and less exploitation of scale economies.

High number of buyers ($N > N^{**}$)

When $N > N^{**}$, some prices higher than $p^M - t$ arise in equilibrium provided that $t > t_R$, where $t_R < t^{**}$ (see *Figure 3-5).* This implies that the social planner can never implement a price equal to $\overline{c}_E$ and, if Pareto-dominance is accepted as a selection concept, the optimal penalty is t_R (strictly speaking is slightly higher than t_R), which makes the entrant provide the good at a price $p^M - t_R$. Note that the implemented price is higher the higher the number of buyers. The intuition is that the higher N, the higher N^* and the weaker the incumbent's incentive to deviate from a price p above $p^M - t$. This makes such prices emerge in equilibrium for lower and lower penalty values. Hence, the threshold t_R decreases, while the implemented price increases.

3.7.2 The entrant's choice

The entrant has an interest in offering a penalty such that at equilibrium it will be able to enter the industry and the price it obtains from buyers is the highest possible. Provided that the selection concept of Pareto-dominance is accepted, looking at *Figures 3-3,3-4,3-5 and 3-6*, it is easy to see that this is achieved by choosing a very large penalty $\widetilde{t}$ (strictly speaking the optimal penalty must be slightly higher than $\widetilde{t}$), so that the potential entrant can prevent any problem due to fragmentation by setting the price $p_E = c_I$. However, the same result can be obtained by offering to pay a lower penalty t^* (strictly speaking we should say that the penalty is slightly higher than t^* since for $t = t^*$ both entry and no-entry equilibria may arise). To sum up, the entrant reaches the same payoff with either a penalty t^* or $\widetilde{t}$. So far we have assumed that the penalty is always credible, independently of its level. However, $\widetilde{t}$ involves a higher payment and in some circumstances this might raise some doubts about its credibility, at least more than t^* does. We now turn to the issue of credibility.

3.8 Credibility of the penalty

Sofar, we have just *assumed* that it is credible for firm E to pay the penalty to the buyers which have chosen it in case the number of these buyers is not large enough to make entry profitable. In this section, we briefly analyse the issue of the credibility of the penalty.

The payment of the penalty is written in the contract with the buyers and it is therefore enforceable in courts. Suppose that by not paying the penalty firm E has to default and go bankrupt. In our model, the firm is not incumbent in the industry considered but assume that it does operate in other sectors when the game starts. Denote with π_E the value of the stream of profits it makes in all the sectors it operates.

The model can then be extended to endogenise the credibility of the penalty by adding the following node in our game. After observing the number of buyers $N - S$ which address it after the auctions, firm E has to decide whether to provide the good or not. If it does not provide the good (does not enter), it has the choice between defaulting, which gives it a payoff of $-\pi_E$, and paying the penalty, which gives it a payoff of $-t(N - S)$.

Therefore, the penalty is credible only if: $-t(N - S) > -\pi_E$. Otherwise, firm E prefers to default. Buyers anticipate this and would not address orders to the potential entrant.

Note that the interesting implication of this analysis is that the larger the potential firm (the more outside profits it has) the more likely for the penalty to be credible and in turn for entry to occur in the industry.

3.9 Conclusions

We have provided a formalisation for the argument that buyers' power fosters competition by facilitating entry. In our model, fragmented buyers suffer from lack of coordination: each of them might address a more inefficient incumbent rather than the potential entrant if fearing that the latter might not provide the good. As a result, entry might not occur in the industry. If buyers could coordinate their decisions, this problem would not arise and the entrant would operate at equilibrium. Therefore, this paper provides some efficiency rationale for centralised buying agencies, to which independent buyers delegate their purchasing decisions.

Our paper also indicates a mechanism which helps a potential entrant which faces such coordination problems. We have showed that exclusion is less likely to occur if the entrant offers a contract to the buyers which establishes a penalty in case orders are not going to be fulfilled. The penalty represents a commitment device for the entrant[20], as it becomes costly

[20] Of course, any coordination problems would be solved if the entrant could sink its fixed costs before the auctions take place. Our model is of interest only for those situations where the investment takes time to be

for it not to honour the orders received. The penalty clause gives then an incentive to buyers to address the entrant, by relaxing the coordination problem. For low values of the penalty, exclusion might still exist at equilibrium, but we have showed that the penalty clause reduces the price that buyers would pay the incumbent even when it continues to be a monopolist. For high values of the penalty, exclusion of the more efficient entrant never occurs. We have also studied the optimal penalty level chosen by the entrant an by a hypotethical social planner.

made and the firm does not have the means to credibly commit to entry.

3.10 Appendix

For simplicity we consider $N^*(p)$ as a continuous function. Adopting the convention that the incumbent has no incentive to deviate when $\pi_I' \leq 0$, we have to study the sign of the following function:

$$\pi_I'(p,t;N,c_I,c_E,f) = \left(p^M - p\right)\left(\frac{f}{p-c_E+t}\right) - (c_I - p)N \tag{3.4}$$

In particular, $\pi_I'(p,t) \leq 0$ iff

$$t \geq t\left(p;p^M,N,c_I,c_E,f\right) \equiv \frac{\left(p^M-p\right)f}{N(c_I-p)} - (p-c_E) \tag{3.5}$$

Recall that the equilibria we are looking for may arise only for prices and values of the penalties such that $t \in \left(t^*,\hat{t}\right]$ and $p \in \left(\max\left\{p^M - t, \overline{c}_E\right\}, \min\left\{c_I, p^{ex}(t)\right\}\right]$.[21] Hence, in the area we are concerned, the function $t(p)$ is shifted downward as N increases, tends to infinite as p approaches c_I and has a minimum in $p = c_I - \frac{\sqrt{Nf(p^M-c_I)}}{N}$.

Recall also that in order for the market to be viable to the entrant, we imposed the condition:

$$N > \frac{f}{c_I - c_E} \tag{3.6}$$

Further restrictions on the parameters imposed in the model are $p^M > c_I > c_E$ and $f > 2\left(p^M - c_E\right)$.

We want to show that:

1. *When* $N \in \left(\frac{f}{c_I-c_E}, \widehat{N}\right)$, $\pi_I'(p,t) > 0$ *for all the relevant prices and values of the penalty.*
2. *When* $N \in \left[\widehat{N}, N^{**}\right)$, $\pi_I'(p,t) \leq 0$ *for* $t \in \left[t_R, \hat{t}\right]$ (with $t_R > t^{**}$) *and for* $p \in \left[\overline{c}_E, \min\left\{p^d(t), p^{ex}(t)\right\}\right]$.
3. *When* $N \geq N^{**}$, $\pi_I'(p,t) \leq 0$ *for* $t \in (t_R, t^{**}]$ *and* $p \in \left(p^M - t, p^d(t)\right]$ *and for* $t \in \left(t^{**}, \hat{t}\right]$ *and* $p \in \left[\overline{c}_E, \min\left\{p^d(t), p^{ex}(t)\right\}\right]$, with $t_R \leq t^{**}$.

Proof. When $p = \overline{c}_E$,

$$t\left(c_E + \frac{f}{N}; N, p^M, c_I, c_E, f\right) = f\frac{p^M - c_I}{N(c_I - c_E) - f} \tag{3.7}$$

[21] Strictly speaking, $\overline{c}_E$ belongs to the set when it is higher than $p^M - t$.

As a function of N, it is continuous and positive given condition 3.6, and strictly decreasing.

We first show that there exist a unique number of buyers such that $t\left(\overline{c}_E; p^M, N, c_I, c_E, f\right) = \widehat{t}$.

The threshold $\widehat{t}$ of the penalty is given by:

$$\widehat{t} = f\frac{N-1}{N} \tag{3.8}$$

As a function of N, it is continuous for $N > 0$ and strictly increasing.

Let us denote with d the difference between $t\left(\overline{c}_E; p^M, N, c_I, c_E, f\right)$ and $\widehat{t}$:

$$d = \frac{f}{N}\frac{p^M N - c_I N^2 + c_E N^2 + fN - c_E N - f}{N\left(c_I - c_E\right) - f} \tag{3.9}$$

$d(N)$ is continuous and strictly decreasing, $\lim_{N\to\infty} d(N) = -f$ and $\lim_{N\to\left(\frac{f}{c_I - c_E}\right)^+} d(N) = \infty$. By a continuity argument it can be shown that there exist a unique $\widehat{N} > \frac{f}{c_I - c_E}$ such that $t\left(\overline{c}_E; p^M, N, c_I, c_E, f\right) \geq \widehat{t}$ for $N \leq \widehat{N}$. More precisely,

$$\widehat{N} = \frac{1}{2\left(c_I - c_E\right)}\left(p^M + f - c_E + \sqrt{\left(p^M + f - c_E\right)^2 - 4f\left(c_I - c_E\right)}\right) \tag{3.10}$$

and it is always defined given the admissible values of the parameters.

Similarly, it can be shown that there exist a unique $N^{**} > \frac{f}{c_I - c_E}$ such that $t\left(\overline{c}_E; p^M, N, c_I, c_E, f\right) \geq t^{**}$ for $N \leq N^{**}$, where the threshold t^{**} of the penalty is given by:

$$t^{**} = p^M - c_E - \frac{f}{N} \tag{3.11}$$

and the difference between the $t\left(\overline{c}_E; p^M, N, c_I, c_E, f\right)$ and t^{**} is given by:

$$D = \frac{1}{N}\frac{N\left(p^M - c_E\right)\left(2f - N\left(c_I - c_E\right)\right) - f}{N\left(c_I - c_E\right) - f} \tag{3.12}$$

N^{**} is:

$$N^{**} = \frac{f}{c_I - c_E}\left(1 + \sqrt{\frac{p^M - c_I}{p^M - c_E}}\right) \tag{3.13}$$

Note that, by assumption, for any N, $\widehat{t} > t^{**}$. Hence, $N^{**} > \widehat{N}$.

Given the admissible values of the parameters, the function $t(p;N^{**})$ is increasing when $p \geq c_E + \frac{f}{N^{**}}$. Since by decreasing N, $\overline{c}_E$ increases and the price where $t(p;N)$ is minimised decreases, for any $N < N^{**}$ the slope of the function $t(p;N)$ in $p \geq c_E + \frac{f}{N}$ is also positive. Moreover, as the function $t(p;N)$ is shifted upward by decreasing N while the thresholds t^{**} and $\widehat{t}$ decrease, when $N \in \left(\frac{f}{c_I - c_E}, \widehat{N}\right)$, $t(p;N) > \widehat{t}$ for all the prices $p \in [\overline{c}_E, c_I]$, while when $N \in \left[\widehat{N}, N^{**}\right)$ $t(p;N) > t^{**}$ for all the prices $p \in [\overline{c}_E, c_I]$.

Hence, when $N \in \left(\frac{f}{c_I - c_E}, \widehat{N}\right)$, for all the pairs (t,p) such that $t \in \left(t^{*}, \widehat{t}\right]$ and $p \in \left(\max\left\{p^M - t, \overline{c}_E\right\}, \min\left\{c_I, p^{ex}(t)\right\}\right]$, $\pi_I'(p,t) > 0$.

Instead, when $N \in \left[\widehat{N}, N^{**}\right)$, $\pi_I'(p,t) \leq 0$ for the pairs (t,p) such that $t \in \left[t_R, \widehat{t}\right]$ and $p \in \left[\overline{c}_E, \min\left\{p^d(t), p^{ex}(t)\right\}\right]$ where $t_R \equiv t\left(\overline{c}_E; p^M, N, c_I, c_E, f\right) \in \left(t^{**}, \widehat{t}\right)$.

When $N \geq N^{**}$, $t(\overline{c}_E, N) \leq t^{**}$. Recall that we are not concerned to the pairs (t,p) such that $t \leq p^M - p$.

Since $t(\overline{c}_E, N) \leq t^{**}$, independently of the slope of the function $t(p;N)$ in $p = c_E + \frac{f}{N}$, there exist a unique price $p_R \in [\overline{c}_E, c_I)$ such that $t(p;N) \geq p^M - p$ for $p \geq p_R$. Hence, when $p \in [\overline{c}_E, p_R]$ condition 3.5 becomes $t > p^M - p$. Being a bit loose and using t_R to denote $t(p_R, N)$, $(t_R \leq t^{**})$, we can conclude that $\pi_I'(p,t) \leq 0$ for the pairs (t,p) such that $t \in (t_R, t^{**}]$ and $p \in (p^M - t, p^d(t)]$ and for the pairs (t,p) such that $t \in \left(t^{**}, \widehat{t}\right]$ and $p \in \left[\overline{c}_E, \min\left\{p^d(t), p^{ex}(t)\right\}\right]$.

The threshold $\widetilde{t}$, by assumption, belongs to $\left(t^{**}, \widehat{t}\right)$ for any N, and is given by:

$$\widetilde{t} = f + c_E - c_I \tag{3.14}$$

Following the same logic as before, it is easy to see that there exist a unique $\widetilde{N} \in \left(\widehat{N}, N^{**}\right)$ such that $t\left(\overline{c}_E; p^M, N, c_I, c_E, f\right) \geq \widetilde{t}$ when $N \leq \widetilde{N}$, where

$$\widetilde{N} = \frac{f}{c_I - c_E} + \frac{f\left(p^M - c_E\right)}{\left(c_I - c_E\right)\left(f - c_I + c_E\right)} \tag{3.15}$$

Moreover, when $N \in \left[\widehat{N}, \widetilde{N}\right)$, $\pi_I'(p,t) \leq 0$ for the pairs (t,p) such that $t \in \left[t_R, \widehat{t}\right]$ and $p \in \left[\overline{c}_E, \min\left\{p^d(t), p^{ex}(t)\right\}\right]$ where $t_R \equiv t\left(\overline{c}_E; p^M, N, c_I, c_E, f\right) > \widetilde{t}$. ■

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Chapter 4

The welfare effects of competition for Foreign Direct Investments

4.1 Introduction

When establishing new plants overseas, multinational firms (MNEs) are often offered substantial investment incentives by host countries. Examples can be found in a number of sectors and countries[1]. Just to mention some striking cases, LG Electronics, the South Korean group, received Pounds 247m for an investment in a semiconductor and electronics plant in South Wales[2]; Alabama attracted a Mercedes-Benz factory with a package worth over \$250m[3] in what is considered a high-water mark in the annals of state-aid. When Ford and Volkswagen inaugurated AutoEuropa, a joint venture which is Portugal's biggest foreign investment and the largest manufacturing project ever undertaken in the country, one third of the Es395bn invested were contributed by the Government[4].

Since foreign investments are increasingly courted worldwide as providers of jobs and new technology, when a company announces it is looking for a new site, fierce competition among eager suitors often arises. This happened with Toyota, which announced its intention to produce its smallest car in Europe and made it clear it planned to take advantage of financial assistance, where it was offered[5]. Similarly, bids from various regional development agencies were solicited

[1] To our knowledge, very few data have been collected about these deals. For this reason, most studies refer to anecdotal data.
[2] Financial Times, July 24, 1997.
[3] Financial Times, November 18, 1997.
[4] Financial Times, November 8, 1995.
[5] Financial Times, April 14, 1997.

by Acer, Taiwan's biggest computer company, when it announced it was considering locations for its first full-scale European manufacturing plant. Eventually the company decided to locate in Wales, but the North-East England Development Agencies alleged that Wales had involved in "unfair" practices to win the FDI to the detriment of North-East England.[6].

These few examples show that bidding wars among countries or regions to attract FDI are often intense and the debate about their consequences is open[7].

The aim of this paper is to provide some insight into this issue. It is often held that competition for FDI results in a waste of resources: either the firm receives a transfer from a jurisdiction where it would have located anyway, in the absence of any incentive; or competition escalates into a bidding *crescendo* that injures all the involved jurisdictions. This argument motivates the attempts of some Governments to limit competition in this sphere. For instance, in UK the IBB (Investment in Britain Bureau) has established common guidelines that financial assistance offered by the single regional agencies should respect. In the USA, there is support for Congress to mandate an end to the incentives wars by banning subsidies[8].

However, this paper suggests that competition for FDI might have a positive role: it might facilitate efficiency-enhancing location decisions that would have not been made otherwise. In particular, it assumes that one potential location (for instance, a depressed region) benefits more from the inward FDI; yet, the MNE finds it more profitable to locate in the other (richer) region, subsidies being equal. In this case, subsidy competition might succeed in changing the firm's incentives and might be the "invisible hand" that channels society's resources where they are valued the most and where they would have not gone if subsidies were banned or standardized. Hence, a trade off arises: banning subsidies (or imposing uniformity) helps avoiding that incentives reach excessively high levels due to the "externality problem", but it prevents competition from performing its allocative function and is not necessarily beneficial. Indeed, subsidy competition is shown to increase total welfare if the depressed region obtains the investment, if the positive externality associated to it is quite strong and if the difference between the two regions is sufficiently high.

Obviously, the previous trade-off could be solved by a supra-national authority which would try to capture the positive role of subsidies avoiding that countries waste resources bidding one against the other. To do it, it would allow only the depressed region to offer subsidies and only when it competes with a rival one sufficiently advanced and the positive externality is

[6]Financial Times, December 22, 1997.

[7]For example, see The Economist, February 1, 1997.

Besides, this issue was the focus of a Conference (The Economic War Among the States) held in Washington D.C. on May 21-22, 1996. For a review of the main points raised by the discussion, see the magazine of the Federal Reserve Bank of Minneapolis, "The Region" (special issue), June 1996.

[8]See Burstein and Rolnick (1995).

sufficiently strong or when the externality is extremely strong. Both the regions are forbidden to offer subsidies otherwise. These conclusions are consistent with the European regulation in this sphere (art. 87-89 of the EU Treaty) and emphasize an idea that is receiving support also at WTO level.

These results have been derived assuming that the MNE has pre-committed to investing in one of the two countries. We also study the case where the firm has the option to serve both markets by exporting from its home base. It is shown that the national and aggregate welfare effects of subsidy competition can be very different in these two cases. This suggests that all the feasible alternatives available to the MNE must be taken into account when assessing whether subsidy competition might have negative consequences or not.

This paper is related to several strands of literature. First, to the public finance literature which has studied the problem of competition among jurisdictions according to two main approaches. The "Tiebout tradition" emphasizes that intergovernmental competition leads to an efficient provision of local public goods and allocation of the economic activity, thereby pointing out the risks of imposing uniformity and of preventing competition. However, this approach is not very reasonable when dealing with state-aid schemes for FDI, especially with incentives to specifically targeted firms.

A second approach addresses the issue of tax competition assuming different jurisdictions attempting to tax capital earnings within their boundaries, when capital is mobile among them and using tax revenues to provide public goods. For the well known externality problem, the resulting competition is inefficient because it determines too low tax rates and the underprovision of public goods. Anything that limits this kind of competition is, therefore, desirable[9].

Yet, this literature is more appropriate when dealing with *competition for portfolio investments* rather than *for FDI*[10]. Recently the distinction between capital and firm mobility has been stressed[11], and the characterizing features of FDI have been taken into account in modelling intergovernmental competition. However, as long as it is assumed that countries are symmetric, conclusions are very similar to the previous ones. Since there is no social gain from the MNE's location in a jurisdiction rather than in another, the only element at work is the externality problem which keeps subsidies away from their efficient level. This would give a rationale for a ban on subsidies or to a policy of state-aid control[12] like in Markusen, Morey

[9]See Wildasin and Wilson(1991) for a comprehensive overview of models with symmetric countries; Bucovesky(1991) and Wilson(1991) for models with countries different in size.

[10]See Markusen (1995), for a distinction between the two.

[11]Doyle and van Wijnbergen (1984) and Bond and Samuelson (1986) first take into account this distinction and study the location choice of a specific profit-making firm. However, they assume that the firm bargains with only one government at a time and do not describe a proper bidding war. Black and Hoyt (1989) introduce the auction in the framework, assuming a firm that simultaneously negotiates with several governments.

[12]This kind of models can be essentially associated to the literature on "strategic trade policy".

and Olewiler (1995) and in Haaland and Wooton (1999). Similarly, when the benefits associated to the FDI are assumed to differ across potential locations[13] but the investment profile determined by subsidy competition is the same as in the case in which incentives cannot be offered, conclusions do not change: competition has no positive effects and merely results in a waste of resources, as in Haufler and Wooton (1999).

The results of the analysis might dramatically change if letting governments compete through subsidies alters the MNE's incentives with respect to the case in which subsidies are ruled out. Competition performs this role in the model of Black and Hoyt (1989) and of Haaparanta (1996), but the welfare effects associated to it are not studied. Barros and Cabral (1999) investigate this issue. They show that a small country with higher unemployment benefits from engaging in a subsidy game and that total welfare may be higher in equilibrium with respect to the case in which subsidies are forbidden. Their work is the closest to ours, but we generalize their analysis in many respects. First, a general set up is adopted which encompasses different sources of welfare gains associated to a firm's investment and which relies on general payoffs. Moreover, while they assume that FDI is always done in one of the two countries, we study also the case with an exporting option. Finally, this paper considers a number of extensions to the basic framework: first, it analyses the solution that maximizes the total welfare of the two countries; second, it briefly discusses how the conclusions can change according to the distribution of the bargaining power between countries and the MNE and the case where there is uncertainty about the benefits associated to the FDI when the countries offer their bids.

Competition for FDI has been studied also in a dynamic framework by King and Wellig (1992), King, McAfee and Wellig (1993) and by Besley and Seabright (1999). In particular the last work shows that intergovernmental competition may induce an inefficient investment profile because countries' bids for the investment today may be distorted by the burden of the subsidies expected for the future, thereby failing to reflect the intrinsic benefits yielded by the investment.

The rest of the paper is organized as follows. In section 4.2, the model is presented. Section 4.3 solves the subsidy game and analyses its welfare effects when exports are not an alternative to FDI. Section 4.4 relaxes this hypothesis and presents a parametric model which helps clarifying the issue. Section 4.5 concludes the paper.

[13] As suggested by the literature on the "new economic geography".

4.2 The model

We consider two countries or regions, (A and B), each one willing to attract a manufacturing plant of a producer from a third country, that we denote as the MNE.

The MNE's problem is whether to set up an affiliate in one of the two regions (and in which of the two) or not to invest abroad and hence to export from its country of origin. If the MNE exports, it bears a trading cost per unit of output equal to t (which is the same for serving both regions). We assume that t is significantly higher than the transportation costs (say t'[14]) between the two regions. If the MNE invests abroad, it incurs a set-up cost F, independent of the volume of output[15].

When locating in a region, the MNE determines a positive externality, for which a variety of explanations have been identified. For instance, FDI can have a positive impact on local employment[16] and on real wages[17]; the MNE's more advanced technology may spill over local firms[18] (through imitation, reverse engineering or turnover of domestic employees from the MNE to local firms) which thus, may increase their productivity; obviously technological spillover may benefit also consumers; FDI, as channel of technological diffusion may have a positive impact on the rate of technological progress and on the growth rate of the host economies[19]; the MNE's entry in an industry may introduce additional competition, thereby increasing overall welfare; moreover, even if such competition may damage local firms, it may stimulate the development of the local suppliers' industry which, in turn, can benefit final-goods local producers through subsequent forward-linkages. In some cases, MNEs can act as catalyst for the development of local production[20]; MNEs' location can also increase the variety of goods and services available in the host market, or may provide them at a lower price.

Obviously, there may be also costs associated to the MNEs' location in a region. They comprehend the costs of foreign ownership of local factors of production and of the loss of control

[14] t' can be interpreted as a measure of the integration between the two regions. If $t' = 0$, the two regions are completely integrated. In the parametric example illustrated in Section 4.4 we adopt this assumption and we discuss its consequences.

[15] We assume that fixed costs are high enough so that the MNE does not find it profitable to set up a plant in each region; equivalently that transportation costs between the two regions are low enough.

[16] The creation of jobs related to FDI can be substantial. For instance, in UK, the new foreign investments recorded from January to April 1997 created nearly 50,000 jobs; 6,000 of them were generated by the investment of LG Electronics in South Wales (Financial Times, November 5, 1997).

[17] See DeBartolome and Spiegel (1995).

[18] For an extensive review of theoretical results and empirical evidence about technological spillovers see Blomström and Kokko (1998). More recently Braconier and Sjöholm (1999), Baldwin et al. (1999) and Bloström and Sjöholm (1999) find evidence of international R&D spillovers through inward FDI.

[19] For recent contributions see Baldwin et al. (1999) and Barrell and Pain (1997, 1999).

[20] See Markusen and Venables (1999) and Haaland and Wooton (1999) for a theoretical analysis of this role of MNEs and Hobday (1995) for case-study findings.

of the domestic economic activity; MNEs might extract know-how from the host economy[21] or might exploit all the locational advantages without creating stable linkages; FDI might also determine anti-competitive effects; moreover, the high dependency on foreign MNEs might lead to instability: the perceived danger is that the external circumstances might change in such a way that the economy over a very short period loses its attractiveness for FDI, entailing substantial adjustment costs. However, in this model the benefits of inward FDI are assume to dominate the costs, otherwise countries or regions would not actively promote FDI's attraction.

The previous observations are translated in the assumptions that the welfare of a region when obtaining the location of the MNE (denoted by W_i^{Ii}, $i = A, B$) is higher than the welfare when the MNE locates in the rival region (denoted by W_i^{Ij}, $i, j = A, B$):

$$\begin{aligned} \Delta W_A &= W_A^{IA} - W_A^{IB} \geq 0 \\ \Delta W_B &= W_B^{IB} - W_B^{IA} \geq 0 \end{aligned} \tag{4.1}$$

Moreover, the welfare gains positively depend on the intensity of the externality, captured by the parameter ϕ (the more effective the diffusion of the modern technology or the larger the creation of new jobs the higher the benefit enjoyed by the host region):

$$\Delta W_i = \Delta W_i(\phi) \qquad \text{with } \frac{\partial \Delta W_i(\phi)}{\partial \phi} > 0 \tag{4.2}$$

where $i = A, B$ and $\phi \in [\phi^{\min}, \phi^{Max}]$ [22].

Since the aim of the paper is to analyze the effects of subsidy competition when regions differ in the way they benefit from inward FDI, one region (region B) is assumed to enjoy a higher welfare gain than the other:

$$\Delta W_B(\phi) \geq \Delta W_A(\phi) \qquad \text{for } \phi \in [\phi^{\min}, \phi^{Max}] \tag{4.3}$$

B can be thought as a *depressed region* while A is a *more advanced economy*, for instance with a lower level of unemployment or technologically more advanced. The idea is that a given amount of new jobs is valued less where the level of unemployment is lower or that the lower the technological lag of a region, the lower its increase of productivity as a consequence of

[21] Kogut and Chang (1991) and Neven and Siotis (1996) find evidence for technology sourcing as a motive for FDI.

[22] The idea is that if $\phi < \phi^{\min}$ the externality is not strong enough so that the benefits of inward FDI dominate the costs and $\Delta W_i(\phi) < 0$. For instance, if the spillover effect and hence the increase of productivity of local firms is not strong enough, it does not outweigh the "competition effect" and local firms are driven out of the market.

the imitation of a MNE's modern technology[23]. Hence, the additional welfare gain enjoyed by region B increases with the difference between the two regions, expressed by the parameter α. A simple way to model this idea is to assume that:

$$\Delta W_B(\phi) - \Delta W_A(\phi) = g(\alpha)\,\Delta W_A(\phi) \equiv \Delta(\alpha,\phi) \tag{4.4}$$

where $\alpha \in [0,1]$ while $g(\alpha)$ is strictly increasing and convex in α and it is such that $g(0) = 0$ (when the regions are perfectly symmetric they enjoy the same welfare gain).

Note that the previous formulation also implies that:

$$\frac{\partial \Delta(\alpha,\phi)}{\partial \phi} = g(\alpha)\frac{\partial \Delta W_A}{\partial \phi} \geq 0 \tag{4.5}$$

In other words, the stronger the externality, the higher the difference between the benefits enjoyed by the two regions. For instance, the higher the creation of employment, the more relevant is the additional welfare gain that the depressed region enjoys relative to the more advanced one; the more effective the diffusion of the MNE's modern technology, the higher the increase of productivity of the country lagged behind relative to the increase of the more advanced country and thus the higher the difference between the benefits enjoyed.

Finally, it is required that when the difference between the region is at the highest the additional welfare gain of the depressed region is sufficiently high (*i.e.* $g(1) > 1$) and so it is when the externality is very strong $\left(i.e.\ \Delta W_A\left(\phi^{Max}\right) > \max\left\{\frac{\Pi_M^{IA}}{g(1)-1}, \frac{\Pi_M^{IA}}{g'(0)}\right\}\right)$.

The two regions differ also from the point of view of the MNE, in the sense that its profits (denoted by Π_M^{Ii}, with $i = A, B$) are higher when it locates in the region that needs less the investment. For instance, this region is more advanced and has better infrastructures, higher per-capita income and better access to adjacent markets; skilled labour force or specialized input suppliers are available and it offers agglomeration economies[24] to exploit. Obviously, the more advanced is the region, the stronger the MNE's preference for locating there. These ideas are translated in the assumptions that $\Pi_M^{IA} \geq \Pi_M^{IB}$ and that, for simplicity:

$$\Pi_M^{IA} - \Pi_M^{IB} = \alpha \Pi_M^{IA} \geq 0 \tag{4.6}$$

Overall, the higher the difference between the two regions, the higher the additional welfare

[23] Barrell and Pain (1997) provide some evidence that the spillover effects generated by inward investments are more apparent and more quickly felt where domestic producers are relatively less productive.

[24] Head et al (1995) and Barrell and Pain (1999) provide evidence that agglomeration economies can be relevant for location decisions.

gain of the region that needs more the investment, but also the higher its "handicap" in the MNE's location choice[25].

In order to attract the MNE, the two regions offer lump-sum subsidies[26] denoted by T_A and T_B. The government is assumed to make a valid commitment about subsidies whose burden is distributed across the population in a lump-sum fashion. Each country's objective function is total domestic welfare. The ownership of the MNE is assumed to be dispersed around the world so that its profits are not included in the regional welfare.

The timing of the game is the following (see Figure 4-1) :

- at $t = 0$, the MNE announces it is considering the possibility to invest abroad.
- at $t = 1$, both regions simultaneously set the level of subsidies offered to the MNE (conditional on her locating in its territory).
- at $t = 2$, the MNE decides whether to export or to invest abroad and in the latter case where to locate.
- at $t = 3$, the externality associated to the investment of the MNE (if done) provides its effects and the equilibrium payoffs for the MNE and for the competing regions are determined.

The analysis begins with the last stage and works backward to solve for the subgame perfect Nash equilibrium.

Three possible configurations can arise at the last stage[27]: (i) The MNE decides to export. This case is denoted by **(E)**. (ii) The MNE decides to invest in region A. This case is denoted by **(IA)**. (iii) The MNE decides to invest in region B. This case in denoted by **(IB)**. For each configuration the MNE's equilibrium profits and the welfare of the two regions are denoted as follows:

[25]The assumption that both the difference of welfare gains between the two regions and the difference of the MNE's profits depend on the same parameter α is a simplification. There could exist different reasons why the MNE finds it less profitable to locate in one region and why the same region benefits more from the investment. However, the essence of the results would remain the same. It could also be the case that the MNE finds it more profitable to locate in the depressed region, for instance, to take advantage of lower factor costs. In this case without paying subsidies the region which values more the investment would be able to obtain it, so that letting government compete through subsidies would be definitely inefficient. However, it should be noted that, recently, the fast-growing companies are shifting to higher rather than lower factor cost areas, to benefit from elements like the ones previously described.

[26]Actually, incentives can be provided in a very wide range of forms: cash grants, like we are assuming, tax breaks or tax holidays, favourable financing or loans at below market rates, public expenditure for roads or airports or workers training. Moreover these kind of incentives are more and more often complemented by an intensive promotional and assistance activity.

[27]We exclude the uninteresting case where the MNE finds it more profitable not to sell in the market.

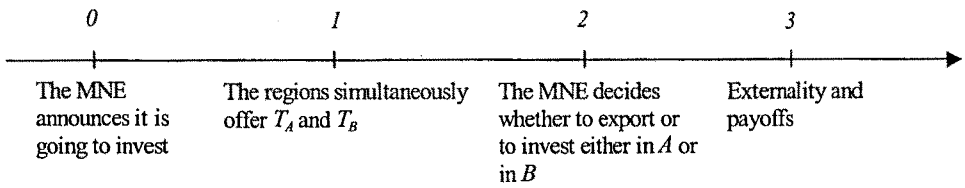

Figure 4-1: *Time – line*

Case (E): the MNE exports.
$\pi_M^E = \Pi_M^E(t)$
$w_i^E = W_i^E$ with $i = A, B$.
Case (IA): the MNE invests in region A.
$\pi_M^{IA} = \Pi_M^{IA} - F + T_A$.
$w_A^{IA} = W_A^{IA} - T_A$
$w_B^{IA} = W_B^{IA}$.
Case (IB): the MNE invests in region B.
$\pi_M^{IB} = \Pi_M^{IB} - F + T_B$.
$w_A^{IB} = W_A^{IB}$
$w_B^{IB} = W_B^{IB} - T_B$.

The analysis is continued distinguishing two main cases. One in which the MNE has decided *ex – ante* to invest abroad; a second case in which the MNE *a priori* does not exclude the possibility to export instead of investing in one of the two regions.

This distinction in relevant because, as the next two sections will make clear, the welfare effects of the subsidy game can be very different according to which one is the case.

4.3 Exports are not an alternative to investments

This section assumes that the MNE finds it more profitable to invest abroad rather than to export even if no subsidies are offered.

More formally:

$$\pi_M^{IA}(T_A = 0) > \pi_M^E \tag{4.7}$$

This condition is more likely to be satisfied the lower the fixed set-up costs and the higher the transportation costs from the MNE's country of origin.

4.3.1 Choice of location by the multinational

The MNE decides to locate in region B when $\pi_M^{IB} > \pi_M^{IA}$, that is when

$$T_B > T_A + \Gamma \tag{4.8}$$

where $\Gamma = \Pi_M^{IA} - \Pi_M^{IB} = \alpha \Pi_M^{IA} \geqslant 0$.

When the two regions are perfectly symmetric $(\alpha = 0)$, they are absolutely equivalent for the MNE's location choice and each one would only need to offer a subsidy slightly higher than the other to obtain the FDI. Instead, if $\alpha > 0$, the MNE makes higher profits when locating in the more advanced region and hence, to attract the investment, the depressed region has to pay a subsidy greater by the amount Γ than the subsidy offered by the rival one. The higher the difference between the two regions (the higher α), the higher the additional costs that the MNE bears when locating in the depressed one, the higher the "premium" to be paid by such region to obtain the investment.

4.3.2 The subsidy game

In this section the equilibria resulting from the subsidy game[28] are studied and it is shown that, even if the multinational has a "preference" for the more advanced region, there are cases in which the depressed one succeeds in winning the subsidy game.

The maximum bid that each region is willing to offer is the one for which it is indifferent between attracting the MNE and the MNE locating in the other region:

$$T_A^{Max} \text{ is such that } w_A^{IA}\left(T_A = T_A^{Max}\right) = w_A^{IB}\text{; therefore, } T_A^{Max} = \Delta W_A$$
$$T_B^{Max} \text{ is such that } w_B^{IB}\left(T_B = T_B^{Max}\right) = w_B^{IA}\text{; therefore, } T_B^{Max} = \Delta W_B$$

Obviously, since region B benefits more than region A from the FDI, it is willing to offer more. Yet, it is not obvious that it wins the auction, because it suffers the disadvantage Γ in the MNE's location choice. Indeed, region B must benefit so much that, despite the premium to be paid, succeeds in overbidding region A. In other words,

[28] Our analysis, for semplicity's sake, is developed assuming complete information; however, this subsidy game gives the same equilibrium outcome as the one resulting in a more realistic framework with incomplete information about the bidders' valuations, with heterogeneity of the seller preferences over the bidders and in which the bidding process is conducted according to an "open ascending auction" with full handicaps. A number of examples provide likelihood to this kind of auction. They illustrates cases in which the firm approaches sequentially the various locations, somehow negotiating a recruitment subsidy with the first jurisdiction and then going to another and asking it to match the offer or offer a better deal, with the previous one still allowed to win the location decision by making further counteroffers. See Nunn, Klacik and Schoedel (1996) or Gibson and Rogers (1994) for a detailed description of some examples.

(i) the region that needs more the investment wins the auction when $T_B^{Max} - \Gamma > T_A^{Max}$[29]. An equilibrium exists if region A offers any subsidy belonging to $[T_A^{Max}, T_B^{Max} - \Gamma]$ and region B offers Γ more than its rival. Among all these equilibria, the unique one that is not weakly dominated is chosen:

$$\begin{cases} T_A = T_A^{Max} \\ T_B = T_A^{Max} + \Gamma \end{cases} \tag{4.9}$$

(ii) the more advanced region obtains the FDI when $T_A^{Max} \geq T_B^{Max} - \Gamma$. The possible equilibria are such that region B offers any subsidy belonging to $[T_B^{Max}, T_A^{Max} + \Gamma]$ and region A offers $T_B - \Gamma$. The equilibrium that is not weakly dominated is:

$$\begin{cases} T_A = T_B^{Max} - \Gamma \\ T_B = T_B^{Max} \end{cases} \tag{4.10}$$

The following Lemma describes which equilibrium is likely to emerge according to the values of the relevant parameters.

Lemma 17 : *There exists critical values ϕ^* and ϕ^{**} (with $\phi^* < \phi^{**}$) such that:*

- if $\phi \leq \phi^*$ the region that needs more the MNE's investment never obtains it.

- if $\phi^* < \phi < \phi^{**}$ the region that needs more the MNE's investment obtains it iff $\alpha > \alpha^*(\phi)$

-if $\phi \geq \phi^{**}$ the region that needs more the MNE's investment obtains it for any $\alpha > 0$.

Proof. See Appendix A. ∎

According to Lemma 17, the region that needs more the investment manages to obtain it either when the externality is extremely strong or when the latter is sufficiently strong and competition takes place between two regions which are sufficiently different, for instance a depressed region and a rival one advanced enough. The intuition is that the weaker the externality, the lower the difference of the welfare gains between the two regions; hence, when ϕ is low enough, the additional welfare gain of the region that needs more the investment is never sufficiently large to compensate its disadvantage in the MNE's location choice and, therefore, to win the auction. Conversely, when the externality is extremely strong, this region overbids the rival one in any case. Instead, when ϕ lies in-between these two extreme values, the difference between

[29]For simplicity, we assume the following tie-breaking rule:

region A wins all ties if $T_A^{Max} \geq T_B^{Max} - \Gamma$
region B wins all ties if $T_B^{Max} - \Gamma > T_A^{Max}$.

the two regions must be sufficiently relevant in order to make the additional welfare gain of the "depressed" one high enough to compensate the higher costs the MNE incurs when locating there. Note that the threshold $\alpha^*(\phi)$ is decreasing in ϕ. The reason is that the higher ϕ, the higher the additional welfare gain of the region that values more the investment and the easier for it to win the auction.

4.3.3 The welfare analysis

The non-cooperative solution

It is usually thought that intergovernmental competition to support the location of firms in particular countries or regions mainly results in a waste of resources: either the firm receives a transfer from a jurisdiction where it would have located anyway or competition escalates into a bidding *crescendo* that injures all the involved jurisdictions. Therefore, all the participants would be at least as well off if no subsidies were given.

This section shows that this argument fails to be true when countries or regions are asymmetric in the benefit they enjoy from the MNE's investment. In such a case, as the following Propositions will illustrate, the region that needs more the investment suffers a welfare loss if subsidies are forbidden. On top of this, also the joint welfare of the two regions may decrease when subsidies are ruled out with respect to the case in which governments are allowed to "bid" for firms.

Proposition 18 : *When exports are not an alternative to FDI, the region that needs less the investment always loses from the existence of a subsidy game.*

Proof. When region A overbids the rival region, its welfare change relative to the case in which subsidies are banned is $w_A^{IA}\left(T_A = T_B^{Max} - \Gamma\right) - w_A^{IA}\left(T_A = 0\right)$. It is clearly negative since the MNE locates in region A anyway if no subsidies are paid and this region has to waste resources to maintain the same location decision. When region B wins the subsidy game, the welfare change is $w_A^{IB} - w_A^{IA}\left(T_A = 0\right) = -\Delta W_A$ which is negative by assumption. ■

Proposition 19 : *When exports are not an alternative to FDI, the region that needs more the investment never loses from the existence of a subsidy game.*

Proof. When region A obtains the FDI, the equilibrium welfare of region B does not change relative to the case in which subsidies can not be offered. When region B overbids region A the result is just the opposite; first, when subsidies are not allowed it never succeeds in obtaining the location of the MNE; second, region B's equilibrium bid is strictly lower than the level of subsidy for which it is indifferent between having or not having the MNE; thus, $w_B^{IB}(T_B = T_A^{Max} + \Gamma) > w_B^{IA}$ and the welfare change of the depressed region is positive. ■

Thus, when the "advanced" region obtains the FDI, subsidy competition is obviously inefficient, since regions waste resources in the counterbidding process and the MNE receives a grant from the region where it would have located anyway. However, as shown, the possibility to offer subsidies generates a welfare gain when it changes the MNE's decision, so that it locates in the other region. In this case, competition leads the investment where it is needed more and where otherwise it would not have gone and a trade-off arises: banning subsidies (or imposing uniformity) helps avoiding that incentives reach excessively high levels due to the externality problem but it prevents competition from performing its allocative function. This might indeed cause a reduction of the joint welfare of the two regions with respect to the case in which offering subsidies is allowed. As shown in Proposition 20, this happens when the positive externality associated to the inward FDI is sufficiently strong and when competition takes place between very different regions, for instance between a depressed region and a region which is significantly advanced. When this is the case, the additional welfare gain of the region that needs more the investment is so high that not only allows to overbid the rival region and to obtain the MNE's location but also compensates the rival region's welfare loss.

Proposition 20 *: When exports are not an alternative to FDI, total welfare increases iff the region that needs more the investment obtains it,* $\phi > \phi^{***}$ $(> \phi^{*})$ *and* $\alpha > \alpha^{**}(\phi)$ $(> \alpha^{*}(\phi))$.

Proof. See Appendix B. ■

4.3.4 Extensions

The cooperative solution

The trade-off between the externality problem and the allocative function associated to subsidy competition could be solved by a supra-national authority, concerned with the joint welfare of the two regions but unable to control the behaviour of the MNE, which can enforce rules about the possibility to offer subsidies. Such an institution would try to capture the positive role of subsidies to facilitate an efficient allocation of the economic activity, paying the minimum amount needed for this to happen. Thus, first it would forbid the "advanced" region to offer subsidies, so that the other one has to pay only the amount Γ to win the auction. Second, it would allow the region that needs more the investment to offer subsidies only when its welfare gain, net of the subsidy paid, is larger than the welfare loss of the other region. This is the case either when the intensity of the positive externality is sufficiently high and the "depressed" region competes with a rival sufficiently advanced or when the externality is extremely strong. Both the regions are forbidden to offer subsidies otherwise. Obviously both regions are better off with respect to the uncooperative case, even if individually they would always have incentive to deviate from this solution.

Proposition 21 *:To maximize total welfare, only the region which needs more the investment is allowed to offer subsidies, and only when* $\phi > \phi^{**}$ *or* $\phi^{*} < \phi \leq \phi^{**}$ *and* $\alpha > \alpha^{*}(\phi)$.

Proof. See the proof of Lemma 17: the condition for the region that needs more the investment to be allowed to offer subsidies ($\Delta W_B - \Gamma > \Delta W_A$) and the condition for such region to win the auction coincide. ■

This analysis reflects the rationale of the European regulation in this sphere. In the EU there does not exists a specific discipline for MNEs' incentives, which are regulated applying the general legislation about state-aids (which, however, cover most of FDI incentives), contained in art. 87-89 (ex 92-94) of the Treaty of the EU. In principle, state aids are forbidden because they threaten fair competition between Member States. However the Commission can allow to offer incentives when they promote a development in the interests of the Union, like reviving depressed regions (art. 87(3a)). Each case must be notified to the Commission which will judge whether the previous criterion is satisfied or not, and will assess whether the type and volume of the aid are appropriate for the objectives which are hoped for.

In other words, the Commission distinguishes between *advanced* and *depressed* regions; only the latter can provide grants[30] and only when the investment is likely to generate a *significative benefit*. Besides, to avoid that too high resources are wasted when depressed regions compete one against the other, the Commission tries to curb the amount of incentives paid and imposes specific ceilings to the financial support that can be offered: in the case of regions falling under Art. 87(3a) the net aid allowed varies from region to region, with the maximum being 75% of the investment cost of the project[31]; for those regions under Art 88(3c) the net aid allowed also varies from region to region: the highest is 30%. Moreover, the European Court of Justice has decided that the Commission can forbid regional aid for an investment that would increase

[30] The idea of strategically targeting incentives toward areas with high unemployment and depressed economic activity is gaining support also at WTO level and in the US. See, for instance, Farrell (1996).

[31] Following this criterion, a number of state-aid projects has been blocked and the repayment of funds has been demanded. However, in practise, no objections are raised to the majority of State-aid cases. One reason is that incentives are offered in many ways other than grants, which can considerably more complicated and less easily identifiable. Thus, the official position on incentives often bears little relation to the full extent of financial help made available, which the Commission can hardly assess. To solve this problem, the Commission is trying to implement a more transparent and efficient policy of state-aid control, in particular strenghtening its ability to have complete information at disposal (see, for example, the Proposal for a Council Regulation laying down detailed rules for the application of Art. 88 of the EC Treaty, 18 February 1998).

overcapacity in the Union or aid that would relocate an investment from a less to a more prosperous region.

The MNE has more bargaining power than the competing countries

In the previous sections it was implicitly assumed that the MNE has less bargaining power than the competing regions who move first and make an offer which can only be accepted or left.

Imagine a different bargaining process: the MNE moves first and chooses one of the two regions to which it proposes its location, conditional on being paid a given amount of subsidy; the selected region can take it or leave it; if the first proposal is rejected, the MNE makes a second offer to the other region. In this case, the MNE would ask for the maximum amount that the selected region is willing to offer and would make the first offer to the depressed (advanced) one whenever $T_B^{Max} - \Gamma > T_A^{Max}$ $\left(T_B^{Max} - \Gamma \leq T_A^{Max}\right)$. As a result, it would be able to entirely capture the welfare gains determined by its location and subsidy competition would never be welfare improving. Obviously, this is an extreme case, but it suggests that in order to assess whether there can be welfare gains associated to subsidy competition it is important to take into account the capability of the MNE to extract rent from the potential host countries.

The winner's curse

The basic set-up presented in the previous sections can also be easily adopted to analyse a problem which is receiving a great deal of attention in the debate about the abolition of subsidies.

Imagine that when countries offer their bids the intensity of the positive externality is unknown (yet, it is common knowledge that ϕ is distributed according to a given distribution function). In expected terms the conclusions of the analysis have the same flavour as in the case in which the intensity of the externality is perfectly anticipated. However, *ex-post* when the uncertainty reveals and the true externality realizes, the actual value can be lower than expected so that the bidders may have overestimated the benefits associated to the FDI and the winner can overpay for the investment. Hence, it may be that the region that values more the investment suffers an *ex-post* welfare loss from having engaged in a subsidy game and having obtained the FDI. This issue is commonly indicated as the *winner's curse*[32] and has been discussed especially in the United States where it happened that States have paid millions dollars for a plant that promised to employ thousands workers, but the jobs actually created resulted significantly lower than promised or the plant shut down within few years[33].

[32] The expression winner's curse in used a bit "loosely" relative to its precise meaning as defined by the auction theory.

[33] A famous case is the one of Pennsylvania, which spent some $70 million convincing VW to build a factory

At present, the problem is capturing attention also in Europe, since the severe crisis in the Far East has induced some Asiatic firms to significantly reduce the investments made in the past or indeed to close the plants installed. Investments for which generous financial incentives were paid[34].

Note, however, that it may also be the case that the realized externality is higher than expected so that the regions gain more than what estimated *ex-ante*. In other words, the message here is that banning subsidies can prevent losses occurring when future is surprisingly disappointing, but can also prevent relevant gains when anticipations are accurate or indeed cautious relative to what realizes ex-post. Hence, banning subsidies does not solve this problem[35] in which overestimations and ex-post losses may occur because the future cannot be perfectly anticipated and not for strategic behaviours. A completely different problem is the case in which the MNE realizes relevant investments and afterwards uses this fact to increase its bargaining power threatening the host country to reduce the investment or to relocate if it does not receive further financial incentives. This issue will be the focus of future research.

Exports are the alternative to investments

An interesting case to analyze is the one where the MNE has not pre-committed to investing in one of the two countries and may decide to serve both markets by exporting from its home base.

As the following Section will make clear, in this context the key element is whether or not a region prefers that the MNE exports with respect to its investment in the rival location. If the MNE's exports is a quite undesirable alternative, the welfare gains associated to the possibility to offer subsidies are highly improved. The opposite might hold when the fact that the MNE exports is not that unpleasant for the competing regions. Overall, the results of the welfare analysis can dramatically change.

There are many elements to take into account when reasoning on whether a region prefers the MNE to export or to invest in the rival one. For instance, in both cases the region (say region i) does not benefit from job creation and, from this point of view, it is indifferent between the two alternatives. Eventually, it may find the latter more desirable, if some positive effects related to the increased employment in the rival region spill over it. However, locating in region j implies, for the MNE, the possibility to serve region i's market baring lower costs than when

with its promised 20,000 jobs; yet the plant employed 6,000 workers and shut down within a decade. The same has happened in a number of smaller deals that did not generate headlines.

[34]Financial Times, 7 September 1998.

[35]A more appropriate instrument might be, like in the UK, to condition the grant to a "claw back" clause which enables the government to recover the grant or stop payment if the targets of capital expenditures and job creation are not being met.

it exports from its home country. This is beneficial for consumers of region i, but it may be prejudicial for its local firms. Besides, region i's local firms may be damaged by the fact that the producers of the rival region are made more efficient by the technological spillovers, when the MNE invests there, while region i's consumers may benefit from this as well as from the higher degree of competition introduced in region j's market by the MNE's entry (if the two economies are to some extent integrated). Overall, consumers tend to find the MNE's investment in the rival region more desirable than the fact that the MNE exports, while local firms have opposite preferences.

To understand which alternative is preferred to the other and to what extent, these countervailing elements must be weighed. However, to do it, it is necessary to depart form the general set up adopted up to now and to resort to a more specific model presented in the following Section. Studying this model it will be possible to compare the welfare effects of subsidy competition when exports are not a feasible alternative to FDI with the welfare effects when exports are an alternative to FDI.

4.4 A parametric model

4.4.1 The set up of the model

The competing regions and the MNE: in each region there is a local firm (also denoted with A, B) that produces the same good as the MNE (denoted with M). The demand functions of this good in the two regions are given by:

$$Q_i = (1 - P_i)\frac{S_i}{2} \qquad\qquad i = A, B \tag{4.11}$$

where Q_i is total output sold in region i, P_i the associated market price and S_i a measure of the size of region i. Since differences in size are not relevant to the purpose of this work, the two regions are assumed to have the same size ($S_A = S_B = S$). Their overall market is integrated ($t' = 0$ so that exports between the two regions do not incur in transportation costs; besides, firms cannot discriminate the price between the two markets) and $Q = q_A + q_B + q_M$ denotes the total output sold by the firms. The three firms compete *à la* Cournot and their variable production costs are assumed to be constant and are denoted, respectively, by c_A, c_B, and c_M. The MNE uses the most efficient technology while region B is the least technologically advanced so that $c_M = 0, c_B = \frac{1}{6}$ and $0 \leq c_A < \frac{1}{6}$. Thus, the value of c_A indicates the difference of technological level between the two regions: the lower c_A the higher the difference. Each region's total domestic welfare is given by the consumer surplus, plus the profits of the local firm minus the subsidy eventually paid. The trading cost per unit of output t born by the MNE is assumed to belong to $[0, \frac{7+6c_A}{18}]$ [36]. Since the overall market is integrated and the MNE incurs a set-up cost F to establish a plant, it invests only in one of the two regions if it opts for FDI.

The externality associated to the FDI: this model focuses on the *technological spillover* determined by the MNE's investment: the local firm gains partial or total access to the MNE's technology so that its production costs become $c_i(1-\phi)$, with $i = A, B$ and $\phi \in [0,1]$[37]. The creation of such an externality represents the reason why a region is interested in having the FDI. The parameter ϕ expresses the per cent reduction in the costs of the local firm; when $\phi = 0$ no technological spillover occurs; when $\phi = 1$ the spillover is complete: the local firm entirely appropriates the MNE's technology and becomes as efficient as it is. Note that this formulation implies that the benefits generated by the FDI are more apparent and more quickly felt where domestic firms are relatively less productive. Moreover, the stronger the spillover (the higher ϕ), the higher the absolute reduction of production costs of the region technologically lagged behind with respect to the absolute reduction of the advanced region.

The structure of the game and all the elements not specified are the same as in the general model presented in Section 4.2.

4.4.2 The last stage of the game

Solving the standard Cournot model, the equilibrium payoffs for each configuration arising at the last stage of the game are obtained.

If the MNE exports:

$$\pi_M^E = \frac{S(1+c_A+c_B-3t)^2}{96} \tag{4.12}$$

$$w_i^E = \frac{S(3-c_i-c_j-t)^2}{64} + \frac{S(1-3c_i+c_j+t)^2}{16} \tag{4.13}$$

with $i, j = A, B$ and $i \neq j$.

The cases in which the MNE locates in region A and in region B are perfectly symmetric.

[36]This assumption and $c_B = \frac{1}{6}$ guarantee to have positive quantities produced by the firms in any configuration. Moreover, the latter is the maximum value of c_B such that the country lagged behind benefits from the FDI more than the advanced one.

[37]Note that, it is assumed that the spillover has only a local effect, while the market between the two regions is completely integrated. A justification of this apparent contraddiction is that a major channel for technological diffusion is the migration of local workers from MNEs to local firms. In many cases, for instance in Europe, while the goods market is highly integrated, the opposite holds for the labour market. This prevents the techonological spillover from spreading on a wide area. Morevoer, there is evidence that spillovers are local. See, for instance, Eaton and Kortum (1996), Caballero and Jaffe (1993) and Keller (1998).

Hence, if the MNE invests in region i:

$$\pi_M^{Ii} = \frac{S(1+c_i(1-\phi)+c_j)^2}{16} + T_i - F$$

$$\begin{aligned} w_i^{Ii} &= \frac{S(3-c_j-c_i(1-\phi))^2}{64} + \frac{S(1+c_j-3c_i(1-\phi))^2}{16} - T_i \\ w_j^{Ii} &= \frac{S(3-c_j-c_i(1-\phi))^2}{64} + \frac{S(1-3c_j+c_i(1-\phi))^2}{16} \end{aligned} \tag{4.14}$$

with $i, j = A, B$ and $i \neq j$.

4.4.3 The two regions' welfare gains

Profits of the local firm: the profits of the local firm are higher when the MNE invests in its region rather than in the rival's one, because in the former case it benefits from the reduction of its own costs:

$$\Delta\pi_i = \pi_i^{Ii} - \pi_i^{Ij} = \frac{S\phi}{16}(3c_i + c_j)[2 + (2-\phi)(c_j - 3c_i)] \geq 0 \tag{4.15}$$

for any $\phi \in [0,1]$ and $0 \leq c_A < c_B = \frac{1}{6}$. Obviously, the stronger the spillover, the higher the gain in terms of profits. Note also that $\Delta\pi_i > 0$ for any $\phi > 0$. In other words, the local firm gains in terms of profits even if the spillover is very weak. The intuition is that, given that the overall market is integrated, the "competition effect" associated to the MNE's investment that the domestic firm has to face is the same both if the MNE locates in its region or in the other one[38]. Therefore, the profit of the local firm is higher in the former case, regardless how small is ϕ, because at least it gains something from the MNE's entry in the market.

Consumer surplus: both regions' consumer surplus is higher when the MNE locates in the region technologically lagged behind (region B):

$$\Delta CS = CS^{IB} - CS^{IA} = \frac{S\phi}{64}(c_B - c_A)[6 - (2-\phi)(c_A + c_B)] \geq 0 \tag{4.16}$$

for any $\phi \in [0,1]$ and $0 \leq c_A < c_B = \frac{1}{6}$. The idea is that, owing to the technological spillover, the production costs of the least efficient firm are reduced and this reduction is higher than the one that would have occurred if the MNE had located in the more advanced region. Given the assumption of integrated markets, the consumers of both regions benefit from this. The gain in terms of consumer surplus rises with the intensity of the spillover because the higher ϕ the

[38]This would not be true if there were transportation costs between the two countries.

higher the additional reduction in the costs of the firm technologically lagged behind.

Overall, the difference between a region's welfare when obtaining the location of the MNE and when the MNE invests in the rival one is given, respectively, by:

$$\begin{aligned} \Delta W_A &= \Delta\pi_A - \Delta CS \\ \Delta W_B &= \Delta\pi_B + \Delta CS \end{aligned} \quad (4.17)$$

They verify the basic assumptions illustrated in Section 4.2:

- Both ΔW_A and ΔW_B are positive if the technological spillover occurs. Note that in the case of the advanced region, the gain in terms of profits more than compensates the loss in terms of consumer surplus.

- They are both increasing in the intensity of the spillover. This is obvious for the region lagged behind, since $\Delta\pi_B$ and ΔCS are increasing in ϕ. Instead, in the case of the advanced region, a stronger spillover implies a larger loss in terms of consumer surplus; however, $\Delta\pi_A$ is increasing in ϕ and this effect prevails.

- $\Delta W_B \geq \Delta W_A$ because, for a given ϕ, the region which is technologically lagged behind enjoys a larger absolute reduction of production costs when obtaining the MNE's location and gains not only in terms of profits but also of consumer surplus. Since the more region B is lagged behind the larger its additional reduction of production costs, the difference between the benefits increases as the difference of technological levels increases. $\Delta W_B = \Delta W_A$ when they are perfectly symmetric (i.e. when $c_A = c_B$).

- The difference between the benefits increases as the intensity of the spillover increases. Again, the higher ϕ the higher the additional reduction of costs of the region lagged behind[39]. If no spillover occurs $(\phi = 0)$, $\Delta W_A = \Delta W_B = 0$.

- The MNE's profits are higher when it locates in the more advanced region (subsidies being equal) and the premium Γ amounts to $\frac{S}{16}\phi\,(c_B - c_A)\,[2 + (c_A + c_B)\,(2 - \phi)] \geq 0$. The intuition is that, locating in a region, the MNE makes the production costs of the local firm decrease (of ϕ per cent). Since the overall market is integrated, it turns out that it is more profitable to benefit the more competitive local firm (the one in country A) because the absolute reduction of costs is lower. For the same reason, $\frac{\partial\Gamma}{\partial c_A} < 0$: the lower c_A, the higher the MNE's advantage from locating in region A, the higher the "premium"

[39]The convexity assumption and the condition imposed when the difference of technological levels and the intensity of the externality are the largest are also satisfied.

to be given by region B. Similarly, the stronger the spillover, the higher the additional reduction of the region lagged behind, the higher the"premium" to be paid. Note that in this model it is the existence of the technological spillover that creates the disadvantage of the region lagged behind in the MNE's location choice. In fact, if no technological spillover occurs, $\Gamma = 0$ and the MNE is indifferent between locating in region A and in region B subsidies being equal.

4.4.4 The welfare effects of subsidy competition

Exports are not an alternative to investments

The MNE finds it more profitable to invest abroad rather than to export even if no subsidies are offered, when the following condition is satisfied:

$$F < \frac{S}{16}(3t - \phi c_A)\left[2 + c_A(2-\phi) + \frac{1}{3} - 3t\right] \tag{4.18}$$

Lemma 17 bis and Proposition 20 bis illustrate, in the present context, the results obtained in Section 2.3.

In particular, the region technologically lagged behind always obtains the FDI when the technological spillover is sufficiently strong. Instead when the spillover is positive but not that high, the less advanced region wins the auction when the difference of technological level between the competing regions is high enough $(c_A < c^*(\phi))$[40]. When no spillover occurs, $\Delta W_A = \Delta W_B = \Gamma = 0$ for any c_A and c_B and, given the tie-breaking rule assumed, the more advanced region always wins the auction.[41]

Total welfare increases relative to a situation in which subsidies are banned when competition takes place between a region technologically lagged behind and a rival one significantly advanced.

Lemma 17 bis: *If $\frac{16}{23} \leq \phi \leq 1$, the MNE locates in the region technologically lagged behind for any feasible value of c_A.*

if $0 < \phi < \frac{16}{23}$, the MNE locates in the region technologically lagged behind iff

$$0 \leq c_A < \frac{14+23\phi}{138(2-\phi)} = c^*(\phi).$$

[40] The model has been solved also for a generic value of $c_B \leq \frac{1}{6}$. We do not illustrate this part because it does not add anything to the basic intuition. The main difference is that there is a scale effect and if $c_B \leq \frac{5}{23(2-\phi)}$ the region lagged behind obtains the FDI for any feasible value of $c_A < c_B$.

[41] Notice that, in this model, $\phi^{\min} = \phi^* = 0$. The intuition is that for $\phi = 0 = \phi^{\min}$ not only ΔW_A and ΔW_B are equal to zero but also the premium Γ.

if $\phi = 0$, the MNE never locates in the region technologically lagged behind.

Proposition 20 bis: *When exports are not an alternative to FDI, total welfare increases iff the less advanced region obtains the FDI, $\phi > 0$ and $c_A < c^{**}(\phi)$*[42].

When exports are the alternative to investments, the welfare effects of subsidy competition can be dramatically different as it will appear neatly comparing these results with the ones presented in what follows.

Exports are the alternative to investments

This section analyzes the case in which, when no subsidies are given, the MNE finds it more profitable to export than to invest abroad; in particular, fixed costs are assumed to be slightly higher than the level for which there is indifference:

$$F = \frac{S}{16}(3t - \phi c_A)\left[2 + c_A(2 - \phi) + \frac{1}{3} - 3t\right] + \varepsilon \tag{4.19}$$

The equilibria of the subsidy game are unchanged compared to the case studied in the previous section, but the results of the welfare analysis can dramatically change. As anticipated, to assess the welfare effects of subsidy competition when the MNE exports in absence of subsidies it is crucial to study whether each region prefers the MNE to export or to invest in the rival location. In this specific model two opposite effects are relevant to this purpose. On the one hand, the consumer surplus of a region is higher when the MNE locates in the rival region than when it exports. In the former case transportation costs are saved and the production costs of the firm in the region that hosts the MNE are decreased by the technological spillover. Since the overall market is integrated, also the consumers of the region where the MNE does not locate benefit from this. On the other hand, the profits of the local firm are higher when the MNE exports because in such a case the other two competitors are less aggressive: the MNE has to bear transportation costs while the local firm of the other region does not benefit of the technological spillover. In other words, for the local firm of a region the investment of the MNE in the rival region just represents the entry in the market of a very efficient competitor whose positive effects (the technological spillover) it does not even enjoy.

Which one of these effects prevails depends first upon the transportation costs from the MNE's home country. In particular, in this model the fact that the MNE exports becomes more and more desirable as transportation costs increase: actually, the higher t the lower the consumer surplus but the less competitive the MNE and the higher the profit of the local firm;

[42] $c^{**}(\phi) = \frac{50 - \sqrt{2500 - \frac{2}{3}(83\phi - 166)\left(-18 + \frac{51}{3} - \frac{51}{6}\phi\right)}}{2(166 - 83\phi)}$

with a linear demand the latter receives more weight than the consumer surplus in the welfare function so that it increases at a rate which is higher than the one at which the consumer surplus decreases. Therefore, the higher the transportation costs the less likely a region prefers that the MNE invests in the rival location rather than it exports.

On top of this, which of the two alternatives generates a higher welfare depends upon the technological level of the region. Let us consider first the more advanced region and then the region lagged behind[43].

- **The welfare effects of subsidy competition on the more advanced region.**

In the more advanced region (region A) it is more likely that the welfare achieved when the MNE exports is lower than the welfare achieved when the MNE invests in the rival one *the less efficient is the local firm.* The reason is that with a linear demand the less efficient the local firm the less it benefits from having weaker competitors when the MNE exports. Therefore, when $c_A > \overline{c_t}$, the gain in terms of local profits is dominated by the loss in terms of consumer surplus. Obviously, the threshold is increasing in t.

Overall, the lower the transportation costs and the less advanced the region, the more likely it gains from engaging in subsidy competition with respect to the case in which subsidies are ruled out (as summarized in Table 1). More details will be provided in the following lines and in Appendix C; however, what is really relevant is that when exports are the alternative to FDI the more advanced region *can gain from subsidy competition*, while this possibility never occurs when the MNE always invests in one of the two countries. The intuition is that in the latter case the MNE locates in the more advanced region if subsidies are ruled out. Hence, such a region cannot but lose from the introduction of subsidy competition. This is not obvious when the MNE exports if subsidies are prohibited, as exports may be an undesirable alternative, while offering subsidies serves at avoiding it and may be beneficial.

In particular, when transportation costs are sufficiently low, the fact that the MNE exports is quite undesirable for region A and $w_A^{IB} > w_A^E$ for a wide range of values of c_A[44]. Therefore, unless the local firm is extremely efficient, the region gains from the fact that subsidies can be offered because this serves at avoiding its least preferred outcome. In other words, anything is better than exports, either having to pay to obtain the MNE's location (when $w_A^{IB} > w_A^E$, $w_A^{IA}(T_A^*) - w_A^E > w_A^{IA}(T_A^*) - w_A^{IB} > 0$), or indeed losing the investment $\left(w_A^{IB} - w_A^E > 0\right)$.

[43] In what follows, the value of ϕ has been set equal to $\frac{2}{3}$ to make the algebra simpler. The flavour of the result is the same for any value of ϕ but this particular value has been chosen because it allows to consider both the case in which the more advanced region wins the auction and the case in which the regions lagged behind wins it.

[44] $\overline{c_t} < c^*\left(\frac{2}{3}\right)$ for $\frac{1}{27} \leq t < \frac{82}{1035}$ where $c^*\left(\frac{2}{3}\right)$ is the threshold which determines who wins the auction.

Table1: *Welfare change of region A*

transportation costs	$\Delta \mathrm{w}_A > 0$
$\frac{1}{27}$[45] $\leq t < \frac{82}{1035}$	for $\bar{c}_t < c_A < \frac{1}{6}$
$\frac{82}{1035} \leq t < \frac{1}{9}$	for $\hat{c}_t < c_A < \frac{1}{6}$
$\frac{1}{9} \leq t \leq \frac{7}{18}$	never

Conversely, when transportation costs are very high w_A^{IB} is never higher than w_A^E. Hence, the region necessarily suffers a welfare loss when it does not obtain the FDI $\left(w_A^{IB} - w_A^E < 0\right)$ but, in principle it might gain when it is chosen as a location by the MNE $\left(w_A^{IA}(T_A = 0) > w_A^E\right)$. However, since the fact that the MNE exports is quite desirable and the region ends up competing fiercely to avoid that the MNE chooses the rival location, once paid the equilibrium subsidy it achieves a welfare which is lower than the one attained banning subsidies and letting the MNE export. Overall, the region never gains from engaging in a subsidy game.

For intermediate transportation costs $w_A^{IA}(T_A = 0) - w_A^E$ can be large enough to more than compensate the equilibrium subsidy that the region pays to obtain the FDI. This is the case on condition that c_A is higher than the critical value $\hat{c}_t$. The reason is that the less efficient the region, the higher the absolute reduction of production costs determined by the technological spillover, the higher the gain in terms of consumer surplus when it obtains the FDI relative to the case in which the MNE exports. In addition, note that, given the level of transportation costs, if c_A is sufficiently low, the profit of the local firm is higher when the MNE exports than when the region obtains the FDI $\left(\pi_A^{IA} - \pi_A^E < 0 \text{ when } c_A < \frac{t}{2}\right)$: if the local firm is already sufficiently efficient, it does not benefit so much from the technological spillover and the loss in terms of profits due to the "competition effect" associated to the MNE's arrival dominates. Therefore, the higher c_A, the more limited the loss in terms of profits if $\pi_A^{IA} - \pi_A^E$ is negative or the higher the gain in terms of profits, if $\pi_A^{IA} - \pi_A^E$ is positive.

- **The welfare effects of subsidy competition on the region lagged behind.**

In the region technologically lagged behind (region B) it is more likely that $w_B^{IA} > w_B^E$ the *more efficient is the local firm of the rival region.* The reason is that if the local firm of region A is already quite efficient, region B does not benefit so much from the fact that the rival one fails to enjoy the technological spillover when the MNE exports instead of investing there, and the loss of consumer surplus prevails.

[45] Transportation costs higher than $\frac{1}{27}$ensure that, for any c_A, the contraint (4.19) is satisfied by positive values of the fixed set-up costs.

Overall, as illustrated in Table 2, the lower the transportation costs and the higher the difference of technological level between the two regions, the more likely the one lagged behind gains from engaging in a subsidy game.

In particular, when t is sufficiently low region B draws so little benefit from the fact that the MNE exports that w_B^E is always lower than w_B^{IA}. Hence, the region lagged behind *always strictly gains from subsidy competition* (both when it obtains the MNE's location and when it does not) as subsidies prevent exports, alternative which the region finds worse than the investment in the rival location. Instead, when exports are not a feasible alternative to FDI, the MNE invests in the more advanced region in absence of subsidies, and region B strictly gains from subsidy competition only when it obtains the FDI.

Table 2: *Welfare change of region B*

transportation costs	$\Delta \mathrm{w}_B > 0$
$\frac{1}{27} \leq t \leq \frac{1}{9}$	always
$\frac{1}{9} < t < \frac{25}{207}$	$0 \leq c_A < \overline{\overline{c_t}}$
$\frac{25}{207} \leq t \leq \frac{7}{18}$	$0 \leq c_A < \widetilde{\widetilde{c_t}}$

As transportation costs increase the fact that the MNE exports becomes more attractive for region B and $w_B^{IA} > w_B^E$ on condition that $c_A < \overline{\overline{c_t}}$. This threshold is decreasing in t so that for intermediate transportation costs $w_B^{IA} > w_B^E$ for a wide range of values of c_A[46] and region B gains from subsidy competition when it obtains the location of the MNE and in some cases even when it does not[47]. However, when c_A is higher than the threshold, region B loses the auction and would have been better off if subsidies had been banned and the MNE had exported. Hence, in this context, *also the region lagged behind can lose from participating to the subsidy game* as losing the auction may be worse than what happens when subsidies are banned (i.e. exports); instead, it never suffers a loss when exports are not an alternative to FDI as at worst it does not succeed in obtaining the FDI and this is exactly what happens when subsidies cannot be offered. For high transportation costs, the MNE's exports are quite desirable for region B so that it always suffers a welfare loss when the MNE invests in the more advanced region[48] but it can enjoy a welfare gain when it obtains the location of the MNE. This is the case when the difference of technological level is sufficiently high, as the more advanced region is not willing to offer too much for the FDI and the equilibrium subsidy is not that high; thus,

[46] $\overline{\overline{c_t}} > c^* \left(\frac{2}{3}\right)$ for $\frac{1}{9} < t < \frac{25}{207}$.
[47] See Appendix D for a detailed explanation.
[48] $\overline{\overline{c}}_t < c^* \left(\frac{2}{3}\right)$ for $\frac{25}{207} \leq t \leq \frac{7}{18}$.

once paid it, the welfare of region B is higher than the welfare associated to a ban on subsidies and to exports.

To conclude the Section let us consider the impact of allowing to bid for firms on total welfare.

- **The effects if subsidy competition on the two regions' joint welfare.**

When transportation costs are sufficiently low (see Table 3), subsidy competition *always increases total welfare* relative to the case in which subsidies are banned. In fact, it may be that both regions gain from subsidy competition, so that total welfare obviously increases. In this case banning subsidies is definitely inefficient because it makes the regions' least desirable alternative occur while allowing to offer them would prevent this and just for this reason would make each region better off wherever the MNE locates. Alternatively, it may be that the region lagged behind gains and the advanced one loses, but the welfare gain of the former prevails and total welfare increases again. Note that since the fact that the MNE exports is quite undesirable for the two regions, *the beneficial effects associated to subsidy competition are much stronger than in the case in which exports are not an alternative to FDI*[49].

Conversely, for transportation costs sufficiently high *total welfare is never increased by subsidy competition.* In this case, either both regions lose from subsidy competition and total welfare obviously decreases or the region lagged behind gains but not enough to dominate the welfare loss of the advanced region. The intuition is that the fact that the MNE exports has become very attractive for the two regions; this implies that a region does not value that much the FDI if the alternative is that the MNE exports while it values much more the FDI if the alternative is that the MNE locates in the rival region. Therefore, letting governments offer subsidies gives them the incentive to strongly compete one against the other dissipating the benefits associated to the MNE's investment. Instead, banning subsidies would avoid this waste of resources and would determine an outcome (exports) that is for sure better for the region that loses the auction and that is not that bad even for the region that obtains the FDI. As a result, once paid the equilibrium subsidy, either also this region suffers a welfare loss with respect to the case in which subsidies are ruled out or it gains but not enough to compensate the welfare loss of the other region.

For intermediate transportation costs total welfare increases for c_A belonging to a particular set[50] and as transportations costs increase the range of c_A for which total welfare increases

[49] Recall that, when exports are not an alternative to FDI, it is never the case that both regions enjoy a welfare gain and total welfare increases only when the MNE locates in the region technologically lagged behind and the local firm of region A is extremely efficient. In particular, $c^{**}\left(\frac{2}{3}\right) \simeq 0.0234$.

[50] See Appendix E for a detailed explanation.

restricts till the point in which subsidy competition is never welfare improving. To conclude, the outcome of the welfare analysis is definitely different from the case in which exports are not an alternative to FDI. In particular, the beneficial effects associated to subsidy competition are stronger or weaker relative to the case in which the MNE is assumed to always invest in one of the two countries, according to the level of transportation costs or, equivalently, according to how much the fact that the MNE exports is desirable.

Table 3: *Change of total welfare*

transportation costs	$\Delta w_A + \Delta w_B > 0$
$\frac{1}{27} \leq t < \frac{-864+60\sqrt{5289}}{48654}$	always
$\frac{-864+60\sqrt{5289}}{48654} \leq t < \frac{-1863+207\sqrt{46441}}{428490}$	$0 \leq c_A < c_1$ and $c_2 < c_A < \frac{1}{6}$
$\frac{-1863+207\sqrt{46441}}{428490} < t < \frac{1}{9}$	$0 \leq c_A < c_1$ and $c_3 < c_A < \frac{1}{6}$
$\frac{1}{9} \leq t < \frac{-27+3\sqrt{681}}{276}$	$0 \leq c_A < c_1$
$\frac{-27+3\sqrt{681}}{276} \leq t < \frac{7}{18}$	never

4.5 Conclusion

This paper investigates the welfare effects of subsidy competition for FDI. It considers two regions and it assumes that a region enjoys higher welfare gains when it obtains the location of the MNE, for instance because unemployment is higher in this region. Yet, the MNE finds it more profitable to locate in the other region, subsidies being equal, for instance because this latter region has a higher per-capita income.

In such a framework, it has been shown that under some conditions the possibility to offer subsidies allows the depressed region to overbid the other one and to "win" the location of the MNE. This would never happen if subsidies were forbidden or standardized. For this reason, the depressed region never loses from subsidy competition, while the more advanced one never gains. Moreover, it has been shown that subsidy competition increases total welfare (relative to a situation in which incentives are banned) if the depressed region obtains the investment, if the externality associated to it is sufficiently strong and if the difference between the two regions is sufficiently high. In such a case, subsidy competition leads the investment where otherwise it would not have gone, namely in the region where it generates the largest welfare gain, so large to outweigh the costs in terms of rents transferred to the MNE and of losses of the other country.

It has also been shown that the welfare gains associated to this possibility can be higher if an institution, concerned with total welfare, makes the two countries collude to transfer the

MNE the lowest possible subsidy compatible with the aim of leading the investment where it is valued the most. The conclusions obtained are consistent with the European regulation in this sphere.

These results have been derived assuming that the MNE has ex-ante decided to invest abroad, in the sense that it finds it more profitable to invest rather than to export, even if subsidies are not offered. Relaxing this assumption, the welfare effects of subsidy competition can totally change. To have some insights about this issue, a parametric examples has been developed which helps understanding some of the elements at work. For low transportation costs from the MNE's home country, it may be the case that both countries gain from subsidy competition and even that they gain when they do not obtain the investment. Thus, the beneficial effects of subsidy competition are much stronger than in the case in which the MNE always invests in one of the two countries. However, when transportation costs are very high the opposite occurs so that social competition is never welfare improving. This analysis emphasizes that the alternatives available to the MNE play an important role in determining whether subsidy competition has negative consequences or not.

Finally, all these results strongly depend on the implicit assumption that the MNE has less bargaining power than the competing countries. In the opposite case, subsidy competition never increases total welfare because the MNE captures all the gains associated to the investment.

4.6 Appendix

Appendix A: Proof of Lemma 17

The depressed region wins the auction when $\Delta W_B - \Gamma > \Delta W_A$. Equivalently, when

$$g(\alpha)\,\Delta W_A(\phi) - \alpha\pi_M^{IA} > 0$$

Define $H(\alpha,\phi) = g(\alpha)\,\Delta W_A(\phi) - \alpha\pi_M^{IA}$.

(i) Consider $H(1,\phi) = g(1)\,\Delta W_A(\phi) - \pi_M^{IA}$.

By assumption, $H(1,\phi^{\min}) < 0$[51], $H(1,\phi^{Max}) > 0$, $H(1,\phi)$ is continuous over $[\phi^{\min},\phi^{Max}]$ and $\frac{\partial H(1,\phi)}{\partial\phi} = g(1)\frac{\partial \Delta W_A}{\partial\phi} > 0$. For the intermediate value theorem, there exist a unique ϕ^* such that $H(1,\phi^*) = 0$ and $H(1,\phi) > 0$ for $\phi > \phi^*$.

(ii) Take a $\phi \in [\phi^{\min},\phi^*]$ and consider H as a function of α only. By assumption and by step (i), $H(0,\phi) = 0$, $H(1,\phi) \leq 0$ and $H(\alpha,\phi)$ is convex[52] over $[0,1]$. This implies that when ϕ

[51] Recall that $\Delta W_A(\phi^{\min}) = 0$.
[52] Strictly convex for $\phi > \phi^{\min}$.

is chosen in $[\phi^{\min}, \phi^*]$, $H(\alpha, \phi) \leq 0$ for any $\alpha \in [0,1]$ and the depressed region never succeeds in winning the auction.

(iii) Consider $\frac{\partial H(\alpha,\phi)}{\partial\alpha} = g'(\alpha)\Delta W_A(\phi) - \pi_M^{IA}$. By assumption, if $\phi = \phi^{\min}$, $\left.\frac{\partial H(\alpha,\phi^{\min})}{\partial\alpha}\right|_{\alpha=0} < 0$. Moreover, for any $\phi \in (\phi^{\min}, \phi^*]$, $\left.\frac{\partial H(\alpha,\phi)}{\partial\alpha}\right|_{\alpha=0}$ must be negative: since in this interval $\frac{\partial^2 H(\alpha,\phi)}{\partial^2\alpha} > 0$, if $\left.\frac{\partial H(\alpha,\phi)}{\partial\alpha}\right|_{\alpha=0}$ were positive or equal to zero, it should be strictly positive for any $\alpha > 0$; hence, $H(\alpha,\phi)$, which is equal to 0 in $\alpha = 0$, would be strictly positive for any $\alpha > 0$ and this contradicts the fact that $H(1,\phi) \leq 0$ for $\phi \leq \phi^*$.

(iv) Consider $\left.\frac{\partial H(\alpha,\phi)}{\partial\alpha}\right|_{\alpha=0}$. By assumption, it is negative if $\phi = \phi^{\min}$ and it is positive if $\phi = \phi^{Max}$. Moreover, it is continuous and strictly increasing in ϕ. Therefore, there exists a unique ϕ^{**} such that $\left.\frac{\partial H(\alpha,\bar{\phi})}{\partial\alpha}\right|_{\alpha=0} \geq 0$ if $\phi \geq \phi^{**}$, with $\phi^{**} > \phi^*$ for (iii).

(v) Take a $\phi \in (\phi^*, \phi^{**})$ and consider H as a function of α only. By assumption and by step (i), $H(0,\phi) = 0$, $H(1,\phi) > 0$, $\frac{\partial^2 H(\alpha,\phi)}{\partial^2\alpha} > 0$ and $\left.\frac{\partial H(\alpha,\phi)}{\partial\alpha}\right|_{\alpha=0} < 0$. It is straightforward that there exists a unique $\alpha^*(\phi)$ such that $H(\alpha^*, \phi) = 0$ and $H(\alpha,\phi) > 0$ for $\alpha \in (\alpha^*(\phi), 1]$. Moreover, for the Implicit Function Theorem, $\left.\frac{\partial\alpha^*(\phi)}{\partial\phi}\right|_{\alpha^*,\phi} = \frac{-g(\alpha^*)\left.\frac{\partial\Delta W_A}{\partial\phi}\right|_{\phi=\phi}}{g'(\alpha^*)\Delta W_A(\phi) - \pi_M^{IA}}$ and it is negative because $g(\alpha^*) > 0$ and $\frac{\partial\Delta W_A}{\partial\phi} > 0$ by assumption, while $g'(\alpha^*)\Delta W_A(\phi) - \pi_M^{IA} > 0$ because $\alpha^* > \hat{\alpha}$ [53].

(vi) Finally, take a $\phi \geq \phi^{**}$. $H(0,\phi) = 0$, $H(1,\phi) > 0$, $\left.\frac{\partial H(\alpha,\phi)}{\partial\alpha}\right|_{\alpha=0} \geq 0$ and $\frac{\partial^2 H(\alpha,\phi)}{\partial^2\alpha} > 0$. Therefore, $H(\alpha,\phi) > 0$ for any $\alpha > 0$. ■

Appendix B: Proof of Proposition 20

The welfare gain of the depressed region, net of the equilibrium subsidy to be paid is $\Delta W_B - \Delta W_A - \Gamma$. The welfare loss of the advanced region is $-\Delta W_A$. Therefore, subsidy competition increases total welfare relative to the case in which subsidies are forbidden, iff $F(\alpha,\phi) = [g(\alpha) - 1]\Delta W_A(\phi) - \alpha\pi_M^{IA}$ is positive.

(i) By assumption, $F(1, \phi^{\min}) < 0$, $F(1, \phi^{Max}) > 0$ and $\frac{\partial F(1,\phi)}{\partial\phi} = [g(1) - 1]\frac{\partial W_A(\phi)}{\partial\phi} > 0$. Therefore, there exists a unique $\phi^{***} \in [\phi^{\min}, \phi^{Max}]$ such that $F(1,\phi^{***}) = 0$ and $F(1,\phi)$ is positive for $\phi > \phi^{***}$. Note that ϕ^* is such that $g(1)\Delta W_A(\phi^*) - \pi_M^{IA} = 0$ and hence $\phi^{***} > \phi^*$.

(ii) Take a $\phi \in [\phi^{\min}, \phi^{***}]$ and consider F as a function of α only. By assumption and by step (i), $F(0,\phi) = -\Delta W_A(\phi) \leq 0$, $F(1,\phi) \leq 0$ and $F(\alpha,\phi)$ is convex[54] over $[0,1]$. This implies that choosing any $\phi \in [\phi^{\min}, \phi^{***}]$, $F(\alpha,\phi) \leq 0$ for any $\alpha \in [0,1]$ and subsidy competition never increases total welfare.

[53] $\hat{\alpha}$ is the value that makes $\frac{\partial H(\alpha,\phi)}{\partial\alpha}$ equal to zero. When $\alpha > \hat{\alpha}$, $\frac{\partial H(\alpha,\phi)}{\partial\alpha} > 0$.

[54] Strictly convex for $\phi > \phi^{\min}$.

(iii) Take a $\phi \in (\phi^{***}, \phi^{Max}]$ and consider F as a function of α only. By assumption and by step (i), $F(0,\phi) < 0$, $F(1,\phi) > 0$, $\frac{\partial^2 F(\alpha,\phi)}{\partial^2 \alpha} > 0$. Regardless the sign of $\left.\frac{\partial F(\alpha,\phi)}{\partial \alpha}\right|_{\alpha=0}$, there exists a unique $\alpha^{**}(\phi)$ such that $F(\alpha^{**},\phi) = 0$ and $F(\alpha,\phi) > 0$ for $\alpha \in (\alpha^{**}(\phi), 1]$. Note that $\alpha^{*}(\phi)$ is such that $g(\alpha^{*})\Delta W_A(\phi) - \alpha^{*}\pi_M^{IA} = 0$ so that $\alpha^{**}(\phi) > \alpha^{*}(\phi)$.

(iv) Finally, for the Implicit Function Theorem, $\left.\frac{\partial \alpha^{*}(\phi)}{\partial \phi}\right|_{\alpha^{*},\phi} = \frac{-[g(\alpha^{**})-1] \left.\frac{\partial \Delta W_A(\phi)}{\partial \phi}\right|_{\phi=\phi}}{g'(\alpha^{**})\Delta W_A(\phi) - \pi_M^{IA}}$ and it is negative because $\frac{\partial \Delta W_A(\phi)}{\partial \phi} > 0$ by assumption, $[g(\alpha^{**}) - 1] > 0$ because if it were less or equal to zero it would contradict the fact that $[g(\alpha^{**}) - 1]\Delta W_A(\bar{\phi}) - \alpha^{**}\pi_M^{IA} = 0$ and $g'(\alpha^{**})\Delta W_A(\phi) - \pi_M^{IA} > 0$ because $\alpha^{**} > \hat{\alpha}$. ■

Appendix C: Proof of the results contained in Table 1

Let us define $\bar{c}_t = \frac{14}{99} + \frac{5}{22}t$ the value of c_A such that country A achieves the same level of welfare when the MNE exports and when it invests in the other country. If $c_A > \bar{c}_t$, $w_A^{IB} > w_A^{E}$. Recall also that, according to Lemma 1 bis, country B obtains the FDI when $c_A < c^{*}\left(\frac{2}{3}\right) = \frac{11}{69}$.

1) $\frac{1}{27} \leq t < \frac{82}{1035}$.

In this case, $\bar{c}_t < c^{*}$. Therefore, if $0 \leq c_A < \bar{c}_t$, the MNE locates in country B and given that $w_A^{IB} < w_A^{E}$, $\Delta w_A < 0$. Instead, when $\bar{c}_t < c_A < c^{*}$, the MNE locates in country B but, since $w_A^{IB} > w_A^{E}$, $\Delta w_A > 0$. Finally, when $c^{*} \leq c_A < \frac{1}{6}$, the MNE locates in country A. Since country A offers a subsidy lower or equal to the level for which it is indifferent between having the MNE or not, $w_A^{IA}(T_B^{Max} - \Gamma) \geq w_A^{IB} > w_A^{E}$, and $\Delta w_A > 0$. As a whole, Δw_A is positive for $c_A > \bar{c}_t$.

2) $\frac{82}{1035} \leq t < \frac{1}{9}$.

In this case, $\bar{c}_t \geq c^{*}$. Therefore, when the MNE locates in country B $(0 \leq c_A < c^{*})$, $w_A^{IB} < w_A^{E}$ and $\Delta w_A < 0$. When the MNE locates in country A $\left(c^{*} \leq c_A < \frac{1}{6}\right)$, Δw_A is positive or negative according to how large is w_A^{E}. If $c^{*} \leq c_A < \bar{c}_t$, $w_A^{E} > w_A^{IB}$ and Δw_A, which is equal to $\frac{S\left(-116+1278c_A-3312c_A^2-297t+1782c_At-405t^2\right)}{1024}$, is positive for $\hat{c}_t < c_A < \bar{c}_t$ [55] where $\hat{c}_t \in (c^{*}, \bar{c}_t)$. If $\bar{c}_t < c_A < \frac{1}{6}$, $\Delta w_A \geq 0$ because $w_A^{IA}(T_B^{Max} - \Gamma) > w_A^{IB} \geq w_A^{E}$. As a whole, Δw_A is positive for $c_A > \hat{c}_t$. Note that when $t = \frac{82}{1035}$, $\bar{c}_t = \hat{c}_t = c^{*}$ and when $t = \frac{1}{9}$, $\hat{c}_t = \bar{c}_t = \frac{1}{6}$.

3) $\frac{1}{9} \leq t \leq \frac{7}{18}$[56].

In this case, $\bar{c}_t \geq \frac{1}{6}$ so that w_A^{IB} is never larger or equal to w_A^{E}. Therefore, when the MNE locates in country B, $\Delta w_A < 0$. When the MNE locates in country A, $\hat{c}_t \geq \bar{c}_t \geq \frac{1}{6}$ and, again, $\Delta w_A < 0$. As a whole, Δw_A is never positive. ■

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[55] $\hat{c}_t = \frac{1278+1782t-\sqrt{(1278+1782t)^2-13248(116+297t+405t^2)}}{6624}$. The other root of $\Delta w_A = 0$ is bigger than $\frac{1}{6}$ and we disregard it.

[56] $t \leq \frac{7}{18}$ ensures that $\pi_M^{E} \geq 0$ for any c_A.

Appendix D: Proof of the results contained in Table 2

Let us define $\bar{\bar{c}}_t = \frac{1-3t}{4}$ the value of c_A such that $w_B^{IA} = w_B^E$. If $c_A < \bar{\bar{c}}_t$ $w_B^{IA} > w_B^E$.

1) $\frac{1}{27} \leq t \leq \frac{1}{9}$.
In this case, $w_B^{IA} > w_B^E$ for any value of c_A. Therefore, country B gains from subsidy competition both when the MNE locates in the other country $\left(\Delta w_B = w_B^{IA} - w_B^E > 0\right)$ and when it obtains the FDI. In the latter case, country B offers a subsidy lower than the level for which it is indifferent between having the MNE or the MNE locating in country A. Hence, $w_B^{IB}\left(T_A^{Max} + \Gamma\right) > w_B^{IA} > w_B^E$ and Δw_B is positive.

2) $\frac{1}{9} < t < \frac{25}{207}$. In this case, $w_B^{IA} > w_B^E$ only for $0 \leq c_A < \bar{\bar{c}}_t$. In this interval, for the reason just explained, Δw_B is positive both when the MNE locates in country B $(0 \leq c_A < c^*)$ [57] and when the MNE locates in country A $\left(c^* \leq c_A < \bar{\bar{c}}_t\right)$. When $c_A \geq \bar{\bar{c}}_t$, country A obtains the investment and since $w_B^{IA} \leq w_B^E$, $\Delta w_B \leq 0$. As a whole, Δw_B is positive for $0 \leq c_A < \bar{\bar{c}}_t$.
3) $\frac{25}{207} \leq t < \frac{1}{3}$. Again, $w_B^{IA} > w_B^E$ only for $0 \leq c_A < \bar{\bar{c}}_t$ but now $\bar{\bar{c}}_t \leq c^*$. Therefore, when $0 \leq c_A < \bar{\bar{c}}_t$, country B obtains the MNE and Δw_B is positive.

When $\bar{\bar{c}}_t \leq c_A < c^*$, the MNE locates again in country B but $w_B^E \geq w_B^{IB}$ and Δw_B, which is equal to $\frac{S\left(88-990c_A+2952c_A^2+135t-810c_At-405t^2\right)}{5184}$, is positive for $\bar{\bar{c}}_t \leq c_A < \overset{\approx}{c}_t$ [58]. When $c_A \geq c^*$, country A obtains the investment and since $w_B^{IA} \leq w_B^E$, $\Delta w_B \leq 0$. As a whole, Δw_B is positive for $0 \leq c_A < \overset{\approx}{c}_t$. Note that when $t = \frac{25}{207}$, $\overset{\approx}{c}_t = \bar{\bar{c}}_t = c^*$, while when $t = \frac{1}{3}$ $\bar{\bar{c}}_t = 0$.
4) $\frac{1}{3} \leq t < \frac{7}{18}$. Now $\bar{\bar{c}}_t \leq 0$ and w_B^{IA} is never larger than w_B^E. When the MNE locates in country B $(0 \leq c_A < c^*)$ Δw_B is positive for $0 \leq c_A < \overset{\approx}{c}_t$. When the MNE locates in country A, $\left(c^* \leq c_A \leq \frac{1}{6}\right)$ Δw_B is negative since $w_B^{IA} < w_B^E$.

Appendix E: Proof of the results contained in Table 3

1) $\frac{1}{27} \leq t < \frac{-864+60\sqrt{5289}}{48654}$.
In this case, when $\bar{c}_t < c_A < \frac{1}{6}$, $\Delta w_A > 0$ and $\Delta w_B > 0$, so that $\Delta w_A + \Delta w_B > 0$. Instead, when $0 \leq c_A \leq \bar{c}_t$ $(< c^*)$, $\Delta w_A \leq 0$ and $\Delta w_B > 0$. In this interval the MNE locates in country B and $\Delta w_A + \Delta w_B$ which is equal to $\frac{S\left(10-132c_A+492c_A^2-27t+162c_At-135t^2\right)}{864}$ is positive, since the determinant of this equation is negative[59].

2) $\frac{-864+60\sqrt{5289}}{48654} \leq t < \frac{82}{1035}$.
In this case, when $\bar{c}_t < c_A < \frac{1}{6}$, $\Delta w_A > 0$ and $\Delta w_B > 0$ so that $\Delta w_A + \Delta w_B > 0$. Instead, when $0 \leq c_A \leq \bar{c}_t$ $(< c^*)$, the MNE locates in country B, $\Delta w_A \leq 0$ and $\Delta w_B > 0$. Defining $c_1 \leq c_2$

[57] In this interval, $c^* < \bar{\bar{c}}_t$.
[58] $\overset{\approx}{c}_t = \frac{990+810t-\sqrt{(-990-810t)^2-11808(88+135t-405t^2)}}{5904}$;we diregard the other root.
[59] $t = \frac{-864+60\sqrt{5289}}{48654}$ is the value of transportation costs such that the determinant is equal to zero.

the two roots of $\Delta w_A + \Delta w_B$, total welfare increases when $0 \leq c_A < c_1$ and $c_2 < c_A \leq \bar{c}_t$. As a whole, in this interval, total welfare increases when $0 \leq c_A < c_1$ and $c_2 < c_A < \frac{1}{6}$.

3) $\frac{82}{1035} \leq t \leq \frac{1}{9}$.

In this case, when $\hat{c}_t < c_A < \frac{1}{6}$, $\Delta w_A > 0$ and $\Delta w_B > 0$ so that $\Delta w_A + \Delta w_B > 0$. Instead, when $0 \leq c_A \leq \hat{c}_t$, $\Delta w_A \leq 0$ and $\Delta w_B > 0$. Note that $\hat{c}_t > c^*$ and thus, in this interval it may be either that the MNE locates in A or in B so that further specifications are needed. Recall that, when country B wins the subsidy game $\Delta w_A + \Delta w_B$ is positive for $0 \leq c_A < c_1$ and $c_2 < c_A < c^*$. When country A obtains the investment, $\Delta w_A + \Delta w_B = \frac{S\left(-58+684c_A-1836c_A^2-81t+486c_At-405t^2\right)}{1024}$. We define c_3 its smallest root[60] and total welfare increases for $c_3 < c_A \leq \hat{c}_t$. $t = \frac{-1863+207\sqrt{46441}}{428490}$ is the value of transportation costs for which $c_2 = c^* = c_3$.

Therefore,

(i) if $\frac{82}{1035} \leq t < \frac{-1863+207\sqrt{46441}}{428490}$, when the MNE locates in country B $(0 \leq c_A < c^*)$ $\Delta w_A + \Delta w_B > 0$ for $0 \leq c_A < c_1$ and $c_2 < c_A < c^*$; when the MNE locates in country A $\left(c^* \leq c_A \leq \hat{c}_t\right)$ $\Delta w_A + \Delta w_B > 0$ because $c_3 < c^*$. As a whole, if t belongs to this interval, total welfare increases for $0 \leq c_A < c_1$ and $c_2 < c_A < \frac{1}{6}$.

(ii) if $\frac{-1863+207\sqrt{46441}}{428490} \leq t < \frac{1}{9}$, when the MNE locates in country B $0(0 \leq c_A < c^*)$ $\Delta w_A + \Delta w_B > 0$ for $0 \leq c_A < c_1$ because $c_2 \geq c^*$; when the MNE locates in country A $\left(c^* \leq c_A \leq \hat{c}_t\right)$ $\Delta w_A + \Delta w_B > 0$ for $c_3 < c_A \leq \hat{c}_t$. As a whole, if t belongs to this interval, total welfare increases for $0 \leq c_A < c_1$ and $c_3 < c_A < \frac{1}{6}$.

4) $\frac{1}{9} \leq t < \frac{25}{207}$.

In this case, Δw_A is always negative, while Δw_B is positive when $c_A < \bar{\bar{c}}_t$. When country B obtains the FDI $(0 \leq c_A < c^*)$ total welfare increases if $0 \leq c_A < c_1$; when the MNE locates in country A, either $\Delta w_A < 0$, $\Delta w_B > 0$ $\left(\text{when } c^* \leq c_A < \bar{\bar{c}}_t\right)$ but the welfare gain of country B is not large enough to compensate the welfare loss of country A $\left(c_3 \geq \frac{1}{6}\right)$; or both country suffer a welfare loss $\left(\text{when } \bar{\bar{c}}_t \leq c_A < \frac{1}{6}\right)$ so that total welfare obviously decreases . As a whole, in this interval, total welfare increases for $0 \leq c_A < c_1$.

5) $\frac{25}{207} \leq t < \frac{7}{18}$.

In this case, Δw_A is negative, while Δw_B is positive for $0 \leq c_A < \tilde{\tilde{c}}_t$. Note that $\tilde{\tilde{c}}_t \leq c^*$[61]. $t = \frac{-27+3\sqrt{681}}{276}$ is the value of transportation costs such that $c_1 = 0$. Therefore,

(i) if $\frac{25}{207} \leq t < \frac{-27+3\sqrt{681}}{276}$, when $0 \leq c_A < \tilde{\tilde{c}}_t$ the MNE locates in country B, $\Delta w_A < 0$, $\Delta w_B > 0$ and total welfare increases for $0 \leq c_A < c_1$. When $\tilde{\tilde{c}}_t \leq c_A < \frac{1}{6}$, both countries suffer a welfare loss from subsidy competition and total welfare obviously decreases.

(ii) $\frac{-27+3\sqrt{681}}{276} \leq t < \frac{7}{18}$, either both countries suffer a welfare loss and total welfare de-

[60] The other root is bigger than $\frac{1}{6}$ so that we disregard it.

[61] $\tilde{\tilde{c}}_t = c_A^*$ for $t = \frac{25}{207}$.

creases; or country B gains and country A loses, but the welfare gain of country B is never large enough to compensate the welfare loss of the other country. In this interval, total welfare in never improved by subsidy competition. ∎

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