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Banal-Estañol, Albert; Macho-Stadler, Ines; Seldeslachts, Jo

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Mergers, Investment Decisions and Internal Organisation

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MERGERS, INVESTMENT DECISIONS AND INTERNAL ORGANISATION

ALBERT BANAL-ESTAÑOL
INÉS MACHO-STADLER
JO SELDESLACHTS

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MERGERS, INVESTMENT DECISIONS AND INTERNAL ORGANISATION

Abstract

We analyse the effects of investment decisions and firms' internal organisation on the efficiency and stability of horizontal mergers. In our framework economies of scale are endogenous and there might be internal conflict within merged firms. We show that often stable mergers do not lead to more e.ciency and may even lead to efficiency losses. These mergers lead to lower total welfare, suggesting that a regulator should be careful in assuming that possible efficiency gains of a merger will be effectively realised. Moreover, the paper offers a possible explanation for merger failures.

JEL Code: L22, D43.

Keywords: horizontal mergers, investment, efficiency gains, internal conflict.

Albert Banal-Estañol
Departament d'Economia i d'Història
Econòmica - Edifici B
Universitat Autònoma de Barcelona
08193 Bellaterra (Barcelona)
Spain
abanal@idea.uab.es

Inés Macho-Stadler
Departament d'Economia i d'Història
Econòmica - Edifici B
Universitat Autònoma de Barcelona
08193 Bellaterra (Barcelona)
Spain
ines.macho@uab.es

Jo Seldeslachts
Departament d'Economia i d'Història
Econòmica - Edifici B
Universitat Autònoma de Barcelona
08193 Bellaterra (Barcelona)
Spain
jseldes@idea.uab.es

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1 Introduction

Mergers are common practice in many markets and their dynamics, as well as their advantages and disadvantages, are often discussed. Especially the analysis of horizontal mergers and their possible efficiency gains have been important topics in recent years (European Commission Report [5]). Economic merger theory shows that a merger can reduce welfare by increasing market power but that it can also create efficiency gains in a variety of ways, thereby making the merger possibly welfare enhancing (see Röller et al. [15] for an overview).

However, many analysts suspect that there are more factors in play. Efficiency gains of mergers should not be taken for granted. The possibility that a merged firm may become more efficient does not mean that these gains will be actually realised as is now widely assumed in the economics literature. This is because of two related factors. First, becoming more efficient requires investment and is thus a strategic decision. Second, a newly merged firm brings together different corporate cultures, which can lead to conflict and therefore possibly less investment.[1]

This paper broadens the theory on horizontal mergers with efficiency gains in concentrated markets. In line with Rajan & Zingales [13], we think it is realistic to claim that the manager and not the owner is in control of many decisions that affect a firm's efficiency.[2] The aim is to shed more light on how merger and investment decisions interact, and look how the internal organization of firms has an influence on these interactions. This approach facilitates the understanding of why some mergers may fail to become more efficient or even fail to happen.

We construct a model of endogenous mergers with three managers. Managers choose whom to form partnerships while anticipating a share of the future revenues. Each manager controls some non-transferable resources, such as organizational or managerial capacities, that determine production costs. They have to decide whether to supply them (*invest*) at a private cost before the formed firms compete in the product market à la Cournot. We assume that when managers are together, the resources of the new formed firm add up the resources that the participating

[1] A recent example can be found in the creation of Corus in 1999. The Anglo-Dutch group became the third-biggest steel company in the world, but its value has dramatically come down. The Economist (March 15th 2003) argues that the error was that Corus "failed to construct a workable model for its internal management, choosing instead to paper over the differences between the English and the Dutch systems."

[2] Rajan & Zingales [13] say that the amount of surplus that a manager gets from the control of residual rights is often more contingent on him making the right specific investment than the surplus that comes from ownership. Hence, access to the resources of the firm can be a better mechanism to describe power than ownership. Of course the agent who owns and uses the assets of the firm can be the same person.

managers control.[3] This allows us to take into account economies of scale.[4]

Currently all discussions on mergers are limited to exogenous efficiencies while the outcomes and policy recommendations could be different when considering investment in a more efficient technology as a choice variable. In a study for the European Commission, Röller et al. [16] lament the lack of economic knowledge about the interaction of merger and investment decisions: "It is not clear how one should treat the endogenous scale economies that are an alienable aspect of concentrated industries".

Forging a common corporate culture out of two or more disparate ones can be costly and can even lead to less efficient and less profitable firms. Surprisingly enough, concepts such as power and conflict within the firm are often forgotten in the economics literature when looking at merger decisions, despite evidence indicating that they play a major role (Seabright [18]). We consider the possibility that, after a merger, managers do not work in the interest of the firm but in their own.[5] It is often said that the motivation of managers to work together in the interest of the firm comes from team spirit and trust in each other (Kandel & Lazear [11]). But, this is exactly what we believe is lacking in a merged firm. Since it is not always possible to write complete contracts in a firm and the privately costly investment is ex ante not verifiable, the lack of trust is leading to a free riding problem. Thus, conflict in our model makes that each manager in a firm invests only when it is privately beneficial to do so. Internal problems may therefore arise, driven by a lack of trust and informational externalities caused by the inability to identify individual contributions (Holmström [9]).

Two extreme cases are considered. First, we analyse the situation where managers cooperate inside the firm when deciding on investment. Equivalently, contracts are assumed to be complete. This setup permits us to investigate what happens when investment is a decision variable and allows us to compare with the realised efficiency gains when managers do not co-

[3] This argument is valid for all cases where the resources are complementary. The same idea is found in Bloch [2] Goyal & Moraga-González [7], where efforts in R&D induce a higher spillover if firms are in a joint venture.

[4] A recent literature on endogenous coalition formation deals with efficiency gains (e.g. Belleflamme [1], Bloch [2] and Yi [19]), but also these authors model efficiency gains as exogenous. Yi [20] lets firms decide on their investment in R&D, but the level of product market collusion is determined by a social planner.

[5] All managers in our model stay in the merged firm and keep control over part of the assets. One could claim that in a merger only *one* manager comes to control all the assets. But this would eliminate all internal problems and is normally not observed in reality. Probably it would be better to model a merger not as a conflict between single managers, but as a lack of trust between the different teams that now have to work together. We think that our way of modelling is a good approximation of this idea, assuming that each manager is the boss of his team and making all strategic decisions.

operate within the firm. It is found that if managers inside a firm cooperate, they have more incentives to do so in a merged firm because of potential economies of scale, but *only* when it is profitable. In other words, even when there is no internal conflict, a potential merger may not necessarily be more efficient. The second scenario considers a situation where the managers do not trust each other. Contracts are not complete and suboptimal investment decisions are likely to occur (Holmström [8]). We find that the conflict of interests within the firm can dominate the possible economies of scale, making a larger merged firm invest less. A merger can therefore even be a *less* efficient firm than non-merged firms.[6]

These equilibrium investment decisions have an impact on the stability of industry structures. When looking at which mergers will effectively materialise, we find for cooperating managers inside the firm a result in the spirit of Salant et al. [17]. If all managers simultaneously can choose to go to the monopoly industry structure, they will do so. This is possible with our merger stability concept in which managers can anticipate the reaction of the others. Thus, when managers cooperate at the investment-decision level, the only stable structure is the monopoly. This complete market concentration does not necessarily lead to a more efficient production. For non-cooperating managers, not only the monopoly structure but the duopoly and triopoly are possible stable outcomes. Two conclusions follow. First, conflict within the firm can lead to less market concentration, even when modelling mergers as the potentially more efficient firms. This is the case when duopoly or triopoly are stable, whereas without conflict the monopoly was always stable. Second, when there will indeed be mergers in equilibrium, these merged firms are sometimes to be found less efficient. This happens when -despite the internal conflict- it is optimal to merge, but -because of more internal conflict and aggressive investment of competitors- managers invest less in the larger merged firms.

Welfare analysis shows that the stable industry structure is too concentrated from a social point of view for both scenarios when merged firms do not become more efficient. A welfare comparison of the stable structures in the no-conflict and conflict situation indicates that the

[6] The set-up of the model and sequence of events is in the same philosophy as Espinosa & Macho-Stadler [6], Rajan & Zingales [13] and Goyal & Moraga-González [7]. In Espinosa and Macho-Stadler [6], partners group into firms in a sequential way, and in the second stage firms compete à la Cournot with a moral hazard problem inside the firms when deciding upon production. In Rajan & Zingales [13], an asset owner chooses how many managers can have access to the assets. The managers who receive access choose their non-contractible investment. In Goyal & Moraga-González [7], firms decide to participate in R&D networks. Given a collaboration network, each firm chooses a non-contractible investment which defines the cost of production and all firms individually compete à la Cournot afterwards.

scenario where managers do not trust each other is always equal or inferior to the case where managers cooperate internally. The cases where the non-cooperating managers do not merge, -leading to less market power and thus better for consumers- are dominated by the loss in efficiency, which is worse for consumers.

These results show that interactions between what is happening inside and outside firms is important in determining the boundaries and efficiency levels of a firm. A regulator should take into account that possible efficiency gains of a merger may not be realised, what could change the decision for approval of this merger as we see when analysing social welfare. Possibly there has to be given also more attention to lack of trust within firms. Our model suggests that internal conflict not only harms firms, but also consumers and therefore total welfare. We give as well an explanation for merger failures. When firms decide to go together, the organisational difficulties that this creates are often underestimated. If managers do not correctly foresee the internal problems, the new firm may not be profitable and thus resulting in a failue.

The paper is structured as follows. Section 2 describes the model. Sections 3, 4 and 5 present the solution of the different stages of the model. Section 6 and section 7 discuss respectively welfare issues and some extensions of the model. All proofs are presented in the Appendix.

2 Model

We consider a situation where three managers have to decide on their productive organisation. In a first stage, managers decide on the industry structure (Ω) and choose whether to set up their own firm or join forces with other managers. Three industry structures can arise. We denote each manager in a monopoly as m and in a triopoly as t. In the duopoly structure, the two managers that merge are denoted by i ('insider') whereas the remaining manager is denoted as o ('outsider'). In the second stage, each manager decides to which extent he invests -at a cost- to reduce production costs. In the first scenario, there is no internal conflict within a firm. Equivalently, all decisions are verifiable and managers behave in the interest of the firm to which they belong. In the second case, their is no control on which managers invest and because of a lack of trust managers do what is best for them individually. In the third stage the formed firms compete à la Cournot.[7]

[7] It is in the interest of all the managers in the same firm to cooperate in the product market. This is because we do not assume that there is an individual cost attached to producing. For a partnership formation model where production is costly for each manager, see Espinosa & Macho-Stadler [6].

To solve the model we proceed by backward induction. We first solve the third stage of the game, where firms simultaneously decide their production level. We consider an homogeneous market with a linear demand, $P(Q) = a - Q$, where a is a positive constant measuring the size of the market and $Q = \sum_{\omega \in \Omega} q_\omega$ is the total production, with q_ω the production of firm w.

Anticipating the Nash equilibrium in outputs, managers take investment decisions simultaneously. The constant marginal cost of firm ω, $\omega \in \Omega$, will be denoted by s_ω, and consists in common marginal cost, S, reduced by the investment of the managers within each firm:

$$s_\omega = S - \sum_{j \in \omega} I_j, \tag{1}$$

where I_j represents investment by manager j in firm ω. The more managers in the firm, the more possibility to lower the costs of production, so there are possibilities for economies of scale in investment. Manager j chooses I_j in the set $\{0, k\}$. Parameter k can be interpreted as the magnitude that investment brings in lowering the production costs of the firm.[8] We assume that in equilibrium all firms in all industry structures produce a non-negative quantity and therefore $k \in [0, \frac{a-S}{2}]$. The cost of an investment I_j is denoted by $C_j(I_j)$, where $C_j(0) = 0$ and $C_j(k) = c$.

In the first stage, the merger stage, managers decide on forming a firm alone or together with other managers. We assume firstly that mangers share profits equally, and discuss later that the results would not change qualitatively if they decide on the sharing rule. An industry structure is stable if no manager or group of managers has an incentive to deviate and form a different firm. The payoff of the formed firm depends on the organisation of the other managers. Hence, in evaluating a possible deviation, managers must make a prediction of what the other managers will do. We adopt the view that the most reasonable prediction when deciding upon a deviation is that the remaining managers will choose the best strategy possible.

Definition 1 *An industry structure Ω is stable if there is no profitable deviation by a group of managers to form another firm, considering that the remaining managers would choose to form firms to maximise their payoff.*

This analysis is relatively simple when considering three managers. When the group considering a deviation is the three-managers firm, we only have to check if this is a profitable

[8] Note that an alternative approach is to assume that the investment belongs to an interval $[0, k]$. Given the linearity of the model, this would be equivalent to the assumption $I \in \{0, k\}$ since the optimal decision on investment is always a corner solution.

deviation since there are no remaining managers. When two managers deviate, the optimal reaction by the third manager is trivially to stay alone. Finally, when only one manager deviates, the remaining two may choose optimally either to go together or to split apart.

When considering a deviation, managers are anticipating the investment outcome in the second stage. When there are multiple Nash equilibria in the investment stage, they have to make a prediction about what will occur as investment outcome. We adopt the view that managers are *optimistic*: when considering a deviation, they predict the investment Nash equilibrium which is most beneficial in terms of profits.[9]

3 Product market competition (3rd Stage)

Assume that an industry structure Ω with r firms has been formed at stage 1 and the investments made in stage 2 imply costs s_υ, for all $\upsilon \in \Omega$. Then each firm $w \in \Omega$ maximizes its profits:

$$\max_{q_\omega} \left\{ \left[a - \sum_{\upsilon \in \Omega} q_\upsilon \right] q_\omega - s_\omega q_\omega \right\}.$$

The Nash equilibrium of the Cournot game leads firm $\omega \in \Omega$ to produce

$$q_\omega = \frac{\left(a + \sum\limits_{\upsilon \in \Omega, \upsilon \neq \omega} s_\upsilon - r s_\omega \right)}{(r+1)} = \frac{\left(a - S - \sum\limits_{\upsilon \in \Omega, \upsilon \neq \omega} I_\upsilon + r I_\omega \right)}{(r+1)}.$$

Without loss of generality we assume $a - S = 1$. The equilibrium (gross) profit for firm ω is

$$\Pi_\omega = \frac{\left(1 - \sum\limits_{\upsilon \in \Omega, \upsilon \neq \omega} I_\upsilon + r I_\omega \right)^2}{(r+1)^2}. \tag{2}$$

4 Endogenous Investment (2nd stage)

In this section we analyse the investment decision for managers as a function of the market structure and the internal commitment. Let us first set the terminology we use. One of

[9] This approach has been used by other authors. Diamantoudi [4] analyses the endogenous formation of coalitions using the concept of 'binding agreements' when there are multiple Nash equilibria and considers different behavioral assumptions, among others the optimistic approach. A similar concept for matching markets has been defined by Demange & Gale [3]. The optimistic view is very demanding in terms of stability since it may induce many deviations. However, in our model with three managers, stability is reached for almost all parameter combinations and this stability concept reduces the number of stable outcomes and allows us to concentrate on 'very' stable industry outcomes.

the main aims of the paper is to investigate whether a merger leads to more *efficiency*. We say that there are efficiency gains when a merged firm produces at a lower marginal cost than would separate entities do. This lowering in marginal costs is due to a higher investment of the managers present in the firm.

Definition 2 *A merger implies* ***efficiency gains*** *when the merged firm has lower production costs. These lower production costs are realised because of a higher investment activity of the managers in the merged firm.*

We consider two extreme cases of internal organisation. First, we discuss the scenario where managers cooperate fully within the firm. This results in the best possible situation for the managers (first best situation). Second, the internal conflict case is looked at.

4.1 No Internal Conflict

If investment is a cooperative decision within the firm, the profit for a manager j in firm $\omega \in \Omega$ with $|\omega|$ managers is

$$\pi_\omega^j = \frac{1}{|\omega|}\Pi_\omega - \frac{1}{|\omega|}\sum_{l\in\omega} C_l \ . \tag{3}$$

Note that maximizing (3) is equivalent to maximizing the (net) profits of the firm. Investment of different firms must form a Nash equilibrium.

It is intuitive enough that costs and gains of investment play a major role in what happens in equilibrium and our analysis is done in function of these two parameters. But apart from costs and gains, the amount in which firms will decide to reduce production costs depends (i) on the size of the firms, i.e. the number of managers in the firm, and (ii), on the competition level. First, the larger a firm is, the more incentives to invest. Since managers in the same firm are cooperating, they will be able to exploit the economies of scale. Second, a firm may want to invest for strategic reasons. Investment activities are strategic substitutes across firms and more investment implies later on a better position in the production phase vis à vis the competitors. Therefore, the more competitors in the market, the more incentives a manager has to invest. This means that the scale effect and strategic effect go in *opposite* directions.[10] Proposition

[10] This is of course an immediate consequence of our model. The number of managers in the market is fixed, so if there are more managers inside the firm -i.e. the firm is larger- there are less managers outside the firm -ie. there are less competitors. However, it seems natural to assume that, *given* a certain industry, larger firms and a more concentrated market go together, even if there would be free entry.

1 states the previous intuition as a function of the parameters of the model. Remark that we state the efficiency gains in the conditional state. At this stage we do not know yet which mergers are going to take place if any.

PROPOSITION 1 *When managers cooperate, for costs/gains of investment going from low to high, we can distinguish four regions:*
(A) All managers invest. Any merger would imply efficiency gains.
(B) Managers in the monopoly and insiders in a duopoly invest, but single-manager firms may not. Any merger would imply efficiency gains.
(C) Managers that set up a firm alone do not invest. Either the monopolists or the insiders invest. There exist therefore always a merger that would lead to efficiency gains, but not any merger would lead to an efficiency gain.
(D) Nobody invests. No merger would imply efficiency gains.

The regions defined in Proposition 1 are stated formally in the Appendix and are depicted in Figure 1.[11] When the investment is free (i.e., $c = 0$), any firm will invest in reducing production costs (region A). On the contrary, when the investment is extremely expensive as compared to the cost-production savings, the optimal decision will be not to invest (region D). For intermediate ranges of costs/gains of investment, the scale and strategic issues determine who invests. Region B shows that the first managers to give up investing are the one-manager firms, because the scale event is strongest: the smallest firms loose first their incentives. In region C, both effects can dominate. In region C1, only monopolists invest because the scale effect dominates. In region C2, the strategic motive is more important and the insiders (competing in the duopoly) invest whereas the monopolists do not. Note that still, *within* the duopoly, the insiders have more incentives to invest than the outsider because of the scale effect. In our model the strategic effects are almost always inferior to the scale effects when there is no internal conflict.

Multiple investment equilibria may exist. The optimal decision for a monopoly and duopoly is always unique. In the triopoly the *type* of equilibrium is unique but it is not always clear which manager invests in equilibrium. There are three equilibria of the type $((k)(k)(0))$ where two managers invest, $I = k$, and the third does not. In another region of the parameters there

[11] Note that the normalisation $a - S = 1$ implies that $k \in [0, 1/2]$ in order to have all firms producing in equilibrium. Without the normalisation, the axes in Figure 1 would have been: $\frac{k}{a-S}$ and $\frac{c}{a-S}$. Comparative statics with respect to $(a - S)$ would simply expand or contract the Figure.

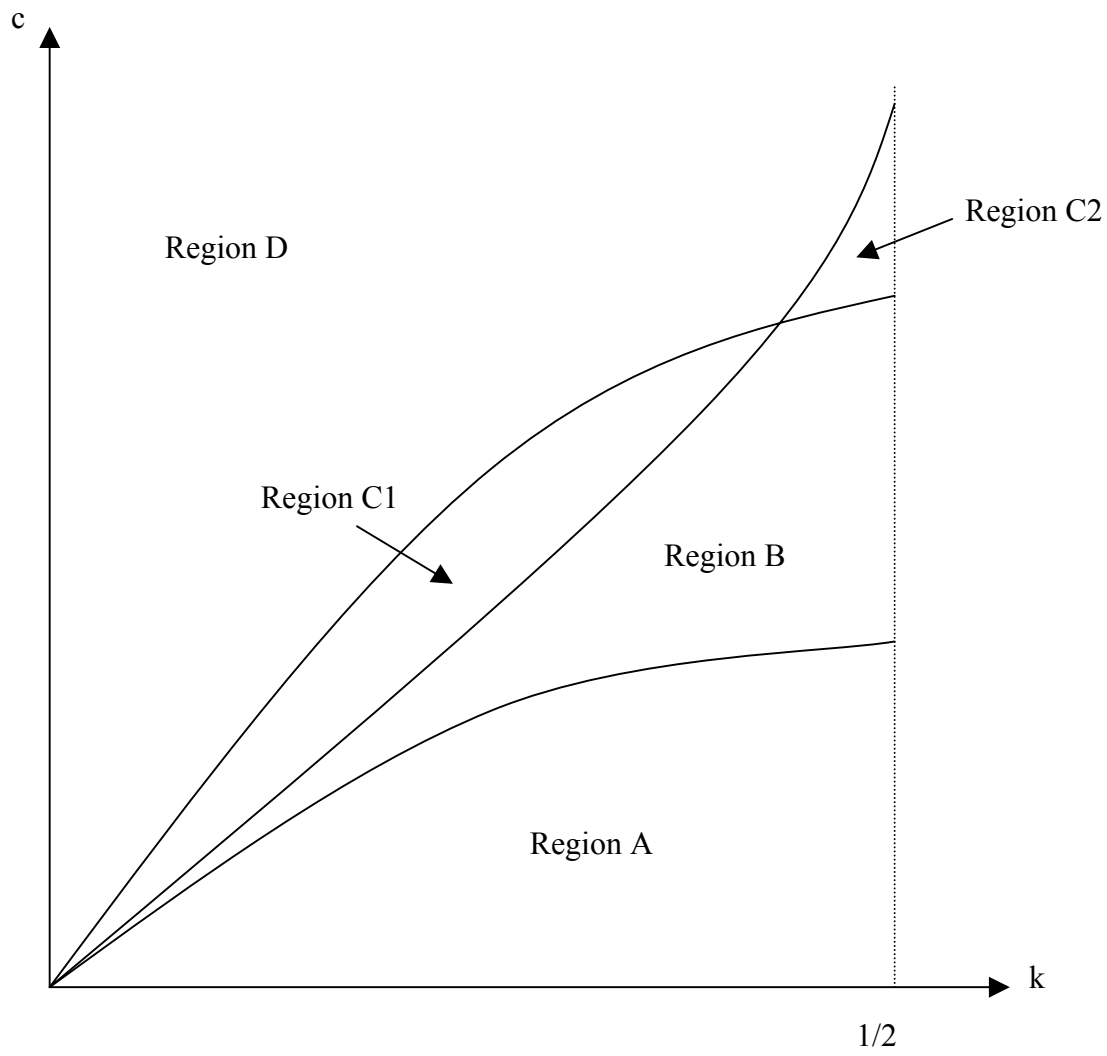

Figure 1: Investment Nash Equilibria when
there is no internal conflict

exist three Nash equilibria where the investment decisions take the form $((k)(0)(0))$. This is because managers are ex-ante symmetric and we cannot say who invests and who not. This is not important in the investment stage, since we only need to know what happens in equilibrium, independent on which person does what.

4.2 Internal Conflict

We now solve the situation where managers within the firm do not cooperate when taking investment decisions. Managers choose again their investment as a function of the gains this investment implies for the profits of the firm to which they belong. But the cost of investing is not shared by the whole firm, the managers *individually* have to bear this cost and a free riding problem might arise. The profit for a manager j in firm $\omega \in \Omega$ with $|\omega|$ managers is

$$\pi_\omega^j = \frac{1}{|\omega|}\Pi_\omega - C_j \ . \tag{4}$$

As in the first best case, the amount in which firms decide to reduce production costs depends (i) on the size of the firms and (ii), on the competition structure. However, the issues are not as clear cut anymore. If a firm is larger, there are still more chances to exploit the economies of scale. But also the possibility for internal conflict grows. In a larger firm each manager receives a smaller share of the gross profits induced by his individually costly investment. The effect of the size of a firm on the incentives to invest can go both ways. Whereas for low costs with respect to gains of investment economies of scale dominates, conflict becomes rapidly more important as costs/gains rise. Thus, managers in larger firms loose much faster their incentives to invest than in the case without conflict. The strategic event still induces managers in a less concentrated market to invest more. It is therefore easy to understand that both the conflict and strategic effect go in the same direction. When conflict is strong, managers in smaller firms -and therefore also facing more competitors- have more incentives to invest. Proposition 2 states the previous intuition as a function of the parameters of the model.

PROPOSITION 2 *When managers do not cooperate inside the firm, for costs/gains of investment going from low to high, we can distinguish four regions:*
(E) Managers in a monopoly and insiders invest. Any merger would imply efficiency gains.
(F) Managers in a monopoly never invest and there is always an equilibrium in which insiders invest. In the equilibrium where insiders invest, a merger towards duopoly would imply efficiency gains. A merger towards monopoly would mean an efficiency loss.

(G) Managers in the monopoly and insiders never invest, but there exists always a single-manager firm that does. Any merger would imply efficiency losses.
(H) Nobody invests. No merger leads to efficiency gains or efficiency losses.

The regions defined in Proposition 2 are stated formally in the Appendix and are depicted in Figure 2. In region E where the investment is close to free, any firm invests. Within this region conflict is not important, and the scale effect dominates, implying that the largest firms in the market have most incentives to invest. For costs/gains of investment rising, the conflict issue, reinforced by the strategic effect, starts interfering with scale and managers in the monopoly stop investing (region F1). Further on, the conflict situation becomes more and more important, making either the insiders or the outsider in duopoly invest (region F2). The conflict effect becomes finally always dominant and insiders never invest anymore (region G). Finally, when the investment is extremely expensive as compared to the cost-production savings, the optimal decision for all managers will be not to invest (region H).

What does this imply for the efficiency gains? As long as the monopolist invests, any merger leads to a more efficient firm. From the moment that managers in the monopoly do not invest and other managers still do, a merger towards monopoly leads to efficiency *losses*. When also the insiders stop investing and the one-manager firm still does, *any* merger leads to efficiency losses. Finally, when nobody invests, a merger does not lead to any efficiency changes.

Summarising the results obtained for both scenarios, some mergers may induce efficiency gains but for this to be true a necessary condition is that the cost of the investment compared to the gains are low enough. If the internal conflict is important, a merger may even imply efficiency losses.

5 Stable market structures (1st stage)

Managers decide in the first stage to stay alone or go together with other managers, anticipating the investment decisions and competition in the market. We analyse the stable industry structures. We consider first the situation with no internal conflict.

5.1 No Internal Conflict

When managers cooperate within the firms, larger firms tend to invest more and tend to be more profitable. This makes it naturally more interesting for managers to merge. The next proposition confirms this intuition.

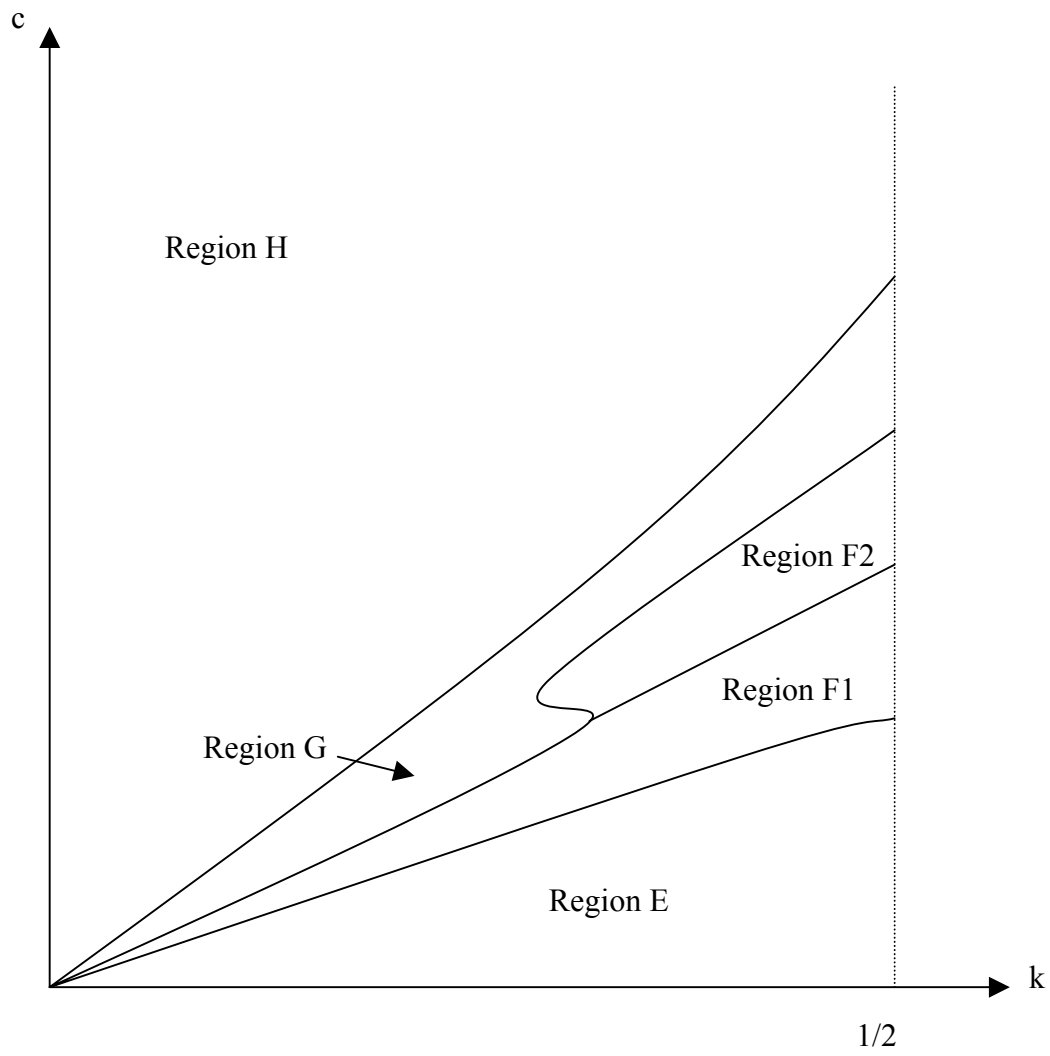

Figure 2: Investment Nash Equilibria when
there is internal conflict

Proposition 3 *When there is no internal conflict within firms, the monopoly is the only stable structure. No stable structure exists for a region where costs and gains of investment are very low.*

The results stated in Proposition 3 are represented in Figure 3. Two different processes lead the monopoly to be the only stable outcome. The first takes place because managers are able to avoid the classical outsider-problem. If a managers tries to free-ride on the others by deviating, the other two *optimally* split apart, making the deviation unprofitable.[12] The other process leads managers very naturally towards the monopoly outcome, because *any* merger is profitable for all managers.

When the cost of investment is high with respect to its gains (region D in the corresponding Figure 1), managers do not invest and the only motive for merging is having more market power. Managers reach thus the monopoly through the first process. However, when the cost of investment is low with respect to its gains (region A), managers always prefer to invest because of economies of scale. Merged entities have therefore lower production costs, leading in general to more incentives to merge than when nobody invests. This situation is similar to the situation described in Perry & Porter [12], where the merged firm has lower production costs than either of the forming firms.[13] In regions B and C, either the first or the second process makes the monopoly the only stable outcome.

5.2 Internal Conflict

We present the stable mergers when conflict within firms happens. For the sake of presentation, we show the results separately for the four regions identified in Proposition 2. Consider first the case corresponding to Proposition 2(E) where the cost of investment is low with respect to its gains, making monopolists and insiders always invest.

[12] The outsider-problem occurs when it is beneficial for all to merge towards monopoly, but it is even better to be the outsider in duopoly. This is the situation in Salant et al. [17]. In their model, where there are no scale economies, merging is beneficial if the number of outsiders is low and the merging firms represent at least 80% of the total market. In our three-firm case this threshold implies the merger towards monopoly.

[13] To be complete, we have to distinguish three different cases when all managers invest. First, for a high enough efficiency gain (a high enough k), the monopoly naturally arises. For intermediate gains, managers still prefer to be an outsider over being in a monopoly, but now the other two will prefer to stay together over being alone. There will be therefore continuously a duopoly, but the formed firms are *not stable*. When gains are low, only the merger towards monopoly is profitable and the reasoning is the same as in the case of no investment.

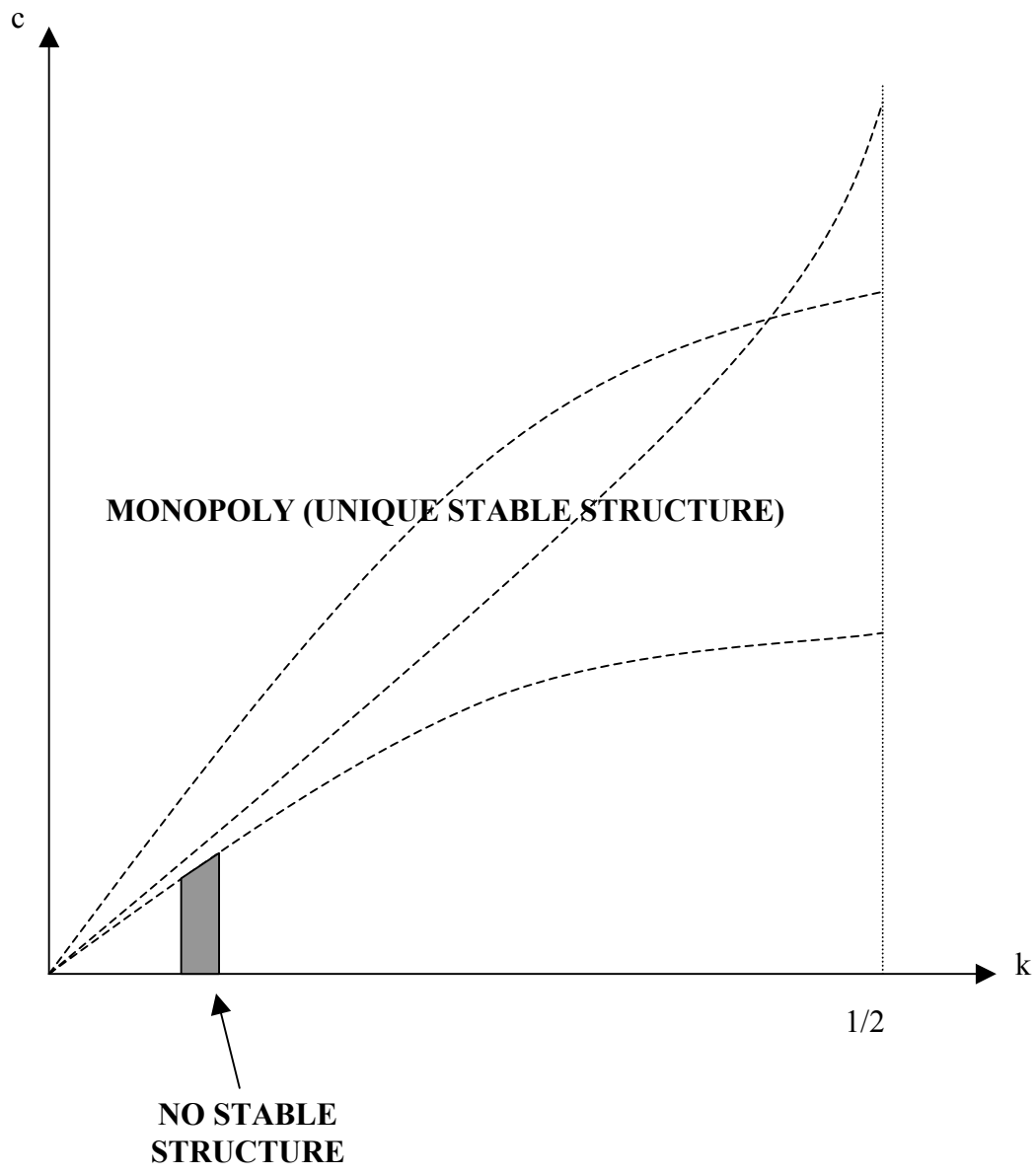

Figure 3: Stable market structures when
there is no internal conflict

Proposition 4 *When there is internal conflict within firms and investment costs/gains are low (monopolists and insiders always invest), the monopoly is the only stable structure.*

When managers always prefer to invest, entities merge towards monopoly for exactly the same reasons as when managers always invest in the no-conflict situation. These results are depicted in the lower part of Figure 4 (equivalent to region E of Figure 2).

The case corresponding to Proposition 2(F) is where the conflict effect starts interfering with the scale effect, making the monopoly never investing and there is always an equilibrium in which insiders invest.

Proposition 5 *When there is internal conflict within firms and costs/gains of investment are intermediate (monopolists never invest and insiders might invest),*
(a) If in equilibrium the insiders always invest, the duopoly or monopoly can be the unique stable industry structure.
(b) If in equilibrium either insiders or the outsider invest, the duopoly is the only stable structure.

Whenever the gains are high, the duopoly in which the insiders invest is the stable industry structure. The conflict effect induces the monopoly not to invest, but it is still not dominating in the two-player firm, making the insiders in the duopoly the best off (See intermediate part of Figure 4, corresponding to region F1 and F2 of Figure 2). In addition, insiders do not have incentives to split apart: the gains are high enough to prevent them to deviate to triopoly. Hence, duopoly is the stable market structure.[14] Insiders obtain here a higher profit than monopolists. This is an important effect that appears with conflict. When there is no internal conflict, monopoly is always superior to being an insider in duopoly.

When gains are lower and costs of investment higher, the stability arguments are again the same as the situation where all managers invest in no-conflict (its three cases also appear here, see footnote 14), but there is an important difference. Here the monopoly does *not* invest. However, even if in this region the monopoly does not invest, the reduction in competition and

[14] In case (b), the investment Nash equilibrium in duopoly is not unique. There is an equilibrium where only the insiders invest and a second where only the outsider invests. When two managers deviate, they are optimistic and expect that in the duopoly structure the Nash equilibrium will be such that they will invest and the outsider will not. They obtain more under this market structure than under triopoly and hence the triopoly is not stable. When deviating from monopoly, the outsider being optimistic, assumes that the final equilibrium is the one in which he invests. However, when the outsider invests, the insiders prefer to break up and to deviate towards triopoly and we have no stability. For the same reason, the outsider-investing duopoly is not stable.

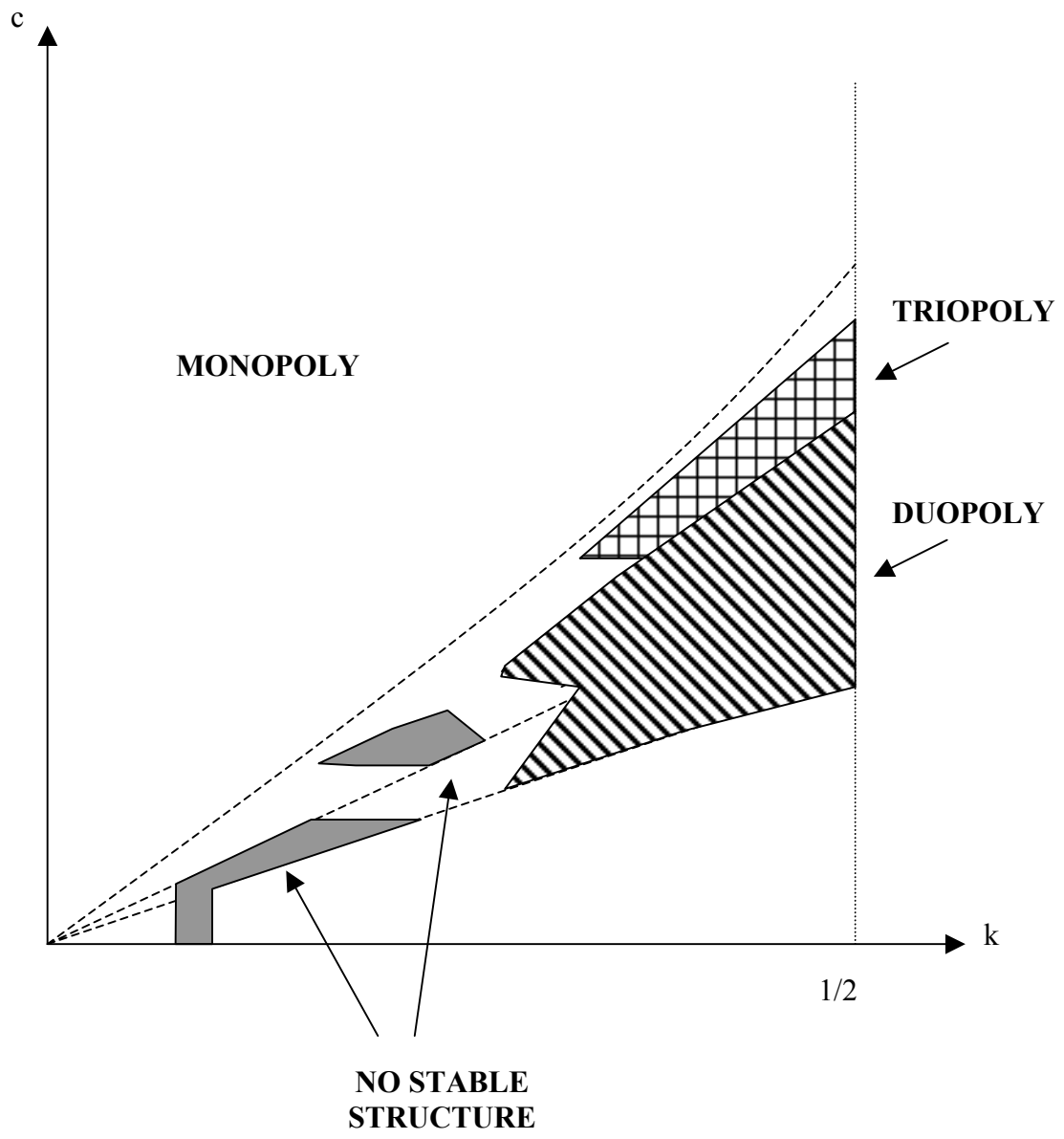

Figure 4: Stable market structures when
there is internal conflict

the lower benefits from investment make the monopoly substantially more beneficial and makes it the only stable industry structure (See region F1 and F2 of Figure 2). A merger to monopoly induces here efficiency losses.

When costs are high with respect to gains, we are in Proposition 2(G) and 2(H). The conflict effect becomes always dominant and neither monopolists nor insiders invest. When the investment is extremely expensive as compared to the cost-production savings, the optimal decision for *all* managers will be not to invest.

PROPOSITION 6 *When there is internal conflict within firms and costs/gains of investment are high (only single-manager firms might invest).*
(a) If only one triopolist invests, the triopoly or monopoly can be the unique stable industry structure.
(b) Otherwise, only the monopoly can be a stable industry structure.

When only one triopolist invests and gains from investment are high enough, it is clear that the triopoly will be the only stable industry structure.[15] In the other cases, monopoly is stable for the same reasons as in region D in Proposition 3.

When managers do not trust each other in a newly merged firm, they are less willing to invest, making in turn a merger sometimes unprofitable. Thus, internal conflict generates less mergers, resulting in a completely or partly deconcentrated industry structure. This indicates that even when numerous factors would lead to monopolisation, managers decide not to merge because of a lack of trust. The monopolisation factors are twofold in our model: possible economies of scale and having more market power. Mergers however still occur because of the monopolisation factors, but the lack of trust makes managers often not investing and mergers lead in this case always to efficiency losses.[16]

In the next section we give, based on our model, a possible explanation for merger failures.

[15] This triopolist does not want to merge with other managers because of the reinforcing conflict and strategic effects. The other two triopolists do not want to go together either. In a duopoly, the non-investing insiders are in a disadvantage with respect to the investing outsider and moreover, they have to share profits.

[16] Our stability concept has an important role in obtaining monopolisation as a stable industry structure. This equilibrium does not arise in some other merger games. For example, in a model where acquisitions are made through a bidding game, Kamien and Zang [10] show that monopoly cannot be an equilibrium while making no acquisition at all always is. This occurs because when deviating, a manager in their model assumes that the others will not change their strategy, which is possible in our model.

6 Merger Failures

If managers cannot perfectly foresee whether there will be internal conflict within the merged firm, it is possible that wrong merger decisions are taken. Suppose that ex-ante managers merge because they expect a priori that there will be no internal conflict, but conflict does arise later on. This misjudgement might lead to a merger failure (less profits in merger than in no-merger). We have indeed found cases where the monopoly is stable under no conflict (Section 5.1) but where in a conflict situation, profits are higher with a lower market concentration (Section 5.2), meaning that because of not foreseeing this conflict, managers have erronously merged.

A similar argument applies when managers are rational but there exists uncertainty about the possibility of internal conflict. Let us assume that ex post -in the investment stage- we are in one of our two extreme cases (no conflict at all or total conflict), but ex ante -in the merger stage- managers cannot perfectly foresee what is going to happen. Thus, managers decide upon merging given their expectations:

$$\begin{aligned} \Pr(Conflict) &= \alpha \\ \Pr(NoConflict) &= 1-\alpha. \end{aligned}$$

Once mergers have occurred, managers realise in which case they are and investment decisions are as described in Section 4. We omit the derivation of the stable structures, but the procedure is similar to the two cases presented before.[17] The stable market structures are obtained by calculating with expected profits and are defined by the investment gains (k), investment costs (c) and expectations (α). For illustrating purposes, we depict in Figure 5 the stability results for the case $k = 1/2$.

When managers merge to monopoly because they expect the merger to be profitable because the risk of internal conflict is sufficiently low, but there arises a conflict later, there are cases where triopoly or duopoly would have been better choices.[18]

7 Welfare

In this section we analyse what would be the socially optimal market structure in each situation (with and without internal conflict) and compare these with the obtained stable outcomes. Total

[17] Calculations are available upon request.

[18] The opposite can also be true. If managers have a priori pessimistic expectations about the degree of internal conflict and choose not to merge, it may well be ex post that a merger would have been profitable.

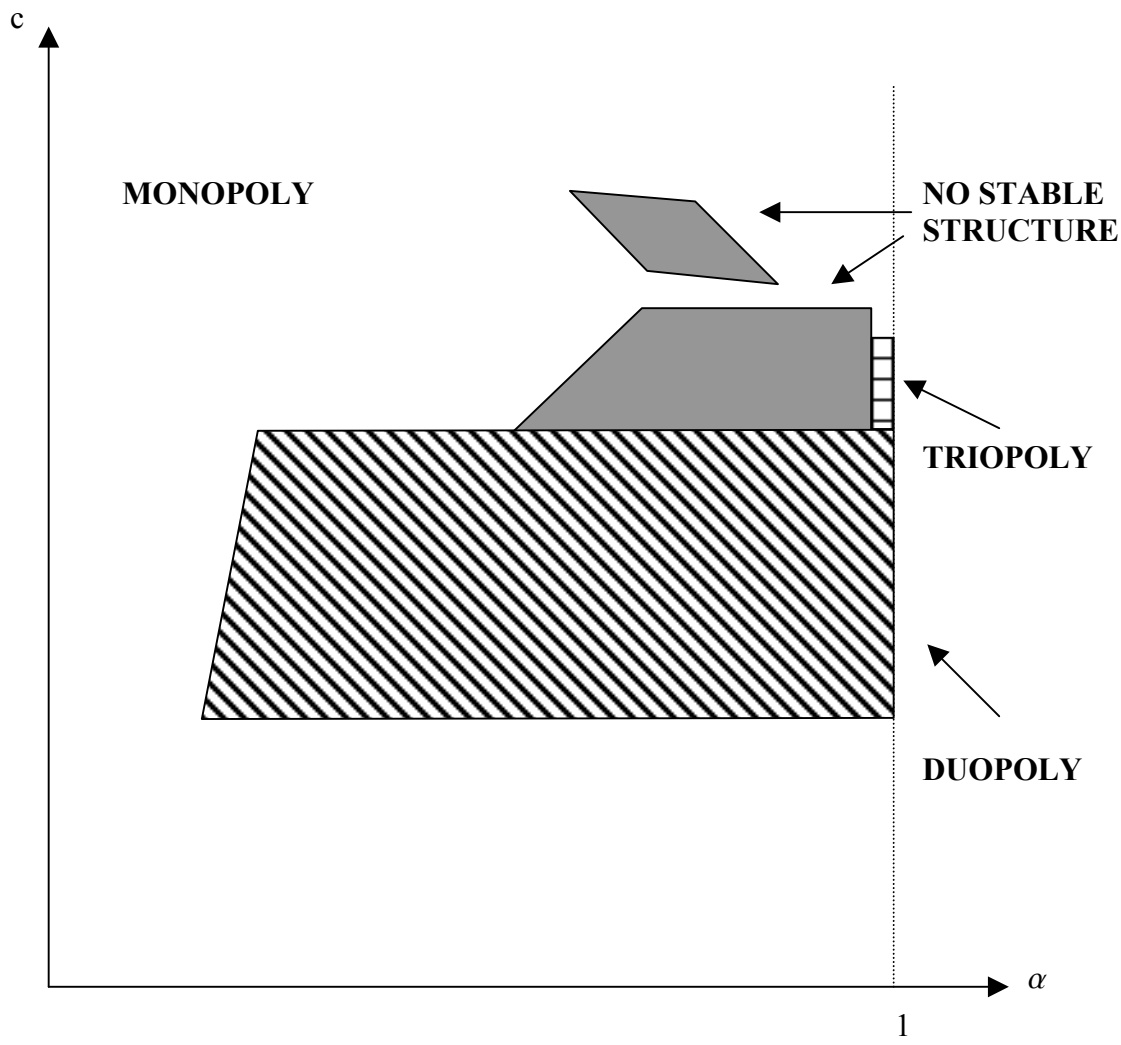

Figure 5: Stable market structures when there is
a possibility of internal conflict (k = 1/2)

welfare is defined as the sum of consumer and producer surplus:

$$W = \frac{Q^2}{2} + \sum_{j=1,2,3} \pi^j.$$

For the consumers, the best solution is where total industry production is highest. Total production is increasing in the level of competition and in firms' efficiency. For both scenarios, when no firm or only the triopolists invest and there are therefore no efficiency gains in merging, production is maximised in the triopoly industry structure. When the monopolists invest and the efficiency gains are important, monopoly is optimal for consumers because the efficiency gains outweigh the market power effects. Duopoly can be output maximising, mostly in the conflict case when insiders in duopoly invest, but managers in the monopoly not.

Looking at the producer surplus, if managers cooperate internally the optimum is always the monopoly. Monopolists are able to replicate or do better what managers do in any other market structure. For non-cooperating managers, total market concentration may not be profit enhancing since conflict may make it impossible for monopolists to replicate what smaller firms do. For example, when the monopolist does not invest but insiders do, it is better to be an insider than a monopolist: the gains in efficiency are higher than the loss of the lower market power. Figure 6 and 7 present the social optimum for both scenarios. In both cases, when costs/gains of investment are low consumers and producers interests coincide and the efficent monopoly is preffered. For cost/gains high, it is unlikely that all managers invest and both groups have opposite interests, but consumer surplus dominates in determining what is best for total welfare and the triopoly structure maximises total welfare. For intermediate cost/gains duopoly can be the social optimum.

In comparing the social outcomes (Figures 6 and 7) with the stable industries (Figures 3 and 4), it is clear that when there are important efficiency gains in mergers, the stable outcome is also socially optimal. When the efficiencies are less important, stable market structures are not welfare maximising.

We also see that it is always as good or better for a society when managers cooperate inside the firm. This is of course because investment is more often done, leading to more efficient firms and thus more production. The non-cooperating managers have sometimes less market power in a stable structure, a good thing for consumers, but this coincides always with also less efficient firms, and the latter effect dominates.

We can derive two main conclusions from the welfare analysis. First, when modelling investment as a decision variable, it becomes clear that where stable mergers would be normally

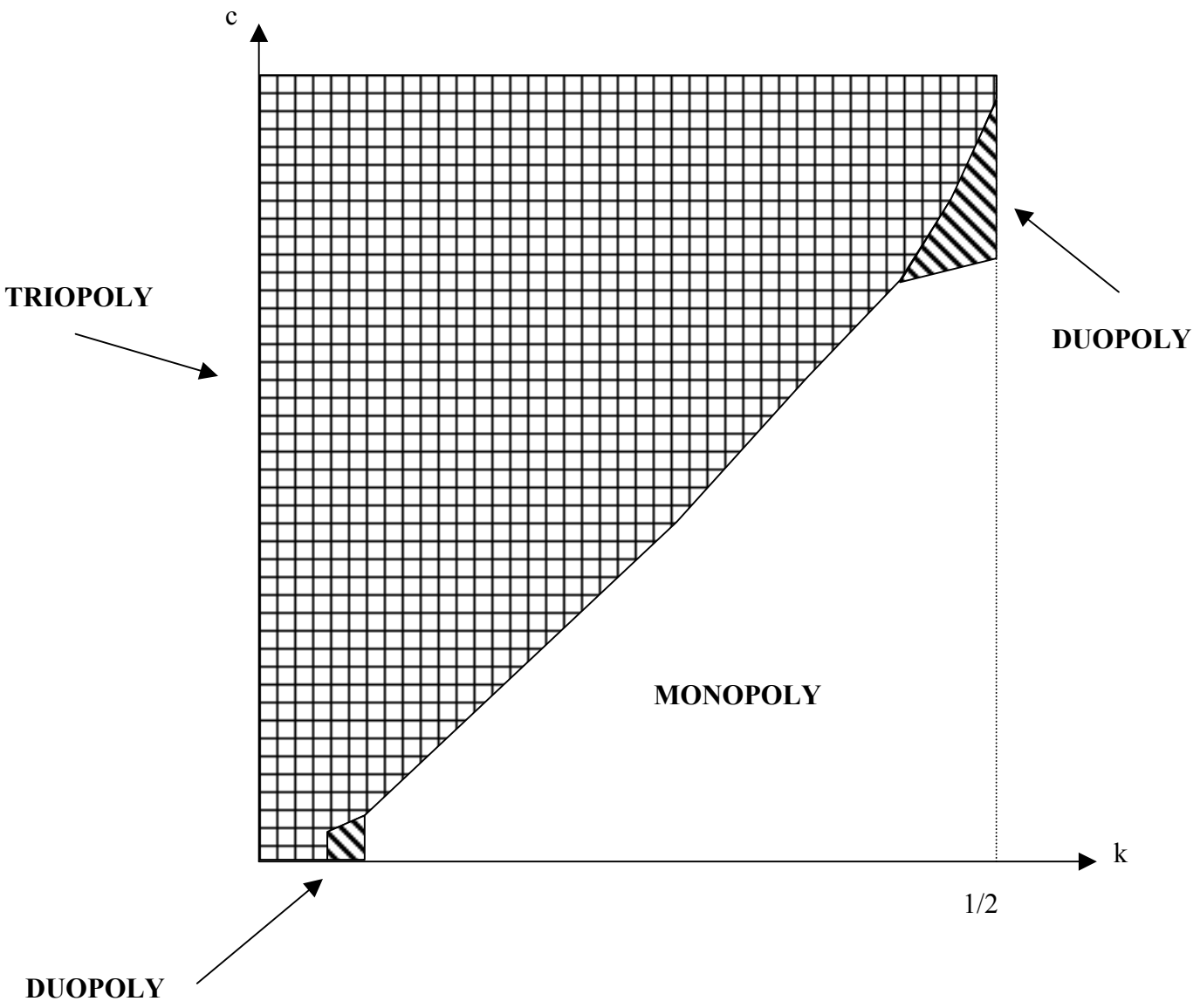

Figure 6: Socially optimal market structures
when there is no internal conflict

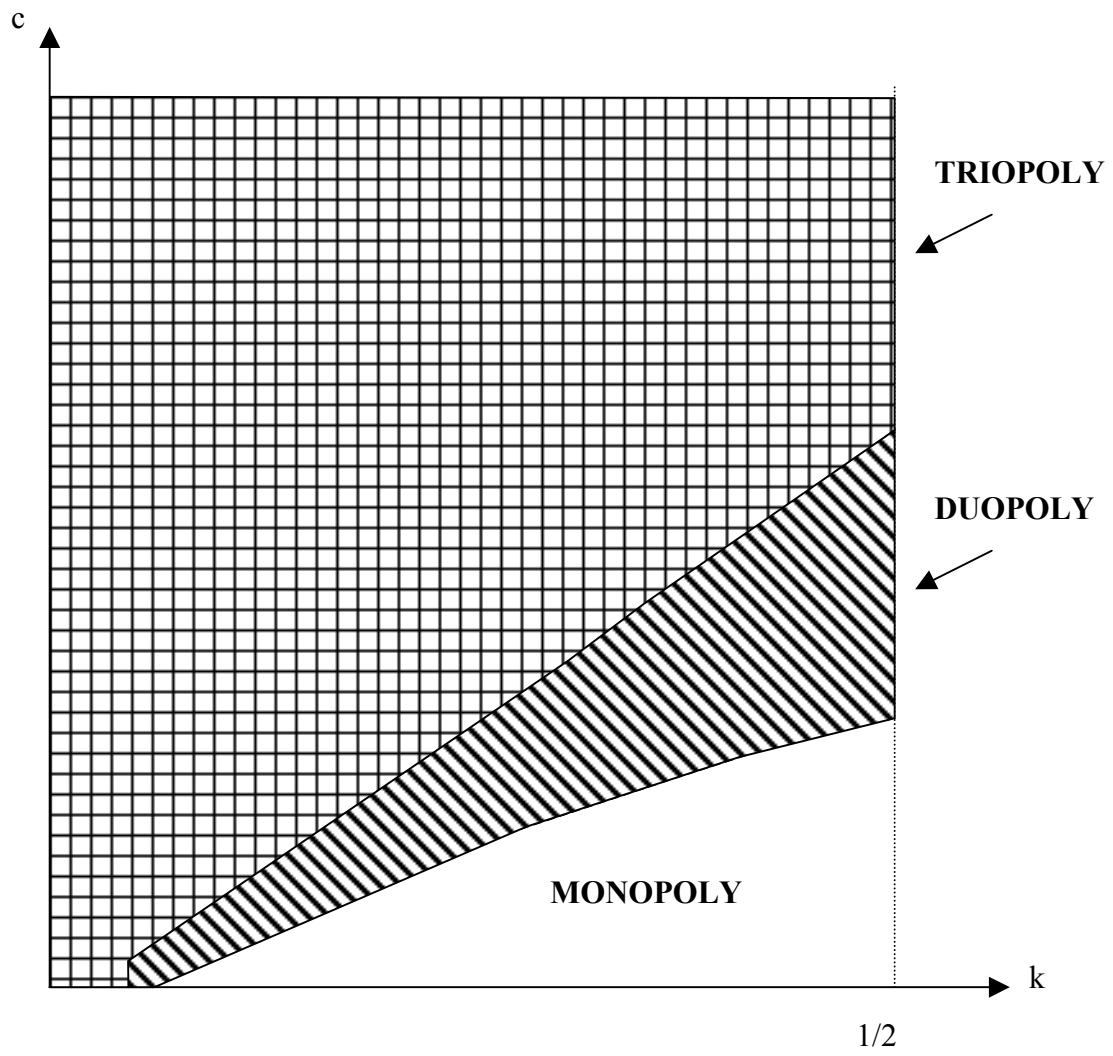

Figure 7: Socially optimal market structures
when there is internal conflict

good for the total welfare if the -exogenous- efficiency gains are high enough, this is not true anymore, because often merging managers prefer not to invest, even when they are internally cooperating. Second, internal conflict might not only be bad for the managers, but also for consumers, because it is leading to less efficiency and -offsetting the lower market power effect- to less production.

8 Discussion

In this section we discuss some assumptions of the model. We constructed a model of endogenous mergers in a concentrated market with only *three managers*. We believe that the main effects present would not change in situations with more than three managers. However, with endogenous investment and our stability concept, this analysis would be extremely complex.

We have chosen for simplicity to present throughout the paper the case where the *sharing rule is exogenous*. Our results qualitatively remain unchanged in a model where the managers optimally decide upon the sharing of the profits when the firm is formed. Note first that it seems natural to assume that when managers are ex ante identical, all the managers in the same firm have to receive ex post the same payoff.[19] Second, the optimal agreement in the conflict case has to maximise the firm's profits taking into account the incentives that this agreement provides. Hence, whether the managers receive their payoff via a fixed fee and/or as a percentage of the joint profit determines the incentives to invest. When all the parameter combinations are such that agreeing on an equal sharing rule of the profits induces the same investment decision as in the non-conflict case, this sharing rule is optimal. When the equal sharing does not give incentives in a multi-manager firm, better investment incentives can be obtained by increasing the percentage of the profits to some managers and compensate the others via a fixed fee. When managers set up the optimal payment scheme, the differences between the conflict and no conflict case are smaller because in conflict the investment levels decrease now more gradually.

We have considered two *extreme situations in terms of conflict* within firms. Realistically, there are different levels of conflict where in the firm managers may commit on some investments and may not on others. If β is the degree of conflict, managers' profits are $\pi_\omega^j = \frac{1}{|\omega|}\Pi_\omega - \left(\beta C_j + (1-\beta)\frac{1}{|\omega|}\sum_{l\in\omega} C_l\right)$. Again, while having an additional parameter, the analysis would yield similar results.

[19] Ray & Vohra [14] have indeed proven that in a sequential coalition formation game where players are identical this is optimal.

Finally, we have adopted the view that when deviating, managers are optimistic in the sense that they predict the prevailing equilibrium in investment to be the one in which their profits are highest. This assumption reduces the set of stable market structures, making in some cases the set empty. If managers were pessimistic and hence less willing to deviate, while the set of empty structures may be smaller, we might have situations with multiple stable structures.

9 Conclusion

The purpose of this paper is to broaden the theory on horizontal mergers with efficiency gains in concentrated markets, including investment as a strategic variable and allowing for a lack of trust within the firm. This approach facilitates the understanding of why some mergers may fail to become more efficient or even fail to happen. Other merger models take investment to be exogenous and treat the firm as a black box, but as Holmström [9] points out, "we cannot claim to fully understand either the internal organisation of firms or the operation in markets by studying them in isolation".

We construct an endogenous merger formation model with three managers simultaneously taking merger decisions. Internal problems may arise on the moment where managers decide on investing. The lack of trust and inability to identify individual contributions may result in free-riding problems and suboptimal decisions.

We find indeed that even when allowing a merger to be potentially more efficient -i.e., a larger firm can produce at a lower cost when having taken the necessary investment decisions- managers in a merged firm do not necessarily want this to happen. People in a larger firm have effectively more incentives to invest because of economies of scale, but only do so when this is profitable. The problems due to a lack of trust -becoming bigger in a larger firm- can even offset the possible economies of scale thereby making a merged firm *less* efficient. In a model of strategic R&D networks with Cournot competition in later stage, Goyal & Moraga-González [7] also find that when R&D is unilaterally chosen, the level of R&D is decreasing in the size of the R&D network.

When managers cooperate internally, we find a complete market concentration to be the only stable outcome. Managers can simultaneously decide together and are able to reach what is for them the best possible industry structure (this is a result similar in the spirit of Salant et al. [17]). With internal conflict, not only monopoly, but only less concentrated market structures and even a completely defragmentated industry is possible in equilibrium.

Therefore, when managers in the same firm trust each other, all merge, but this merged firm is not necessarily more efficient than would be a smaller firm. When managers do not cooperate internally, they may decide not to merge, because of a too high conflict. If they still decide to merge, they may invest less than the smaller firms. Whenever a merger is not leading to more efficiency, a move towards more market concentration is leading to lower welfare. Moreover, the lack of trust seems not only to lead to suboptimal outcomes for the managers, but also from a social point of view: the consumers loose more from the loss in efficiency than they gain due to a lower market power of the firms.

With our results, we want to point out that the recent documents on the "efficiency defence of mergers" (see European Commission Report [5]) are forgetting some essential elements. A regulator should not assume that possible efficiency gains of a merger will be realised, which could change the decision for approval of this merger. Also, although probably not a generalisable result, the lack of trust in recently merged firms may be important not only for managers, but could also be bad for total welfare, indicating that these issues are as well important for policy makers. Finally, our model also gives an explanation for merger failures. When firms decide to go together, the organisational difficulties that this creates are often underestimated. If managers do not correctly foresee internal problems, they merge while this new entity is not profitable and resulting thus in a failure.

10 Appendix

In this section we present the explicit expressions for the different cases in the propositions and their proofs. The proofs are given following a series of lemmas. We denote for simplicity Π_j^m the (gross) profits for each manager in monopoly when j managers invest; $\Pi_{j,l}^i$ and $\Pi_{l,j}^o$ the (gross) profits for each insider and outsider manager, respectively, when j insiders and l outsiders invests; and $\Pi_{1,j}^t$ and $\Pi_{0,j}^t$ the (gross) profits for each triopolist when he invests and when he does not, respectively, in the case the other j triopolists invest ($j = 0, 1, 2$). Similarly we denote π^m, π^i, $\pi^o$and π^t the 'net' profits for each monopolist, insider, outsider and triopolist.

10.1 Proof of Proposition 1

Within each firm, it is always always optimal for the managers to choose a corner solution, where none of them invests or all of them do. Managers in a monopoly invest if and only if $c \leq \overline{c}^m$ where $\overline{c}^m$ is implicitly defined by $\Pi_3^m - \overline{c}^m = \Pi_0^m$. When there is competition, firms condition

their investment decisions to those of the rivals. In a duopoly, insiders' decision depends on the decision of the outsider and vice versa. The insiders invest if $c \leq \overline{c}_1^i$ and if $c \leq \overline{c}_0^i$ depending, respectively, whether the outsider invest or not, where $\Pi_{2,1}^i - \overline{c}_1^i = \Pi_{0,1}^i$ and $\Pi_{2,0}^i - \overline{c}_0^i = \Pi_{0,0}^i$. Similarly, the outsider invest if $c \leq \overline{c}_2^o$ and if $c \leq \overline{c}_0^o$ depending, respectively, whether the insiders invest or not, where $\Pi_{1,2}^o - \overline{c}_2^o = \Pi_{0,2}^o$ and $\Pi_{1,0}^i - \overline{c}_0^o = \Pi_{0,0}^o$. Finally, each triopolist invests if $c \leq \overline{c}_j^t$, where $\Pi_{1,j}^t - \overline{c}_j^t = \Pi_{0,j}^t$.

LEMMA 1 *The relevant cutoffs are ordered as follows:* $\overline{c}_2^t < \overline{c}_1^t < \overline{c}_0^t < \overline{c}^i$; $\overline{c}^o < \overline{c}^i$; $\overline{c}_0^t < \overline{c}^m$ *and* $\overline{c}^o < \overline{c}^m$ *where for simplicity we denote* $\overline{c}^i \equiv \overline{c}_0^i$ *and* $\overline{c}^o \equiv \overline{c}_2^o$.

Proof. By definition, the cutoff points for the triopolists are $\overline{c}_2^t = \frac{3k(2-k)}{16}$, $\overline{c}_1^t = \frac{3k(2+k)}{16}$ and $\overline{c}_0^t = \frac{3k(2+3k)}{16}$. In a duopoly, $\overline{c}_1^i = \frac{4k(1+k)}{9}$, $\overline{c}_0^i = \frac{4k(1+2k)}{9}$, $\overline{c}_2^o = \frac{4k(1-k)}{9}$ and $\overline{c}_0^o = \frac{4k(1+k)}{9}$. Notice that $\overline{c}_0^o$ is not relevant. In the region where the outsider does invest only if the insiders do not ($\overline{c}_2^o < c < \overline{c}_0^o$), the latter always invest ($\overline{c}_0^i > \overline{c}_1^i = \overline{c}_0^o$). Similarly, $\overline{c}_1^i$ is not relevant because when the insiders would stop investing if the outsider invested, the latter never invests. Finally, in a monopoly, $\overline{c}^m = \frac{k(2+3k)}{4}$. The ordering follows from straightforward algebra. ■

The following Lemma characterizes the four different regions in Proposition 1.

LEMMA 2 *The investment decision levels are the following.*

a) If $c \leq \min\{\overline{c}^o, \overline{c}_2^t\}$ *all managers in all firms invest.*

b) If $\min\{\overline{c}^o, \overline{c}_2^t\} < c \leq \min\{\overline{c}^i, \overline{c}^m\}$, *managers in the monopoly and insiders in a duopoly invest but single-manager firms may not.*

c) If $\min\{\overline{c}^i, \overline{c}^m\} < c \leq \max\{\overline{c}^i, \overline{c}^m\}$, *either the insiders or the monopolists invest while the rest never does. If* $k \leq \frac{2}{5}$ *we have that* $\overline{c}^i \leq \overline{c}^m$ *and only the monopolists invest whereas if* $k > \frac{2}{5}$ *we have that* $\overline{c}^i > \overline{c}^m$ *and only the insiders invest.*

d) If $c > \max\{\overline{c}^i, \overline{c}^m\}$, *no manager invests.*

Proof. a) and d) From Lemma 1, if $c \leq \min\{\overline{c}^o, \overline{c}_2^t\}$ all the cutoffs are above and hence all firms invest whereas if $c > \max\{\overline{c}^i, \overline{c}^m\}$ all the cutoffs are below and hence no manager invests.

b) In this region, by definition, the insiders and the monopolists invest. Within the region, as c increases the single-manager firms stop investing gradually (in different order depending on k).

c) From Lemma 1 the cutoffs for all single-manager firms are below and hence they never invest. Straightforward algebra shows that when $k \leq \frac{2}{5}$ we have that $\overline{c}^i \leq \overline{c}^m$ and therefore only the monopolists invest whereas when $k > \frac{2}{5}$ then $\overline{c}^i > \overline{c}^m$and only the insiders invest. ■

This completes the proof of Proposition 1. QED.

Proof of Proposition 2

Each manager in a monopoly invests as long as $c \leq \widetilde{c}_j^m$ when j other managers invest ($j = 0, 1, 2$), where $\Pi_{j+1}^m - \widetilde{c}_j^m = \Pi_j^m$. When the outsider invests in the duopoly, each insider invests if $c \leq \widetilde{c}_{j,1}^i$ depending whether the other insider invests or not ($j = 0, 1$) where $\Pi_{j+1,1}^i - \widetilde{c}_{j,1}^i = \Pi_{j,1}^i$. Similarly, when the outsider does not invest, the cutoff points are $\widetilde{c}_{j,0}^i$ ($j = 0, 1$) with the analogous definitions. The cutoff values for the single-manager firms are the same as in the proof of Proposition 1, $\widetilde{c}_j^o = \overline{c}_j^o$ and $\widetilde{c}_j^t = \overline{c}_j^t$.

Lemma 3 *The relevant cutoffs are ordered as follows:* $\widetilde{c}_2^t < \widetilde{c}_1^t < \widetilde{c}_0^t < \widetilde{c}_0^o$; $\widetilde{c}^m < \widetilde{c}_1^t$; $\widetilde{c}^m < \widetilde{c}_1^i < \widetilde{c}_0^i < \widetilde{c}_0^t$; $\widetilde{c}_2^o < \widetilde{c}_0^o$ *and* $\widetilde{c}_1^i < \widetilde{c}_1^t$ *where for simplicity we denote* $\widetilde{c}^m \equiv \widetilde{c}_2^m$ *and* $\widetilde{c}_j^i \equiv \widetilde{c}_{1,j}^i$.

Proof. In the monopoly structure, $\widetilde{c}_0^m = \frac{k(2+k)}{12}$, $\widetilde{c}_1^m = \frac{k(2+3k)}{12}$ and $\widetilde{c}_2^m = \frac{k(2+5k)}{12}$. We have that all the managers investing is an equilibrium whenever $c \leq \widetilde{c}_2^m$ whereas no manager investing is an equilibrium whenever $c > \widetilde{c}_0^m$. Between $\widetilde{c}_0^m$ and $\widetilde{c}_2^m$ both equilibrium coexist but the former is chosen because it Pareto dominates the latter. Then $\widetilde{c}_0^m$ and $\widetilde{c}_1^m$ are not relevant. In the duopoly structure, the cutoffs for the insiders are $\widetilde{c}_{0,0}^i = \frac{2k(1+k)}{9}$, $\widetilde{c}_{0,1}^i = \frac{2k}{9}$, $\widetilde{c}_{1,0}^i = \frac{2k(1+3k)}{9}$ and $\widetilde{c}_{1,1}^i = \frac{2k(1+2k)}{9}$. The same argument as in the monopoly case applies here and only the cutoffs in which the partner invests are relevant. In turn, the relevant cutoffs for the outsiders are the ones in which none or all the insiders invest. The cutoffs for the outsider and the triopolists are obtained in the proof of the previous proposition. Straightforward algebra leads to the ordering.

■

Lemma 4 *The investment decision levels are the following.*

a) If $c \leq \widetilde{c}^m$ *the managers in the monopoly and the insiders in the duopoly invest.*

b) If $\widetilde{c}^m < c \leq \widetilde{c}_1^i$ *or* $\max\{\widetilde{c}_1^i, \widetilde{c}_2^o\} < c \leq \widetilde{c}_0^i$ *there is an equilibrium in which the insiders in the duopoly invest whereas the managers in the monopoly never invest.*

c) If $\widetilde{c}_1^i < c \leq \min\{\widetilde{c}_2^o, \widetilde{c}_0^i\}$ *and* $\widetilde{c}_0^i < c \leq \widetilde{c}_0^o$ *the insiders and the monopolists never invest and at least one single-manager firm invests.*

d) If $c > \widetilde{c}_0^o$ *nobody invests.*

Proof. a) We can distinguish two subcases: a.1) When $c \leq \min\{\widetilde{c}^m, \widetilde{c}_2^o\}$, from Lemma 3, all the managers invest because all the cutoffs are above. a.2) When $\widetilde{c}_2^o \leq c < \widetilde{c}^m$ the outsider does not invest by definition and there may be a triopolist that does not invest (when $\widetilde{c}_2^t \leq c < \widetilde{c}^m$). In other situations, all managers invest.

b) Here the monopolists stop investing. Again we can distinguish two subcases: b.1) when $\widetilde{c}^m < c \leq \widetilde{c}_1^i$ the insiders always invest independent of the outsider decision. From Lemma 3, depending on the combination of parameters, the outsider may or may not invest whereas there are two or three triopolists doing so. b.2) If $\max\{\widetilde{c}_1^i, \widetilde{c}_2^o\} < c \leq \widetilde{c}_0^i$ there are two possible equilibria in the duopoly: either the insiders do invest and the outsider does not or vice versa. Again from Lemma 3 we can check that there might be one or two triopolists investing.

c) Here the insiders and the monopolists never invest. We distinguish five subcases: c.1) when $\widetilde{c}_1^i < c \leq \widetilde{c}_2^t$ the three triopolists and the outsider invest, c.2) when $\max\{\widetilde{c}_2^t, \widetilde{c}_1^i\} < c \leq \min\{\widetilde{c}_2^o, \widetilde{c}_1^t\}$ or when $\max\{\widetilde{c}_2^o, \widetilde{c}_0^i\} < c \leq \widetilde{c}_1^t$ two triopolist and the outsider invest, c.3) when $\max\{\widetilde{c}_1^t, \widetilde{c}_0^i\} < c \leq \widetilde{c}_0^t$ one triopolist and the outsider invests, c.4) when $\widetilde{c}_0^t < c \leq \widetilde{c}_0^o$ only the outsider invest and c.5) when $c > \widetilde{c}_0^o$ no one invests. ■

This completes the proof of Proposition 2. QED.

Proof of Proposition 3

In the following Lemma, we show that in our game we cannot have multiple stable regions when there is no conflict .

LEMMA 5 *For any combination of parameters, there is at most one stable structure.*

Proof. Remember that we denote π^m, π^i and π^o the 'net' profits for each monopolist, insider and outsider (the equilibria in investment are unique). In order to consider all the possible cases in the triopoly, denote $\pi_a^t \geq \pi_b^t \geq \pi_c^t$ the net profits obtained by each triopolist. In what follows we state the conditions needed to ensure stability. The monopoly is stable when: (1) $\pi^m \geq \pi^i$ and (2) if $\pi_b^t \leq \pi^i$ then $\pi^m \geq \pi^o$ whereas if $\pi_b^t > \pi^i$ then $\pi^m \geq \pi_a^t$ (remember that the deviator is always "optimistic"). The duopoly is stable when (3) $\pi^i > \pi^m$ or $\pi^o > \pi^m$ and (4) if $\pi_b^t \leq \pi^i$ then $\pi^i \geq \pi^o$ whereas if $\pi_b^t > \pi^i$ then $\pi^i \geq \pi_a^t$. The second part of condition (4) is never satisfied ($\pi_a^t \geq \pi_b^t$) and hence condition (4) can be rewritten as (4') both $\pi_b^t \leq \pi^i$ and $\pi^i \geq \pi^o$ should hold. Finally, the triopoly is stable whenever (5) $\pi_a^t > \pi^m$ and (6) $\pi_b^t > \pi^i$.

We are going to show the result by contradiction. Suppose firstly that the monopoly and the duopoly are stable at the same time. From (1) and (3), we get that $\pi^o > \pi^m$ and from (2) and (4') that $\pi^m \geq \pi^o$ and hence a contradiction. Secondly, the duopoly and the triopoly can not be simultaneously stable structures because (4') and (6) can not be satisfied at the same time. Finally, suppose that the monopoly and the triopoly are stable structures. From (2) and (6) we obtain that $\pi^m \geq \pi_a^t$ which is in contradiction with (5). ■

Thanks to the following lemma, we know that the triopoly will never be a stable structure.

LEMMA 6 *Managers always prefer the monopoly to the triopoly.*

Proof. Suppose firstly that the monopolists do not invest. By Lemma 1 none of the triopolists invests either. Since $\Pi_0^m = \frac{1}{12} > \frac{1}{16} = \Pi_{0,0}^t$ the monopoly is always preferred. Next suppose that a given manager invests both in monopoly and in triopoly. Again, the monopoly is always preferred since $\Pi_3^m = \frac{(1+3k)^2}{12} > \frac{(1+3k)^2}{16} = \Pi_{1,0}^t > \Pi_{1,1}^t > \Pi_{1,2}^t$. Last, take the case in which a manager would invest as a monopolist but not as a triopolist. He would prefer a monopoly to a triopoly in which none of the other triopolists invests when $\Pi_3^m - c > \Pi_{0,0}^t$ or in other words when $c < \frac{1+24k+36k^2}{48}$. This is always the case in this region since $c < \overline{c}^m < \frac{1+24k+36k^2}{48}$. When there are one or two other triopolists investing, the monopoly is even more preferred. ■

LEMMA 7 *Managers prefer the monopoly than being insiders in a duopoly.*

Proof. First suppose that a given manager invests both in the monopoly and being insider in a duopoly. Since $\Pi_3^m = \frac{(1+3k)^2}{12} > \frac{(1+4k)^2}{18} = \Pi_{2,0}^i > \Pi_{2,1}^i$, the insiders would never deviate from a monopoly. Second, he always prefers the monopoly whenever he does not invest in either situation because $\Pi_0^m = \frac{1}{12} > \frac{1}{18} = \Pi_{0,0}^i > \Pi_{0,1}^i$. Third, take the case in which he would invest in the monopoly but not in the duopoly (from Lemma 1 the outsider does not invest in this region either). The monopoly is preferred whenever $\Pi_3^m - c > \Pi_{0,0}^i$ or in other words when $c < \frac{1+18k+27k^2}{36}$. This is always the case here since $c < \overline{c}^m < \frac{1+18k+27k^2}{36}$. Finally suppose that as an insider he would invest but not as a monopolist (again the outsider does not invest). He prefers the monopoly as long as $\Pi_0^m > \Pi_{2,0}^i - c$ or $c > \frac{-1+16k+32k^2}{36}$. Since $c > \overline{c}^m > \frac{-1+16k+32k^2}{36}$ this is always the case in this region. ■

LEMMA 8 *The monopoly is the unique stable structure when being in a monopoly is better than being an outsider ($\pi^m \geq \pi^o$) or when insiders in a duopoly would break for triopoly ($\pi_b^t > \pi^i$) . Otherwise, no industry structure is stable.*

Proof. Each one of these conditions, together with Lemma 6 and Lemma 7, ensure that conditions (1) and (2) in the proof of Lemma 5 are satisfied and hence the monopoly is the (unique) stable structure. We show the second statement by contradiction. Suppose firstly that these conditions are not satisfied and that the duopoly is stable. From Lemma 5 the duopoly could only be stable when the monopoly is not or in other words when $\pi_b^t \leq \pi^i$ and $\pi^o > \pi^m$. From Lemma 7 we have that $\pi^m > \pi^i$ and hence $\pi^i \geq \pi^o$. This contradicts the condition (4') in the proof of Lemma 5. Secondly, from Lemma 6 the triopoly is never stable. ■

Lemma 9 *When there is no internal conflict within firms, the monopoly is the only stable structure. No stable structure exists when* (c, k) *are such that* $k_1 \leq k < k_2$ *and* $c \leq \overline{c}_2^t$*, where* $k_1 = \frac{4\sqrt{2}-5}{21}$ *and* $k_2 = \frac{2\sqrt{3}-3}{3}$.

Proof. We are going to prove this lemma following the four parts identified in Lemma 2:

a) We have that $\pi^t = \Pi_{1,2}^t - c > \Pi_{2,1}^i - c = \pi^i$ whenever $k < k_1 = \frac{4\sqrt{2}-5}{21}$ and that $\pi^m = \Pi_3^m - c \geq \Pi_{1,2}^o - c = \pi^o$ whenever $k \geq k_2 = \frac{2\sqrt{3}-3}{9}$. From Lemma 8 the monopoly is stable if $k < k_1$ or $k \geq k_2$ whereas if $k_1 \leq k < k_2$ no industry structure is stable.

b) We are going to show that at least one of the two conditions in Lemma 8 is satisfied. On the one hand we show that when $k \geq \frac{1}{15}$ we have that $\pi^m \geq \pi^o$. If the outsider does invest, $\pi^m = \Pi_3^m - c \geq \Pi_{1,2}^o - c = \pi^o$ when $k \geq k_2$ and in particular when $k \geq \frac{1}{15}$. If the outsider does not invest, $\pi^m = \Pi_3^m - c \geq \Pi_{0,2}^o = \pi^o$ when $c \leq \frac{-1+34k+11k^2}{36}$. This inequality is always satisfied when $k \geq \frac{1}{15}$ and $c < \overline{c}^i$.

On the other hand we show that when $k < \frac{1}{15}$ we have that $\pi_b^t > \pi^i$. Take first the case in which no triopolist invests ($c > \overline{c}_0^t$). We have that $\pi^t = \Pi_{0,0}^t > \Pi_{2,0}^i - c$ (and in particular that $\pi^t > \Pi_{2,1}^i - c$) whenever $c > \frac{-1+64k+128k^2}{144}$. This is always satisfied when $k < \frac{1}{15}$ and $c > \overline{c}_0^t$. Second consider the case where only one triopolist invests. From the definition of the cutoffs (see proof of Lemma 1), the outsider always invests in this region when we impose $k < \frac{1}{15}$. In addition, we have that $\pi_b^t = \Pi_{0,1}^t$. We have that $\pi_b^t = \Pi_{0,1}^t > \Pi_{2,1}^i - c = \pi^i$ whenever $c > \frac{-1+66k+63k^2}{144}$. This is always satisfied when $k < \frac{1}{15}$ and $c > \overline{c}_1^t$. Last take the case in which two triopolists invest (again here the outsider would invest). In this case $\pi_b^t = \Pi_{1,1}^t$ and $\pi_b^t = \Pi_{1,1}^t - c > \Pi_{2,1}^i - c = \pi^i$ whenever $k < \frac{\sqrt{2}-1}{6}$ and in particular when $k < \frac{1}{15}$.

c) In the part of this region where only the monopolists invest we have that $\pi^t = \Pi_{0,0}^t > \Pi_{0,0}^i = \pi^i$ and hence the monopoly is the stable structure. When the insiders invest, we have that $\pi^t = \Pi_{0,0}^t > \Pi_{2,0}^i - c = \pi^i$ whenever $c > \frac{-1+64k+128k^2}{144}$. This condition is always satisfied since $c > \overline{c}^m \geq \frac{-1+64k+128k^2}{144}$.

d) Similar to the first part of part c), the monopoly is stable since $\pi^t = \Pi_{0,0}^t > \Pi_{0,0}^i = \pi^i$. ■

This completes the proof of Proposition 3. QED

Proof of Proposition 4

In this and in the following proofs we are going to use, when possible, Lemma 5. In fact, it applies as long as there is not multiplicity of equilibria in the duopoly investment decisions. As we have seen in the proof of Lemma 4 the region (a) can be divided in two parts.

a.1) When any manager in any situation invests, the stable structures and the proofs are identical to those of Proposition 3 when everyone was investing.

a.2) The monopoly is stable because it is preferred to any other position in any other industry structure. We have that $\pi^m = \Pi_3^m - c > \Pi_{2,0}^i - c = \pi^i$ and that $\pi^m > \Pi_{1,1}^t - c > \Pi_{1,2}^t - c$ and hence managers prefer the monopoly to being insiders and being triopolists investing (independent of being two or three of them doing so). They prefer the monopoly to being outsiders when $\pi^m \geq \Pi_{0,2}^o = \pi^o$ or when $c \leq \frac{-1+34k+11k^2}{36}$ and the monopoly to being triopolists not investing when $\pi^m \geq \Pi_{0,2}^t$ or when $c \leq \frac{1+36k+24k^2}{48}$. These two conditions are always satisfied in this region ($\widetilde{c}_2^o \leq c < \widetilde{c}^m$). Thus, the monopoly is stable and from Lemma 5 it is unique.

Proof of Proposition 5

As we have seen in the proof of Lemma 4 this region can be divided in two parts.

b.1) Here the uniqueness result still applies. Managers prefer being insiders than monopolists whenever $c \leq c_1(k) = \frac{-1+12k+18k^2}{36}$: when the outsider invests $\pi^i = \Pi_{2,1}^i - c > \Pi_0^m = \pi^m$ precisely when $c \leq c_1(k)$ whereas when he does not we have that $\pi^i = \Pi_{2,0}^i - c > \Pi_0^m = \pi^m$ is always satisfied in this region. In addition, $\pi^i \geq \pi_b^t$ independent of the number of triopolists investing and of the choice of the outsider. They also prefer to be an insider than an outsider, $\pi^i \geq \pi^o$, independent of the outsider investment decision. This three conditions are necessary and sufficient to ensure duopoly stability (see proof of Lemma 5).

When $c > c_1(k)$, we have that managers in a monopoly do not invest whereas in any other situation all managers invest (see proof of Lemma 4). Managers prefer the monopoly to being insiders by definition. They also prefer the monopoly to the triopoly $\pi^m = \Pi_0^m > \Pi_{1,2}^t - c = \pi^t$ and hence the triopoly is never stable. Choices between monopoly and outsider and between insider and triopoly are going to determine three different regions. Managers prefer being monopolists than outsiders whenever $c \geq c_2 = \frac{1}{36}$ and they prefer being insiders to triopolists whenever $k \geq k_1$ (see proof of Proposition 3). This defines three regions because: (a) $c_1'(k) > 0$ and the k^* such that $c_1(k^*) = \widetilde{c}_1^i(k^*)$ is larger than the k^{**} such that $c_2 = \widetilde{c}_1^i(k^{**})$ and (b) the k^{***} such that $c_2 = \widetilde{c}_0^i(k^{***})$ is larger than k_1. In the first region, when $k \leq k_1$, the monopoly is stable because condition (1) and the second part of (2) are satisfied. In the second region, when $k \geq k_1$ and $c < c_2$ no structure is stable. The monopoly is not stable because condition (2) is not satisfied and the duopoly is not stable because managers prefer being outsiders than insiders ($\pi^o > \pi^m \geq \pi^i$) breaking condition (4'). Finally, when $c \geq c_2$ (and $c > c_1(k)$) the monopoly is stable because condition (1) and the first part of (2) are satisfied.

b.2) There are two different equilibria in the duopoly (Lemma 4): either the two insiders or the outsider invest. The profits in the investing equilibrium are always higher than in the non-investing one for both the insiders and the outsider ($\Pi^i_{2,0} - c \geq \Pi^i_{0,1}$ and $\Pi^o_{1,0} - c \geq \Pi^o_{0,2}$). Denoting the net profits in the insiders-investing equilibrium as π^i_d and π^o_d and in the outsider-investing one as π^i_e and π^o_e, we have that $\pi^i_d > \pi^i_e$ and $\pi^o_d < \pi^o_e$.

We restate the stability conditions in order to accommodate this multiplicity. The monopoly is stable when: (M1) $\pi^m \geq \pi^i_d$ and (M2) if $\pi^t_b \leq \pi^i_e$ then $\pi^m \geq \pi^o_e$ whereas if $\pi^t_b > \pi^i_e$ then $\pi^m \geq \pi^t_a$. The insiders-investing duopoly is stable when (M3) $\pi^i_d > \pi^m$ or $\pi^o_d > \pi^m$ and (M4) if $\pi^t_b \leq \pi^i_e$ then $\pi^i_d \geq \pi^o_e$ whereas if $\pi^t_b > \pi^i_e$ then $\pi^i_d \geq \pi^t_a$. The outsiders-investing duopoly is stable when (M5) $\pi^i_e > \pi^m$ or $\pi^o_e > \pi^m$ and (M6) if $\pi^t_b \leq \pi^i_e$ then $\pi^i_e \geq \pi^o_e$ whereas if $\pi^t_b > \pi^i_e$ then $\pi^i_e \geq \pi^t_a$. The second part of condition (M6) is never satisfied ($\pi^t_a \geq \pi^t_b$) and hence condition (M6) can be rewritten as (M6') both $\pi^t_b \leq \pi^i_e$ and $\pi^i_e \geq \pi^o_e$ should hold. Finally, the triopoly is stable whenever (M7) $\pi^t_a > \pi^m$ and (M8) $\pi^t_b > \pi^i_d$.

Now we are going to show that the insiders-investing duopoly is stable. Firstly $\pi^i_d = \Pi^i_{2,0} - c > \Pi^m_0 = \pi^m$ whenever $c \leq \frac{-1+16k+32k^2}{36}$ which is always true in this region. Hence condition (M3) is satisfied. We also have that $\pi^t_b > \pi^i_e$ independent of having one or two triopolists investing. If there is one clearly $\pi^t_b = \Pi^t_{0,1} > \Pi^i_{0,1} = \pi^i_e$ whereas if there are two $\pi^t_b = \Pi^t_{1,1} - c > \Pi^i_{0,1} = \pi^i_e$ whenever $c \leq \frac{1+52k+28k^2}{144}$ which is always true when $c < \tilde{c}^t_1$. Finally, the condition $\pi^i_d > \pi^t_a$ is also satisfied since $\pi^i_d = \Pi^i_{2,0} - c > \Pi^t_{1,0} - c > \Pi^t_{1,1} - c$ in this region (as a triopolist, it is always better to be investing). The second part of condition (M4) is satisfied and hence this structure is stable.

This is the unique stable structure. The monopoly is not stable because, as we have seen, $\pi^i_d > \pi^m$ in contradiction with (M1). The outsider-duopoly is not stable either because $\pi^t_b > \pi^i_e$ and hence condition (M6') does not hold. Finally, the triopoly is not stable because $\pi^i_d > \pi^t_a \geq \pi^t_b$ contradicts condition (M8).

Proof of Proposition 6

As we have seen in the proof of Lemma 4 this region (c) can be divided in five parts. Here the uniqueness result applies. Managers clearly prefer to be monopolists rather than insiders ($\pi^m = \Pi^m_0 > \Pi^i_{0,0} > \Pi^i_{0,1}$). We also have that $\pi^t_b > \pi^i$ everywhere except when there are three triopolists investing (case c.1) where this is true only when $c < c_3(k) = \frac{1+34k+k^2}{144}$. Indeed, when there are three triopolists investing this is the condition such that $\pi^t_b = \Pi^t_{1,2} - c > \Pi^i_{0,1} = \pi^i$. When there are two investing we have that $\pi^t_b = \Pi^t_{1,1} - c > \Pi^i_{0,1} = \pi^i$ whenever $c < \frac{1+52k+28k^2}{144}$

which is always the case when $c < \widetilde{c}_1^t$. Clearly, when there is only one $\pi_b^t = \Pi_{0,1}^t > \Pi_{0,1}^i = \pi^i$ (the outsider always invests) and where there is none $\pi_b^t = \Pi_{0,0}^t > \Pi_{0,0}^i > \Pi_{0,1}^i$.

On the other hand, we have that $\pi^m \geq \pi_a^t$ in all cases except when there is only one triopolist investing where this is true only when $c > c_4(k) = \frac{-1+18k+27k^2}{48}$. Indeed, when there is only one triopolist investing this is the condition such that $\pi^m = \Pi_0^m \geq \Pi_{1,0}^t - c = \pi_a^t$ (we can check that the it is better to be the one investing). When there are two investing we have that $\pi^m = \Pi_0^m \geq \Pi_{1,1}^t - c = \pi_a^t$ whenever $c > \frac{-1+12k+12k^2}{48}$ and this is satisfied when $c > \widetilde{c}_1^i$. Therefore they also prefer the monopoly to being triopolist when the three invest. When none of the triopolists invests, clearly $\pi^m = \Pi_{0,0}^m > \Pi_{0,0}^t = \pi^t$.

Hence in all region c) except when there are three triopolists investing and $c \geq c_3(k)$ or when there is one triopolist investing and $c \leq c_4(k)$, the monopoly is the unique stable structure. Conditions (1) and (2) in the proof of Lemma 5 are satisfied.

When there is one triopolist investing and $c \leq c_4(k)$ the triopoly is the unique stable structure. In this region we have seen that $\pi_a^t > \pi^m$ and, as before, $\pi_b^t > \pi^i$ satisfying conditions (5) and (6).

Finally, when there are three triopolists investing and $c \geq c_3(k)$ there is no stable structure. We have that $\pi^o = \Pi_{1,0}^o - c > \Pi_0^m = \pi^m$ when $c < \frac{1+10k+7k^2}{18}$ and $\pi^o = \Pi_{1,0}^o - c > \Pi_{0,1}^i = \pi^i$ when $c < \frac{1+16k+16k^2}{36}$. These two conditions hold when $c < \widetilde{c}_2^t$. Then, since $\pi_b^t \leq \pi^i$, the monopoly is not stable because it would contradict condition (2). The duopoly is not stable either because $\pi^o > \pi^i$ contradicts condition (4'). Lastly, the triopoly is not stable because we have showed that $\pi^m \geq \pi_a^t$, which is in contradiction with condition (5).

This completes the proof. QED

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