Endogenous Mergers and Endogenous Efficiency Gains: The Efficiency Defence Revisited*

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Abstract

We analyse the effects of investment decisions and firms' internal organisation on the efficiency and stability of horizontal mergers. In our framework efficiency gains are endogenous and there might be internal conflict within merged firms. We show that, both with and without conflict, stable mergers often do not generate efficiency gains. In the case of internal conflict, mergers may even lead to efficiency losses. Our welfare results suggest that antitrust authorities may approve welfare-reducing mergers (type II error) and block welfare-enhancing mergers (type I error) if they assume that potential efficiency gains will always be realised. In addition, the paper offers a possible explanation for merger failures.

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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 (Röller et al. [19]). Economic theory shows that a merger can reduce welfare by increasing market power but that it can also create efficiency gains, thereby making the merger possibly welfare enhancing.

This is the approach indicated by the Merger Guidelines of the US Department of Justice, which "...will not challenge a merger if efficiencies are sufficient to reverse the merger's potential to harm consumers in the relevant market" (US Horizontal Merger Guidelines, 1997, section 4). Also the new European Merger Guidelines allow for an efficiency defence: "... [The Commission] may decide that, as a consequence of the efficiencies the merger brings about, there are no grounds for declaring the merger incompatible with the common market." (EC Horizontal Merger Guidelines, 2004/03, art. 77).

This paper broadens the theory on horizontal mergers with efficiency gains in concentrated markets. We argue that 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.[1] In a study for the European Commission, Stennek and Verboven [22] 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". Our aim is to shed more light on how merger and investment decisions interact, and analyse how the internal organisation of firms influences these interactions. Our approach facilitates the understanding of why some mergers fail to become more efficient or even fail to happen. This allows us to pin down some pitfalls for the regulator when taking into account an efficiency defence.

There exist two different strands in the literature for modeling merger formation. In the *exogenous merger literature*, the modeler exogenously fixes a group of firms whose members compare the benefits of going together with the benefits of standing alone. In the more recent *endogenous merger literature* models, all firms are allowed to choose whether to merge or not and how to react to a merger, thus providing a prediction of the final market structure. This

[1] In both the US and European Merger Guidelines this is shortly mentioned. The US Merger Guidelines say "...efficiencies projected by the merging firms may not be realized" (US Horizontal Merger Guidelines, 1997, section 4). The European Merger Guidelines say that "It is incumbent upon the notifying parties that the merger efficiencies are likely to be realised" (EC Horizontal Merger Guidelines, 2004/03, art. 87).

proves to be crucial in making policy recommendations in addition to understanding market outcomes and it is the approach we take in this paper.[2]

Different approaches have been proposed to model mergers endogenously. Some papers rely on non-cooperative game theoretic solutions. But the theory of dynamic processes of merger formation relies on specific assumptions concerning the timing of the game. The alternative way we follow, as do Barros [4] and Horn and Persson [12], is to not fully describe the merger process, but to check whether a particular market structure can be the outcome of a merger process because no firm wants to change the current configuration.

We construct a model of endogenous mergers with three managers (the smallest number possibly having insiders and outsiders), or equivalently with three management teams having aligned interests. Managers choose with whom to merge while anticipating a share of the future revenues. In line with Rajan and Zingales [17], we think it is realistic to claim that the manager, and not the owner, is in control of many decisions within the firm.[3]

Each manager controls some non-transferable resources, such as organisational or managerial capacities. The right use of those resources reduces the marginal costs of production and leads to a more efficient firm. We assume that when managers are together in a firm, the resources of the newly formed firm are the sum of the resources that the participating managers control. This allows us to take into account efficiency gains due to the integration of specific hard-to-trade resources, "synergies" in the terminology of Farrell and Shapiro [6].[4] Accordingly, firms' marginal costs can be reduced further if more managers work in the same firm. At the same time, a merged firm cannot enjoy synergies if it fires a manager and his team.

The possibility that a firm may obtain efficiency gains, however, does not mean that these gains will be actually realised. This is because of two related factors. Firstly, making the right

[2] Motta and Vasconcelos [15] show that a regulator who does not anticipate future competitors' reactions could make wrong decisions. Fridolfsson and Stennek [8] show that firms may merge to preempt their partner merging with a rival, even if this reduces profits with respect to the status quo.

[3] We argue thus that owners do not run the firm because they lack the specific skills and knowledge on organisational and merger variables. This is different from *strategic delegation*, where owners let managers decide on mergers because they gain by delegating control (González-Maestre and López-Cuñat [10]; Straume [23]; Ziss [25]).

[4] Suppose, for example, that two managers decide to merge, and both lead teams that develop computer systems. One team is specialised in basic programming, whereas the other has expertise in system design. Combining their specialised knowledge creates synergies that lead to a more cost-effective and superior computer system, both in calculus performance and usefulness for an organisation.

use of the resources within the firm may imply forgoing a more market oriented use.[5] Hence, the right use of the resources for the firm can be viewed as a relation-specific and costly investment by the management. As a result, managers will only invest if it is in their interest. Secondly, forging a common corporate goal out of two disparate cultures may be difficult. It is said that managers' motivation to cooperate comes from team spirit and trust (Kandel and Lazear [13]). But, this is exactly what may be lacking in a newly merged firm (Seabright [21]). If people do not trust each other, then the parties' primary objective will be to ensure their personal interests, rather than sacrificing those interests for the benefit of all managers in the firm (Flynn [7]).[6] This leads managers to free-ride on the other managers' investments.

While acknowledging that the most realistic case may lie in between, we consider for simplicity two extreme scenarios. In the first, managers completely trust each other and choose investments cooperatively, whereas in the second, managers do not trust each other at all and choose therefore investments independently. When there is *no internal conflict*, we find there are more incentives to invest in a merged firm because of the presence of synergies. When looking at which mergers will effectively materialise, we find that managers mainly choose the monopoly industry structure. But, since managers invest *only* when it is profitable, these mergers are not necessarily more efficient. If the investment costs are high relative to the gains, managers never invest, not even in a large merged firm.

In the second scenario, *internal conflict* can dominate the synergies present and larger firms tend to invest less than smaller firms. These equilibrium investment decisions have an impact on the stability of industry structures. Now all structures are possible stable outcomes. Two conclusions follow. First, conflict within the firm leads to less market concentration, even if mergers could potentially lead to more efficient firms. Second, when there will indeed be mergers in equilibrium, these merged firms may be less efficient than would have been each of the forming firms.

Besides identifying when a regulator should not oppose to a proposed merger, we point out mistakes that would be made if one were to take efficiency gains for granted. A regulator would then approve mergers that are welfare reducing (type II error), both in the no-conflict

[5] Following our previous example, it may be in the best interest of the firm if an information system A is developed, but an information system B has a higher market value. Developing system A comes then at a private cost for the management. See e.g. Fulghieri and Rodrick [9] and Hart and Holmström [11] for a similar argument.

[6] At the same time, we assume that it is not possible to write complete contracts on investment decisions, since in many circumstances, it is intrinsically hard to describe the "right" action in sufficient detail to distinguish it from seemingly similar actions (Mailath et al. [14]).

and conflict case. These mistakes are made more often and are more costly when managers do not cooperate internally. In the no-conflict case, it is also possible that a regulator who takes efficiency gains for granted bans mergers that should have been allowed (type I error). The relative efficiency gains obtained in a merger are in this case more important than predicted with exogenous efficiencies.

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 for the two scenarios. Section 6 discuss welfare issues. Section 7 provides extensions. Finally, Section 8 concludes. All proofs are presented in the Appendix.

2 Model

In the *first stage*, three managers decide on their productive organisation. They choose whether to set up their own firm or join forces with other managers, determining the industry structure (Ω). Three market structures can arise: monopoly, $\Omega_M = \{m\}$ where m stands for a monopoly firm; duopoly, $\Omega_D = \{i, o\}$ where i stands for the two-manager firm set up by the two "insiders" and o for the single-manager firm managed by the "outsider"; or triopoly, $\Omega_T = \{t_1, t_2, t_3\}$, where t stands for triopolist.

We posit that the industry structure that will prevail should be stable. That is, no set of managers can win by deviating from this structure. We consider two natural types of deviations in a merger context. First, all managers of a firm can decide to merge with all managers of another firm. Thus, we consider whether the structure is stable with respect to further concentration. Second, a subgroup of managers of a firm can decide to break up and set up a smaller firm. Thus, we also consider whether the structure is stable with respect to firm break-ups. In evaluating this deviation, managers must make a prediction of what the other managers in the firm will do. We adopt the view that the remaining managers in the firm will optimally choose whether to stay together or break up.[7]

Definition 1 *An industry structure is stable if there is no profitable deviation*

(a) by two or more firms to merge into a larger firm, or

[7] The endogenous merger literature has often made two extreme assumptions regarding the reaction of the managers not involved in the deviation. A first approach is to assume that all other managers will split apart towards stand-alone firms (e.g. Barros [4]). The second assumes that the others will not react at all, which is how Horn and Persson [12] model stability.

(b) by a subgroup of managers of a firm to break up into a smaller one, considering that the remaining managers of the firm would optimally choose whether to separate or stay together.

For simplicity, we present throughout the paper the case where the sharing of a firm's profits is exogenously set to giving all managers an equal part. But as argued in detail in Section 6, our results remain qualitatively unchanged when optimal contracts within the firms are used.

Once firms are formed and the market structure is set, production costs are determined in the *second stage*. Following Perry and Porter [16], we allow the possibility that the merged firm is larger than any of the forming firms, i.e. that it produces at lower marginal costs. We model this by assuming that each manager has a limited amount of resources which, if adequately employed, lower the production costs of the firm. Hence, having more managers in the firm increases the possibilities of reducing the marginal costs of production. Thus, we consider the case where the resources are *complementary* in the production technology.[8] These resources also have an alternative use outside the firm and making the right investment for the firm implies therefore a private cost for the manager. Thus, in contrast to Perry and Porter [16], insiders do not always devote their resources to reduce the marginal costs of the merged firm. Consequently, merged firms might not be more efficient than either of the forming firms. This allows us to differentiate between potential and realised efficiency gains.

To accommodate this additional decision, we assume that the magnitude of the investment by the managers is substracted from the common marginal cost, S. Accordingly, the constant marginal cost of firm ω in a given market structure is given by

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

where $I_j \in \{0, k\}$, represents the magnitude of the investment that manager j brings in lowering the production costs of firm ω.[9] The cost of investment I_j is $C_j(I_j)$, where $C_j(0) = 0$ and $C_j(k) = c$. As explained above, c represents the private benefits lost by making the relation-specific investment I_j, which lowers the marginal costs by k units.[10] If managers' resources do not have any outside value, $c = 0$, then all the managers in all possible market structures devote

[8] Complementary resources allow a merged firm to reach a superior production function and therefore enjoy synergy gains, as defined by Farrell and Shapiro [6]. We do not model investments as substitutes because a merger would then never lead to synergies. This would seriously limit the scope for firms to claim merger-specific efficiency gains and thus the scope for (ab)use of the efficiency defence.

[9] We assume that in equilibrium all firms in all industry structures produce a non-negative quantity and therefore $k \in [0, (a - S)/2]$.

[10] Note that an alternative approach is to assume that the investment belongs to an interval $[0, k]$. Given the

resources to reduce the marginal costs and our model leads to the same qualitative results as Perry and Porter's model.

Managers simultaneously choose whether to make this relation-specific investment. In the first scenario, managers in each firm cooperatively decide which investments to make. In the second, each manager does what is best for him individually. As argued in the introduction, it is not possible to write complete contracts on investment decisions. This is a natural assumption, since we think of investment as managers' decisions to specialise their human capital to the benefit of the firm. Furthermore, it should be easier to describe the right production decision, since this is a better observable and verifiable variable. This explains why we do not model conflict in the production stage.[11]

Given the investment decisions of managers and the resulting marginal costs, we can specify when a merger would lead to efficiency gains (or losses).

Definition 2 *A merger generates efficiency gains (losses) if the merged firm produces at a lower (higher) marginal cost than each of the forming entities would do separately.*

We define thus efficiency gains and losses in the most strict sense. If the merged firm produces at the same marginal cost as one of the forming firms, we say that this firm does not generate efficiency gains nor efficiency losses.

In the *third stage* of the game, firms simultaneously decide their production level. We consider a 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 ω.

We solve the game by backward induction. For each scenario and for each market structure, managers make investment decisions, anticipating production decisions. Multiple Nash equilibria in investment may exist in a particular market structure. If this happens, at the merger stage, managers need to make a prediction about what would be the investment outcome. Like Ray and Vohra [18], we adopt the view that managers are *optimistic*: when considering a deviation leading to that structure, the managers predict that the resulting investment equilibrium will

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.

[11] If we additionally modeled conflict in the production stage, then the differences between the no-conflict and the conflict cases would be exacerbated. For a partnership formation model without investment decisions but with internal conflict in the production stage, see Espinosa and Macho-Stadler [5].

be the one that benefits them the most. Although this view may induce many deviations and no stable industry structure, it allows us to concentrate on the 'very' stable ones.

3 Product Market Competition (3rd Stage)

For either of the two scenarios, suppose that industry structure Ω with n 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 $w \in \Omega$ maximises 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

$$q_\omega = \frac{a + \sum\limits_{\upsilon \in \Omega, \upsilon \neq \omega} s_\upsilon - n s_\omega}{n+1} = \frac{a - S - \sum\limits_{\upsilon \in \Omega, \upsilon \neq \omega} I_\upsilon + n I_\omega}{n+1}, \tag{2}$$

where $I_\omega = \sum\limits_{j \in \omega} I_j$ denotes the total investment in firm ω. Without loss of generality we normalise $a - S = 1$. The equilibrium (gross) profit for firm ω is

$$\Pi_\omega = \frac{\left(1 - \sum\limits_{\upsilon \in \Omega, \upsilon \neq \omega} I_\upsilon + n I_\omega\right)^2}{(n+1)^2}. \tag{3}$$

4 No Internal Conflict

This section continues solving the game by backward induction for the no conflict case. In the following section, we do the same for the conflict scenario.

4.1 Endogenous Investment (2nd stage)

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

$$\pi_\omega^j = \frac{1}{|\omega|} \left(\Pi_\omega - \sum_{l \in \omega} C_l \right). \tag{4}$$

Note that maximising (4) is equivalent to maximising the (net) profits of the firm. Different firms' investments must form a Nash equilibrium.

We present here the equilibrium analysis in function of the costs c and gains k of investment. But apart from costs and gains, the amount in which firms decide to reduce production costs depends on the size of the firm (the number of managers in the firm) and on the competition level. First, a larger a firm has more incentives to invest because it will be able to exploit synergies. Second, a firm may want to invest for strategic reasons. Investment activities are strategic substitutes across firms and more investment implies a better position vis à vis the competitors in the production phase. Therefore, competition enhances incentives to invest. This means that the scale effect and strategic effect go in opposite directions.[12] Proposition 1 presents the equilibrium investment decisions.

Proposition 1 *When managers cooperate internally, there exist* $\overline{c}_2^t(k)$, $\overline{c}^o(k)$, $\overline{c}^i(k)$ *and* $\overline{c}^m(k)$ *that define four different regions:*

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

(B) If $\min\{\overline{c}^o, \overline{c}_2^t\} < c \leq \min\{\overline{c}^i, \overline{c}^m\}$ *the monopolists 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 monopolists or the insiders in a duopoly invest, while the single-manager firms never do.*

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

The regions defined in Proposition 1 are depicted in Figure 1.[13] When the investment is free ($c = 0$) or has very low costs, any firm invests in reducing production costs (region A). On the contrary, when the investment is expensive compared to the savings in production costs, the optimal decision will be not to invest (region D). For intermediate ranges, the synergy and strategic effects determine who invests. Region B shows that the first to stop investing are the one-manager firms, because the synergy effect is the stronger. In region C, either effect can dominate. In region C1, the synergy effect dominates and only monopolists invest. In region C2, the strategic motive is relatively more important and only the insiders in the duopoly invest. Within the duopoly, the insiders have more incentives to invest than the outsider because

[12] This is of course an immediate consequence of having a fixed number of managers. However, it seems natural to assume that, *given* a certain industry, larger firms and a more concentrated market would go together, even if there was free entry.

[13] 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 $k/(a-S)$ and $c/(a-S)$. Comparative statics with respect to $(a - S)$ would simply expand or contract the Figure.

of the synergy effect.

[Place Figure 1 approximately here]

Multiple investment equilibria may exist. Although the *type* of equilibrium is unique, it is not always clear which manager will invest in the triopoly. For example, three equilibria, in which two managers invest and the third does not, coexist in some regions. This is not important in the investment stage because the managers are ex-ante symmetric, but the identity of the managers and their investment decision may be important in the merger stage.

Given the equilibrium investment decisions, we now know what would be the efficiency results of mergers. These are stated in the following corollary in conditional terms, since we do not yet know which mergers will effectively take place.

Corollary 1 *When managers cooperate internally, for rising costs of investment with respect to gains, there exist four different regions as defined in Proposition 1, such that:*
(A) and (B) Any merger would generate efficiency gains.
(C) There always exists a merger that would generate efficiency gains.
(D) No merger would generate efficiency gains.

4.2 Stable Market Structures (1st stage)

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.

Proposition 2 *When there is no internal conflict within firms, either the monopoly or the duopoly is the unique stable structure.*

The stable structures are depicted in Figure 2. Two different processes lead the monopoly to be the main stable outcome. The first merger process takes place when the cost of investment is high (region D in the corresponding Figure 1). No manager would invest and the only motive for merging is having more market power. Salant et al. [20] showed that merging for market power is beneficial only if the merging firms represent at least 80% of the total market, i.e. only if they merge for monopoly in this case. The monopoly is then stable because, if a manager tries to deviate from the monopoly, the other two *optimally* split apart, which makes the deviation unprofitable. Thus, managers are able to circumvent the *outsider-problem*, where it is beneficial for all to merge towards monopoly, but where it is even better to be the outsider in duopoly.

The second process leads managers towards monopoly because this situation is preferred to any other. When the cost of investment is low with respect to its gains and all managers invest (region A), then merged entities have lower production costs than either of the forming firms (as in Perry and Porter [16]). If there are substantial gains from investment, then monopoly dominates any other situation.

If gains are intermediate, being an outsider may be better than being a monopolist, while being an insider in a duopoly may be better than being a triopolist. In this case, the duopoly and not the monopoly would be stable. In most cases, however, the first process leads managers again to monopoly.

[Place Figure 2 approximately here]

Summarising, when there is no internal conflict, monopoly is almost always the unique stable structure. Mergers, however, do not necessary lead to efficiency gains.

5 Internal Conflict

5.1 Endogenous Investment (2nd stage)

When managers within the firm do not cooperate when making investment decisions, then each *individually* bears the cost of investment and a free riding problem might arise. The profit for manager j in firm $\omega \in \Omega$ with $|\omega|$ managers is

$$\pi_{\omega}^{j} = \frac{1}{|\omega|}\Pi_{\omega} - C_j. \tag{5}$$

The effect of the size of a firm on the incentives to invest can now go both ways. Although they still can exploit synergies, larger firms also face more important free-riding problems. Each manager receives a smaller share of the gross profits induced by his individually costly investment. Therefore, managers in larger firms loose their incentives to invest faster for rising costs with respect to gains, since conflict becomes then more important. Proposition 3 states the previous intuition as a function of the parameters of the model.

PROPOSITION 3 *When managers do not cooperate internally, there exist* $\widetilde{c}_0^i(k)$, $\widetilde{c}_1^i(k)$, $\widetilde{c}_0^o(k)$, $\widetilde{c}_2^o(k)$ *and* $\widetilde{c}^m(k)$ *that define four different regions:*

(E) If $c \leq \widetilde{c}^m$ *the monopolists and the insiders in the duopoly invest.*

(F) If $\widetilde{c}^m < c \leq \widetilde{c}_1^i$ *or* $\max\{\widetilde{c}_1^i, \widetilde{c}_2^o\} < c \leq \widetilde{c}_0^i$ *the monopolists never invest, but there always exists*

an equilibrium in which the insiders in the duopoly do.

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

(H) If $c > \widetilde{c}_0^o$ *no manager invests.*

The regions defined in Proposition 3 are depicted in Figure 3. In region E, the synergy effect dominates. When costs rise relatively, the conflict issue, reinforced by the strategic effect, starts interfering with the synergy effect and managers in the monopoly stop investing (region F1). Further on, the conflict effect becomes more important, making either the insiders or the outsider in duopoly to stop investing (region F2). Then the conflict effect becomes dominant and insiders never invest (region G). Finally, when the investment is very expensive, the optimal decision for all managers will be not to invest (region H).

[Place Figure 3 approximately here]

Given the equilibrium investment decisions, we can state what would be the efficiency results of mergers in the following corollary.

Corollary 2 *When managers do not cooperate internally, for rising costs of investment with respect to gains, there exist four different regions as defined in Proposition 3, such that:*

(E) Any merger would generate efficiency gains.

(F) A merger towards duopoly (monopoly) would generate efficiency gains (losses).

(G) Any merger would generate efficiency losses.

(H) No merger would generate efficiency gains or efficiency losses.

5.2 Stable Market Structures (1st stage)

When managers do not cooperate within the firms, larger firms invest less with respect to the cooperation scenario. The next proposition shows that this induces less mergers.

Proposition 4 *When managers do not cooperate internally, for rising costs of investment with respect to gains, there exist four different regions as defined in Proposition 3, such that:*

(E) Either the monopoly or the duopoly is the unique stable structure.

(F) If $\widetilde{c}^m < c \leq \widetilde{c}_1^i$*, either the monopoly or the duopoly is the unique stable structure whereas if* $\max\{\widetilde{c}_1^i, \widetilde{c}_2^o\} < c \leq \widetilde{c}_0^i$*, the duopoly is the only stable structure.*

(G) Each structure can be the unique stable structure.

(H) The monopoly is the unique stable industry structure.

The stable structures for each region are depicted in Figure 4. In region E, entities merge towards monopoly or duopoly for the same reasons as when managers always invest in the no-conflict situation.

Within region F, when the gains are high, the duopoly in which the insiders invest, is the stable industry structure. Since gains are high enough, insiders have no incentives to split apart to triopoly. A further merger is not profitable either. The conflict effect would prevent all from investing. When gains are lower and costs of investment higher, the stability arguments are the same as where all managers invest in the no-conflict scenario and the monopoly is the stable structure. The important difference, however, is that the monopoly does *not* invest. However, even if the monopoly does not invest, it is still the most beneficial structure, because of the reduction in competition and the lower benefits from investment for smaller firms (see the part of region F1 where $c < \widetilde{c}_2^o$ in Figure 3). A merger to monopoly induces now efficiency losses.

Within region G, when only one triopolist invests and gains from investment are high enough, the triopoly is the only stable industry structure. The investing triopolist does not want to merge with the other managers because of the reinforcing conflict and strategic effects. The other two triopolists do not want to go together either, because they would not invest and would have to share profits. In all other cases of regions G and H, monopoly and duopoly are uniquely stable for the same reasons as in region F.

[Place Figure 4 approximately here]

Summarising, internal conflict generates less mergers. Mergers, however, may still occur due to market power reasons, even when managers in merged invest less than in smaller firms. Mergers may lead in this case to efficiency losses.

6 Merger Regulation

In this section, we provide policy advice to a regulator that maximises *consumer welfare.* This is consistent with the current standards used both in the US and the EU to assess mergers.[14,15]

[14] In the US, the "substantial lessening of competition" test (SLC) has been interpreted such that a merger is unlawful if it is likely that it will lead to an increase in price (that is, to a decrease in consumer surplus). In the EU, the Horizontal Merger Guidelines state that the Commission should take into account, above all, the interests of consumers when considering efficiency claims of merging firms (art. 79-81).

[15] As shown in the working paper version of this paper, the results do not change qualitatively when using total welfare.

Consumer welfare with homogenous products and linear demand is given by

$$W_C = \frac{Q^2}{2}. \tag{6}$$

From the consumers' point of view, the best solution is where total industry production is highest, leading to the lowest market price. Total production increases in the level of competition and in firms' efficiency. Thus, the regulator should estimate whether the reduction in competition following the merger will be compensated by the efficiency gains.[16]

First, suppose that we are in the scenario where managers cooperate inside firms. From the regulator's viewpoint, the optimal market structure as a function of the costs and gains of investment is outlined in the following proposition and depicted in Figure 5.

Proposition 5 *For managers cooperating internally:*
(a) Monopoly is the optimal market structure when investment gains are high and costs are low or intermediate, or when gains and costs are intermediate.
(b) Duopoly is optimal if gains and costs are high, or when gains and costs are intermediate.

[Place Figure 5 approximately here]

If the efficiency gains will not be realised, then the regulator should block the proposed merger (upper part of Figure 5, corresponding to Regions $C2$ and D in Figure 1). If, on the other hand, the efficiency gains will be realised, the regulator should allow the merger when these gains are large enough to compensate the loss in competition (bottom and middle parts of Figure 5, corresponding to Regions A, B and $C1$). This never occurs when a merger towards duopoly is effectively proposed. The efficiency effect becomes especially important when managers invest only if they are in larger firms (middle part of Figure 5, corresponding to Regions B and $C1$).

The previous results are useful to compare policy advice based on endogenous versus exogenous efficiency gains. A competition authority that takes efficiency gains for granted can be viewed as a regulator who assumes that the investment costs c are zero. When investment gains are high, this regulator approves a merger towards monopoly (see the line where $c = 0$ in Figure 5). However, for high investment costs, a merger towards monopoly should not have

[16] If firms could additionaly save on *fixed costs* by merging, mergers would become more profitable than is shown in our analysis. But, fixed costs are not transferred to consumers and therefore the consumer optimal market structures would be the same. Thus, when firms can save on fixed costs, this would mainly imply more proposals of welfare-reducing mergers than is shown in our analyis.

been approved because it is not accompanied with efficiency gains. A proposed merger towards duopoly is correctly never approved and poses thus no problems for this regulator.

Surprisingly, this type of regulator is not only too loose in some instances but also too strict in others. For intermediate gains, this regulator blocks the merger to monopoly because the predicted efficiencies do not compensate the reduction in competition. However, when also costs of investment are intermediate, a merger to monopoly should be approved because only large merged firms will invest. The relative efficiency gains obtained in a merger are here thus more important than predicted with exogenous efficiencies.

Remark 3 *For managers cooperating internally, if antitrust authorities take efficiency gains of mergers for granted, then when a merger is proposed, they erroneously allow*
(a) Too many mergers if investment gains and costs are both high (type II error), and
(b) Too few mergers if investment gains and costs are both intermediate (type I error).

If managers do not cooperate inside the firm, despite investing less in larger firms, managers still may like to merge towards a more concentrated market structure (see Figure 4). The optimal market structure with internal conflict for any cost and gain of investment is outlined in the following proposition and depicted in Figure 6.

PROPOSITION 6 *For managers not cooperating internally:*
(a) Monopoly is the optimal market structure if the investment gains are high and costs are low.
(b) Duopoly is optimal if the investment gains are high and costs are intermediate.

[Place Figure 6 approximately here]

The elements which determine the optimal structures are the same as in the previous proposition. However, with internal conflict, merged firms may be less efficient and the regulator should allow firms to merge only in few cases. As before, a regulator that takes efficiency gains for granted ($c = 0$) allows too many mergers towards monopoly when the potential efficiency gains are high.[17] But this mistake is now made more often because the internal conflict problem becomes more severe for higher investment costs c. Moreover, when managers do not cooperate internally, this mistake is more costly, since a merger might lead to efficiency losses. The other type of error -prohibiting a merger that is welfare enhancing for consumers- is not made.

[17] In the area where the optimal market structure is the duopoly, this structure is not proposed.

Remark 4 *For managers not cooperating internally, if antitrust authorities take efficiency gains of mergers for granted, they erroneously allow too many mergers (type II error) when a merger is proposed. This happens more often and is more costly than when managers cooperate internally.*

7 Extensions

Merger failures

Our model can provide an explanation for the widespread phenomenon of merger failures, i.e. merged firms obtaining lower profits than comparable non-merged firms. Until now we have assumed that managers can perfectly predict whether there will be internal conflict within the merged firm. But if the extent of conflict cannot be assessed with certainty, wrong merger decisions may be made.[18] Suppose that, at the time of merging, managers expect no conflict, but conflict does arise afterwards. This misjudgment may lead to a merger failure. Indeed, Figures 3 and 4 show that, for some parameter combinations, high concentration is profitably stable with no-conflict but not under internal conflict.[19] A similar but more subtle argument applies when managers are rational, but there exists uncertainty about the possibility of internal conflict.[20] Suppose that ex ante (in the merger stage) managers cannot perfectly foresee which scenario will arise ex-post (in the investment stage). Thus, they decide upon merging given their expectations. If they predict that the risk of internal conflict is sufficiently low, they may merge into a monopoly. But if then conflict arises, there are cases where triopoly or duopoly would have been better choices.[21]

Endogenous sharing rules

Throughout the paper we considered the sharing rule as exogenous. In this section we argue that our results qualitatively remain unchanged when managers optimally decide upon the sharing of the profits when the firm is formed.

[18] Weber and Camerer [24] show experimentally that managers systematically underestimate merger difficulties. See Banal-Estañol and Seldeslachts [3] for alternative explanations of merger failure.

[19] The opposite can also be true. If managers predict internal conflict and choose not to merge, it may well be ex post that a merger would have been profitable if no conflict arises.

[20] Following a related approach, Banal-Estañol [2] examines how market uncertainty affects the incentives to merge. Amir et al. [1] show that mergers may be profitable if outsiders believe that the uncertain efficiency gains will be large, even if these gains do not materialise ex-post.

[21] See the working paper version of this paper for a more formal exposition of this argument.

Since they are ex-ante identical and have the same bargaining power, it is natural to assume that all managers within a firm receive the same ex-post payoff. When there is no conflict, any sharing rule -and in particular equal sharing- is optimal because the sharing rule has no incentive effects. In a situation of internal conflict, however, the sharing scheme -whether the managers receive their payoff via a fixed fee and/or as a percentage of the joint profit- may affect the incentives to invest. Managers determine the terms of the contract in order to maximise the firm's profits. As an example, we state the optimal contracts for a monopoly in the following proposition.

Proposition 7 *For managers not cooperating internally, there exists* $\widetilde{c}_0^m, \widetilde{c}_1^m$ *and* $\widetilde{c}_2^m (= \widetilde{c}^m)$ *such that the optimal sharing rule is:*
(a) If $c < \widetilde{c}_2^m$ *all managers share the profits equally (all three invest).*
(b) If $\widetilde{c}_2^m \leq c < \widetilde{c}_1^m$ *two share the profits equally and the other receives a fixed fee (two invest).*
(c) If $\widetilde{c}_1^m \leq c < \widetilde{c}_0^m$ *one is the residual claimant and two receive a fixed fee (one invests).*
(d) If $c \geq \widetilde{c}_0^m$ *any sharing scheme (none invests).*

Thus, when the equal sharing rule in the conflict case induces the same investment decisions as in the no-conflict case, i.e. when $c < \widetilde{c}_2^m$ and when $c \geq \overline{c}^m (\geq \widetilde{c}_0^m)$, this sharing rule is optimal. In contrast, in other situations, the equal sharing may not give the right incentives. Better investment incentives can be obtained by increasing the percentage of profits to some managers and compensating the others via a fixed fee. However, in this case the potential synergies will be smaller since the managers receiving a fixed fee will not invest. Thus, when managers set up the optimal payment scheme, although they still invest more in the no-conflict than in the conflict case, the differences between the two change more gradually. However, our results do not change qualitatively by allowing optimal contracts.

Less concentrated industries

We conjecture that our main results hold true in less concentrated industries. First, for internal cooperation, large firms tend to invest more than small firms because of synergies. In the five-manager case, for example, the monopoly invests more than any other firm in any other market structure.[22,23] Second, for internal conflict, large firms tend to invest less than small firms since the conflict effect often dominates the synergy effect. In the five-manager case, there exists a region where monopolists do not invest, whereas managers in other firms do. A merger towards monopoly would then generate efficiency losses. Third, for internal cooperation, only highly concentrated structures should be stable. Merged firms enjoy higher market power and may realise efficiency gains. In the five-manager case, only the monopoly and the duopoly with four insiders can be stable. And fourth, for internal conflict, highly unconcentrated industry structures should also become stable, since mergers may generate efficiency losses. Indeed, for the five-manager case in this scenario, the industry structure in which all managers form firms separately is now also stable.[24]

8 Conclusion

This paper broadens the theory on horizontal mergers by endogenising efficiency gains. Our aim is to analyse when mergers occur and when the realised mergers effectively lead to more efficient firms. Previous studies on mergers have treated these efficiency gains as exogenous. Although a complex issue, a better understanding of when mergers become more efficient seems necessary and urgent. Both the European and U.S. Merger Guidelines now allow firms to use an efficiency defence when proposing a merger.

Our analysis is a first step in this direction. We model the efficiency gains as endogenous by including investment as a strategic decision. The right investment may turn a merged firm into being more efficient because of merger synergies. Moreover, we allow for the possibility of internal conflict at the moment where managers decide on investing, opening thus the black box of a firm's internal organisation after having merged. Indeed, the lack of trust and inability to identify individual contributions in a newly merged firm may result in free-riding problems and suboptimal decisions.

[22] We carried out a numerical simulation in Excel-VBA for the five-manager case, which can be found on the first author's webpage. Computations for less concentrated industries are tedious because of the potential (endogenous) asymmetries between firms of the same size. Some firms may be investing in equilibrium, while others may not.

[23] The five-manager case is interesting because it is the smallest number needed to find not only a merger towards monopoly, but also a merger towards duopoly to be profitable for constant marginal costs. Indeed, merging firms need to amount to at least 80% of the market to be profitable (Salant et al. [20]).

[24] It is possible that, for some parameter combinations, no industry structure is stable in less concentrated industries. This non-existence of stable outcomes is something which unfortunately may sometimes occur (see e.g. Horn and Persson [12]).

The merger formation process is modeled as endogenous, allowing firms to choose with which other firm(s) they merge. This complicates the analysis, but has previously proven to be important in making market structure predictions and policy recommendations. We use a simple setup with three firms, which is the smallest number possible to allow for the possibility of having insiders and outsiders. This setup also allows us to apply a new stability concept which we argue to be natural for mergers in concentrated markets.

Our positive and normative results show that predictions and antitrust advice can be quite different when becoming more efficient is treated as a strategic decision. Potential efficiency gains are not necessarily realised. Although managers do have strong incentives to merge, this is often due to market power reasons. Managers in a larger merged firm may have more incentives to invest because of synergies, but only do so when this is profitable. Conflict within a merged firm can even offset these possible synergies, thereby making managers merge less often. This leads to a less concentrated market structure. More importantly, even when managers do decide to merge, this merged firm may become *less* efficient as compared to firms that would not merge.

This points out the dangers in assuming that potential efficiency gains will be realised. Taking efficiency gains as exogenous may lead an antitrust authority to approve mergers that are welfare reducing (type II error) and block mergers that would have been welfare enhancing (type I error). We show that both type of errors appear if managers cooperate internally after merging. If they do not cooperate, only type I errors are made, but these are now more common and more costly. In addition to the decrease in competition, merged firms may now be less efficient than each of the forming firms. Our paper thus calls for caution in allowing firms to defend a merger on the basis of efficiency gains, especially in situations where information about costs and gains of investing is difficult to verify. Ours is a first attempt to tackle the issue of endogenous efficiency gains in concentrated markets. Further developments in this area are promising avenues for further research.

Appendix

We denote Π_j^m as 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, respectively, when j insiders and l outsiders invest; 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 for the 'net' profits for each monopolist, insider, outsider and triopolist.

Proof of Proposition 1

Within each firm, it is 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. The insiders in duopoly 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. 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 invests ($\overline{c}_0^i > \overline{c}_1^i = \overline{c}_0^o$). 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. ■

We can now characterise the four different regions. In regions (A) and (D), from Lemma 1, if $c \leq \min\{\overline{c}^o, \overline{c}_2^t\}$, all firms invest, whereas if $c > \max\{\overline{c}^i, \overline{c}^m\}$, no manager invests. In region (B), by definition, the insiders and the monopolists invest. Within the region, as c increases, single-manager firms stop investing gradually (in different order, depending on k). In region (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. QED.

Proof of Proposition 2

Lemma 2 *For any combination of parameters, there is at most one stable structure.*

Proof. 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. We state the conditions 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 $\pi^m \geq \pi_a^t$ (the deviator is always "optimistic"). The duopoly is stable when (3) $\pi^i > \pi^m$ or $\pi^o > \pi^m$ and (4) $\pi^i \geq \pi_a^t$. The triopoly is stable when (5) $\pi_a^t > \pi^m$ and (6) $\pi_b^t > \pi^i$.

We show the result by contradiction. Suppose first that the monopoly and the duopoly are stable at the same time. On the one hand, from (1) and (3), we get that $\pi^o > \pi^m$. On the other, from (4) and $\pi_a^t \geq \pi_b^t$, we get that $\pi^i \geq \pi_b^t$ and therefore from (2), we get that $\pi^m \geq \pi^o$. Hence, we have 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). ■

Lemma 3 *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 4 *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 when he does not invest because $\Pi_0^m = \frac{1}{12} > \frac{1}{18} = \Pi_{0,0}^i > \Pi_{0,1}^i$. Third, when he would invest in the monopoly but not in the duopoly (from Lemma 1 the outsider does not invest in this region). The monopoly is preferred when $\Pi_3^m - c > \Pi_{0,0}^i$, thus when $c < \frac{1+18k+27k^2}{36}$. This is always true 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 (the outsider does not invest here). 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 5 *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 ($\pi_b^t > \pi^i$).*

Proof. Each one of these conditions, together with Lemma 3 and Lemma 4, ensure that conditions (1) and (2) in the proof of Lemma 2 are satisfied and hence the monopoly is the (unique) stable structure. ■

We now prove the proposition following the four parts identified in Proposition 1. In region (A), we have that $\pi^t = \Pi^t_{1,2} - c > \Pi^i_{2,1} - c = \pi^i$ when $k < k_1 = \frac{4\sqrt{2}-5}{21}$ and that $\pi^m = \Pi^m_3 - c \geq \Pi^o_{1,2} - c = \pi^o$ when $k \geq k_2 = \frac{2\sqrt{3}-3}{9}$. From Lemma 5, the monopoly is stable if $k < k_1$ or $k \geq k_2$. If $k_1 \leq k < k_2$, the duopoly is stable, since conditions (3) and (4) in the proof of Lemma 2 are then satisfied. In region (B), we show that at least one of the two conditions in Lemma 5 is satisfied. On the one hand we show that when $k \geq \frac{1}{15}$, then $\pi^m \geq \pi^o$. If the outsider does invest, $\pi^m = \Pi^m_3 - c \geq \Pi^o_{1,2} - c = \pi^o$ when $k \geq k_2$ and in particular when $k \geq \frac{1}{15}$. If the outsider does not invest, $\pi^m = \Pi^m_3 - c \geq \Pi^o_{0,2} = \pi^o$ 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, when $k < \frac{1}{15}$, we have that $\pi^t_b > \pi^i$. Take first the case in which no triopolist invests ($c > \overline{c}^t_0$). We have that $\pi^t = \Pi^t_{0,0} > \Pi^i_{2,0} - c$ (and in particular that $\pi^t > \Pi^i_{2,1} - c$) whenever $c > \frac{-1+64k+128k^2}{144}$. This is always satisfied when $k < \frac{1}{15}$ and $c > \overline{c}^t_0$. Second, consider that 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 $\pi^t_b = \Pi^t_{0,1}$. We have that $\pi^t_b = \Pi^t_{0,1} > \Pi^i_{2,1} - c = \pi^i$ whenever $c > \frac{-1+66k+63k^2}{144}$. This is always satisfied when $k < \frac{1}{15}$ and $c > \overline{c}^t_1$. Last take the case in which two triopolists invest (again here the outsider would invest). In this case $\pi^t_b = \Pi^t_{1,1}$ and $\pi^t_b = \Pi^t_{1,1} - c > \Pi^i_{2,1} - c = \pi^i$ whenever $k < \frac{\sqrt{2}-1}{6}$ and in particular when $k < \frac{1}{15}$. In region (C) In the part of this region where only the monopolists invest we have that $\pi^t = \Pi^t_{0,0} > \Pi^i_{0,0} = \pi^i$ and hence the monopoly is the stable structure. When the insiders invest, we have that $\pi^t = \Pi^t_{0,0} > \Pi^i_{2,0} - c = \pi^i$ whenever $c > \frac{-1+64k+128k^2}{144}$. This is always satisfied since $c > \overline{c}^m \geq \frac{-1+64k+128k^2}{144}$. Finally in region (D), the monopoly is stable since $\pi^t = \Pi^t_{0,0} > \Pi^i_{0,0} = \pi^i$.

Proof of Proposition 3

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

Lemma 6 *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 $\widetilde{c}_2^m = \frac{k(2+5k)}{12}$. All 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 equilibria 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 and only the cutoffs in which the partner invests are relevant. In turn, the relevant cutoffs for the outsiders are those in which none or all the insiders invest. The cutoffs for the outsider and the triopolists are obtained in the proof of Proposition 1. Straightforward algebra leads to the ordering. ■

We are now ready to characterise the four different regions. In region (E), we distinguish two subcases. When $c \leq \min\{\widetilde{c}^m, \widetilde{c}_2^o\}$ (E1), from Lemma 6, all the managers invest. When $\widetilde{c}_2^o \leq c < \widetilde{c}^m$ (E2), 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. In region (F), the monopolists stop investing. We distinguish two subcases. If $\widetilde{c}^m < c \leq \widetilde{c}_1^i$ (F1), the insiders invest independent of the outsider decision. From Lemma 6, the outsider may invest whereas there are two or three triopolists doing so. If $\max\{\widetilde{c}_1^i, \widetilde{c}_2^o\} < c \leq \widetilde{c}_0^i$ (F2), either the insiders do invest and the outsider does not, or vice versa. From Lemma 6 we can check that there are one or two triopolists investing. In regions (G) and (H), the insiders and the monopolists never invest. We distinguish five subcases: G1) when $\widetilde{c}_1^i < c \leq \widetilde{c}_2^t$ the three triopolists and the outsider invest, G2) 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 triopolists and the outsider invest, G3) when $\max\{\widetilde{c}_1^t, \widetilde{c}_0^i\} < c \leq \widetilde{c}_0^t$, one triopolist and the outsider invest, G4) when $\widetilde{c}_0^t < c \leq \widetilde{c}_0^o$, only the outsider invest and H) when $c > \widetilde{c}_0^o$ no one invests. QED.

Proof of Proposition 4

In this proof we use when possible Lemma 2. It applies as long as there is not multiplicity of equilibria in the duopoly investment decisions. As shown in the previous proof, region (E) can be divided in two. In region (E1), the stable structures and the proofs are identical to those of Proposition 2 where everyone invests. In region (E2), 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 $\pi^m \geq \Pi^o_{0,2} = \pi^o$ or when $c \leq \frac{-1+34k+11k^2}{36}$ and the monopoly to being triopolists not investing when $\pi^m \geq \Pi^t_{0,2}$ or when $c \leq \frac{1+36k+24k^2}{48}$. These two conditions are always satisfied in this region ($\widetilde{c}^o_2 \leq c < \widetilde{c}^m$). Thus, the monopoly is stable and from Lemma 2 it is unique.

As we have seen in the previous proof, region F can be divided in two parts. In region (F1), the uniqueness result applies. Managers prefer being insiders than monopolists when $c \leq c_1(k) = \frac{-1+12k+18k^2}{36}$: when the outsider invests $\pi^i = \Pi^i_{2,1} - c > \Pi^m_0 = \pi^m$ precisely when $c \leq c_1(k)$, whereas when he does not, $\pi^i = \Pi^i_{2,0} - c > \Pi^m_0 = \pi^m$ is always satisfied in this region. In addition, $\pi^i \geq \pi^t_a$, independent of the number of triopolists investing and of the choice of the outsider. This two inequalities are sufficient to ensure unique duopoly stability (see proof of Lemma 2). When $c > c_1(k)$, managers in a monopoly do not invest, whereas in any other situation all managers invest. Managers prefer the monopoly to being insiders by definition. They also prefer the monopoly to the triopoly $\pi^m = \Pi^m_0 > \Pi^t_{1,2} - c = \pi^t$ and hence the triopoly is never stable. Choices between monopoly and outsider and between insider and triopoly determine three different regions. Managers prefer being monopolists than outsiders when $c \geq c_2 = \frac{1}{36}$ and they prefer being insiders to triopolists when $k \geq k_1$ (see proof of Proposition 2). This defines three regions because: (a) $c_1'(k) > 0$ and the k^* such that $c_1(k^*) = \widetilde{c}^i_1(k^*)$ is larger than the k^{**} such that $c_2 = \widetilde{c}^i_1(k^{**})$ and (b) the k^{***} such that $c_2 = \widetilde{c}^i_0(k^{***})$ 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 $c < c_2$, the duopoly is stable because conditions (3) and (4) are satisfied. Finally, when $c \geq c_2$ (and $c > c_1(k)$), monopoly is stable because condition (1) and the first part of (2) are satisfied.

In region (F2), there are two different equilibria in the duopoly: 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, $\pi^i_d > \pi^i_e$ 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) $\pi^i_d \geq \pi^t_a$. The outsiders-investing duopoly is stable when (M5) $\pi^i_e > \pi^m$ or $\pi^o_e > \pi^m$ and (M6) $\pi^i_e \geq \pi^t_a$. Finally, the triopoly is stable when (M7) $\pi^t_a > \pi^m$ and (M8) $\pi^t_b > \pi^i_d$. We show then that the insiders-investing duopoly is stable. Firstly $\pi_d^i = \Pi_{2,0}^i - c > \Pi_0^m = \pi^m$ when $c \leq \frac{-1+16k+32k^2}{36}$, which is always true in this region. Hence condition (M3) is satisfied. Secondly, the condition $\pi_d^i > \pi_a^t$ is also satisfied since $\pi_d^i = \Pi_{2,0}^i - c > \Pi_{1,0}^t - c > \Pi_{1,1}^t - c$ in this region (as a triopolist, it is always better invest). Condition (M4) is also satisfied and therefore this structure is stable. This is the unique stable structure. The monopoly is not stable because, as we have seen, $\pi_d^i > \pi^m$ in contradiction with (M1). The outsider-duopoly is not stable because condition (M6) does not hold either. Indeed, $(\pi_a^t \geq)$ $\pi_b^t > \pi_e^i$ independent of having one or two triopolists investing. If one invests $\pi_b^t = \Pi_{0,1}^t > \Pi_{0,1}^i = \pi_e^i$ whereas if there are two $\pi_b^t = \Pi_{1,1}^t - c > \Pi_{0,1}^i = \pi_e^i$ whenever $c \leq \frac{1+52k+28k^2}{144}$ which is always true when $c < \widetilde{c}_1^t$. Finally, the triopoly is not stable because $\pi_d^i > \pi_a^t \geq \pi_b^t$ contradicts condition (M8).

As we have seen in the previous proof, regions G and H can be divided in five parts. The uniqueness result applies. Managers prefer to be monopolists rather than insiders ($\pi^m = \Pi_0^m > \Pi_{0,0}^i > \Pi_{0,1}^i$). We also have that $\pi_b^t > \pi^i$ 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 $\pi_b^t = \Pi_{1,2}^t - c > \Pi_{0,1}^i = \pi^i$. When there are two investing, then $\pi_b^t = \Pi_{1,1}^t - c > \Pi_{0,1}^i = \pi^i$ when $c < \frac{1+52k+28k^2}{144}$, which is the case when $c < \widetilde{c}_1^t$. 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, $\pi^m \geq \pi_a^t$ 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, $\pi^m = \Pi_0^m \geq \Pi_{1,1}^t - c = \pi_a^t$ when $c > \frac{-1+12k+12k^2}{48}$ 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, $\pi^m = \Pi_{0,0}^m > \Pi_{0,0}^t = \pi^t$. Hence in all regions 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 2 are satisfied. When there is one triopolist investing and $c \leq c_4(k)$ the triopoly is the unique stable structure. In this region $\pi_a^t > \pi^m$ and, as before, $\pi_b^t > \pi^i$ satisfying conditions (5) and (6). Finally, when three triopolists invest and $c \geq c_3(k)$, the duopoly is stable. Indeed, conditions (3) and (4) are satisfied. First, we have that $\pi^o = \Pi_{1,0}^o - c > \Pi_0^m = \pi^m$ when $c < \frac{1+10k+7k^2}{18}$ and this condition holds when $c < \widetilde{c}_2^t$. Second, by the definition of $c_3(k)$ and since all triopolists invest, $\pi_a^t = \pi_b^t \leq \pi^i$.

Proof of Proposition 5

From (6), consumer welfare is maximised when total production is highest. From (2), total production is given by $Q^{\Omega} = \frac{\sum_{w\in\Omega}\left(1-\sum_{v\in\Omega, v\neq\omega} I_v + nI_\omega\right)}{n+1}$, where $\Omega = \{\Omega_M, \Omega_D, \Omega_T\}$.We prove this proposition following the four parts identified in Proposition 1. In region (A) all managers invest. Hence, $Q^{\Omega_M} = \frac{1+3k}{2}$, $Q^{\Omega_D} = \frac{2+3k}{3}$ and $Q^{\Omega_T} = \frac{3(1+k)}{4}$. Since $Q^{\Omega_T} > Q^{\Omega_D}$ for $k < \frac{1}{3}$, $Q^{\Omega_T} > Q^{\Omega_M}$ for $k < \frac{1}{3}$ and $Q^{\Omega_D} > Q^{\Omega_M}$ for $k < \frac{1}{3}$, the optimal industry structure is triopoly when $k < \frac{1}{3}$ and the monopoly when $k \geq \frac{1}{3}$. In region (C1) only the monopolists invest. Hence, $Q^{\Omega_M} = \frac{1+3k}{2}$, $Q^{\Omega_D} = \frac{2}{3}$ and $Q^{\Omega_T} = \frac{3}{4}$, and the optimal structure is the triopoly for $k < \frac{1}{6}$ and the monopoly for $k \geq \frac{1}{6}$.In (C2), only the insiders in the duopoly invest. Hence, $Q^{\Omega_M} = \frac{1}{2}$, $Q^{\Omega_D} = \frac{2+2k}{3}$ and $Q^{\Omega_T} = \frac{3}{4}$, and the optimal structure is the duopoly. In region (D) no manager invests. Hence, since $Q^{\Omega_M} = \frac{1}{2}$, $Q^{\Omega_D} = \frac{2}{3}$ and $Q^{\Omega_T} = \frac{3}{4}$, the triopoly is the optimal structure. In region (B) the monopolists and the insiders invest, but single manager firms may not. We distinguish seven cases, depending on whether the triopolists and the outsider invest. If the outsider invests, the optimal industry structure is the monopoly when $k \geq \frac{1}{3}$; the duopoly when $k < \frac{1}{3}$ and $k \geq \frac{1}{6}$, $k \geq \frac{1}{9}$ or $k \geq \frac{1}{12}$ when two, one or no triopolist invest, respectively; and the triopoly otherwise. Suppose now that the outsider does not invest. If no triopolist invests, the optimal structure is the monopoly when $k \geq \frac{1}{5}$, the duopoly when $\frac{1}{16} < k \leq \frac{1}{5}$ and the triopoly when $k < \frac{1}{16}$ or $k \geq \frac{1}{12}$ when two, one or no triopolist invest, respectively; and the triopoly is optimal otherwise. If one (resp. two, three) triopolist invests, the optimal industry structure is the monopoly when $k \geq \frac{1}{5}$ (resp., $k \geq \frac{1}{4}$ and $k \geq \frac{1}{3}$) and the triopoly when $k < \frac{1}{5}$ (resp., $k < \frac{1}{4}$ and $k < \frac{1}{3}$).

Proof of Proposition 6

Following the same procedure as the previous proof, we obtain the results plotted in Figure 6.

Proof of Proposition 7

Let us denote the contract of manager i by the fixed fee F_i and the share of the profits by ϵ_i. As we have shown in the proof of Proposition 3, under the equal sharing rule a manager invests if $c < \widetilde{c}_0^m$ when no other manager invests, if $c < \widetilde{c}_1^m$ when one other manger invests and if $c < \widetilde{c}_2^m$ when two other managers invest. Proceeding in the same way for the other possible sharing rules, and comparing the total profits we find the following results. For $c < \widetilde{c}_2^m$, giving all managers the same percentage of profits ($F_i = 0$ and $\epsilon_i = \frac{1}{3}$) yields the best incentives. For

$\widetilde{c}_2^m \leq c < \widetilde{c}_1^m$ the optimal contracts are $F_1 = \frac{1}{3}\Pi_2^m - \frac{2}{3}c$, $\epsilon_1 = 0$ and $F_2 = F_3 = -\frac{1}{6}\Pi_2^m + \frac{1}{3}c$ and $\epsilon_2 = \epsilon_3 = \frac{1}{2}$. For $\widetilde{c}_1^m \leq c < \widetilde{c}_0^m$ the optimal contracts are $F_1 = F_2 = \frac{1}{3}\Pi_1^m - \frac{1}{3}c$, $\epsilon_1 = \epsilon_2 = 0$ and $F_3 = -\frac{2}{3}\Pi_1^m + \frac{2}{3}c$ and $\epsilon_3 = 1$. For $c > \widetilde{c}_0^m$ any sharing rule provides the same incentives.

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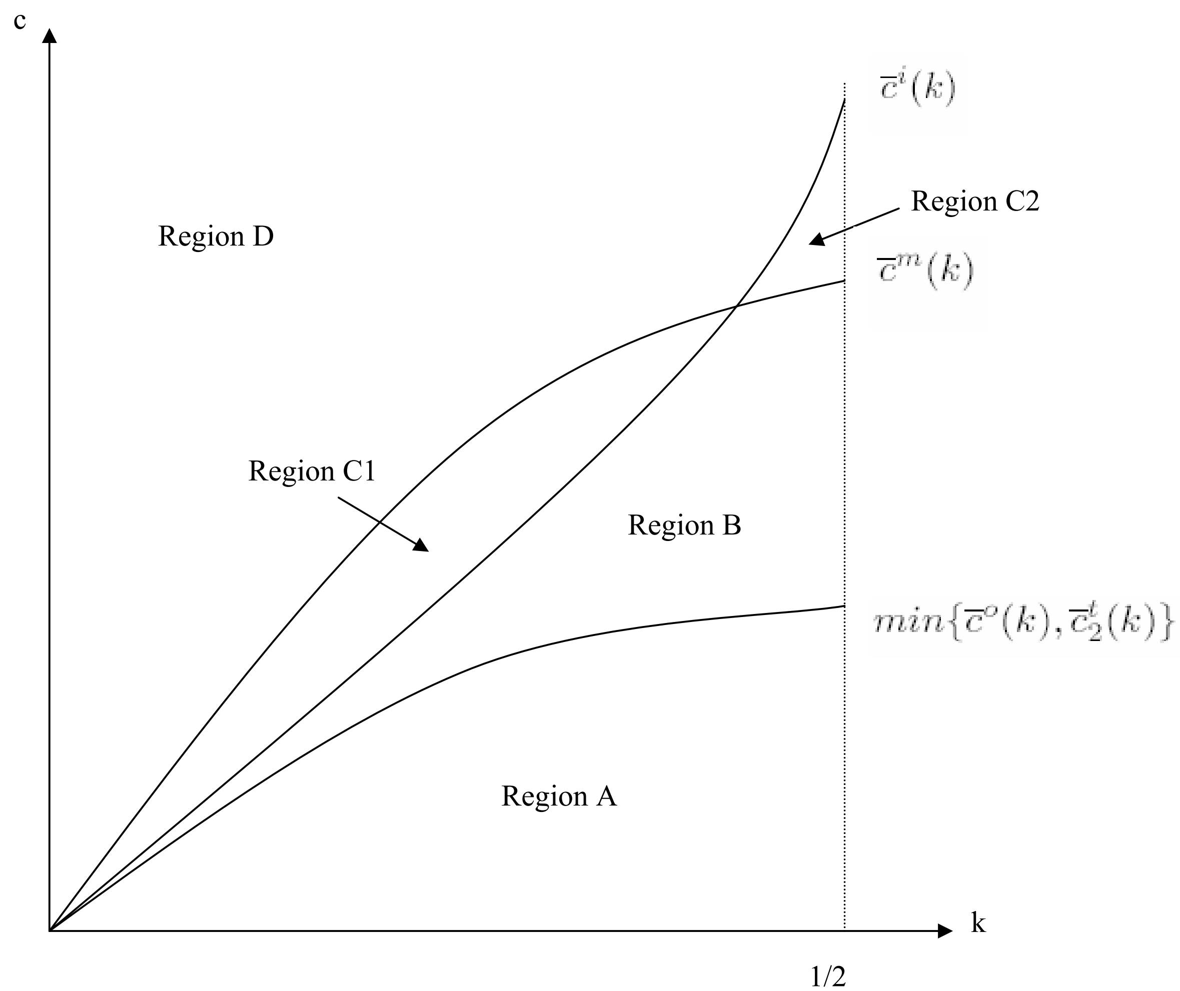

Figure 1: Investment Nash Equilibria when there is no internal conflict

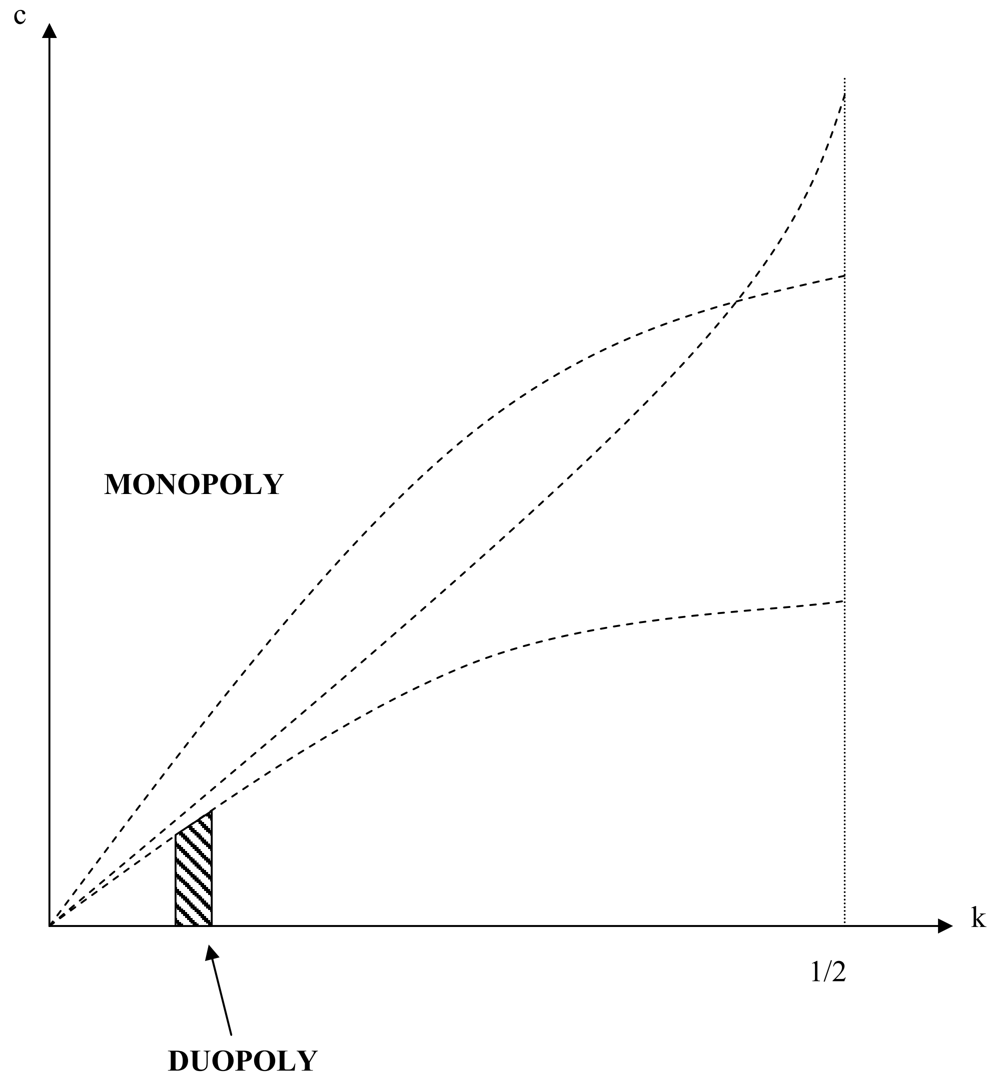

Figure 2: Stable market structures when there is no internal conflict

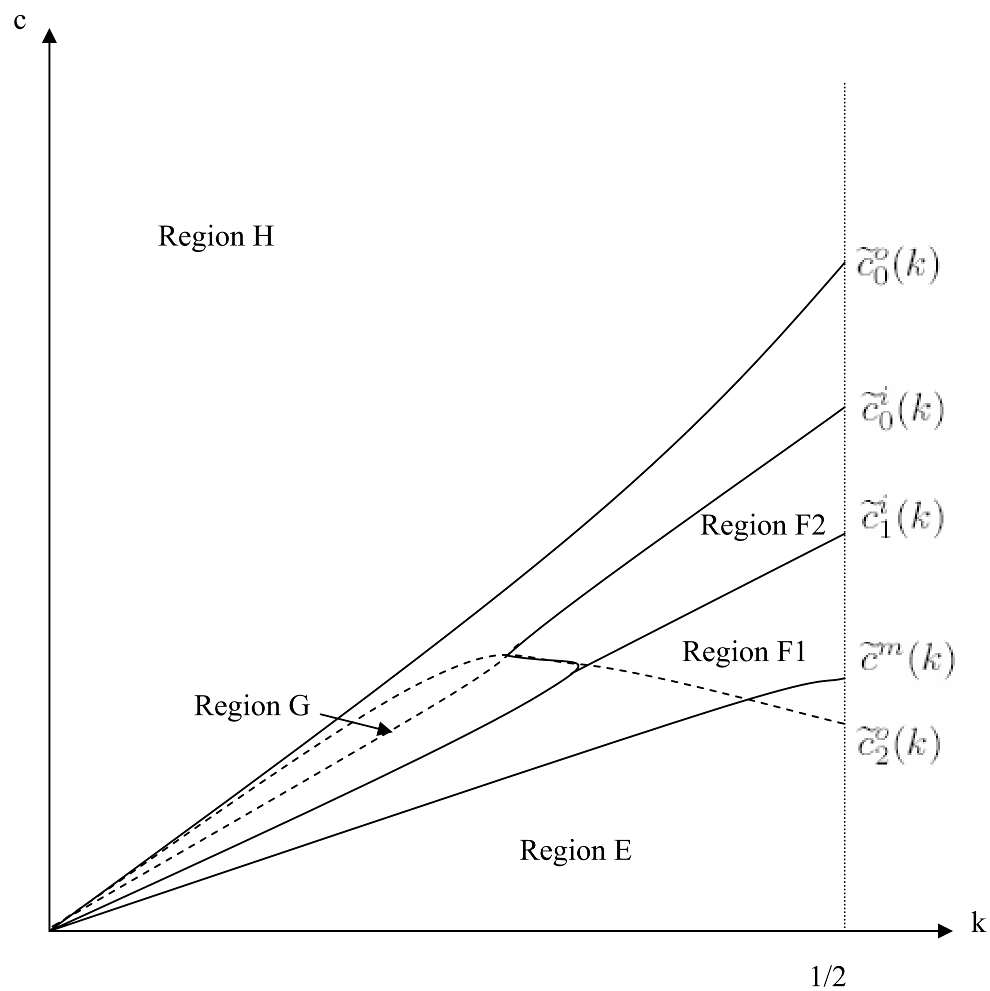

Figure 3: Investment Nash Equilibria when there is internal conflict

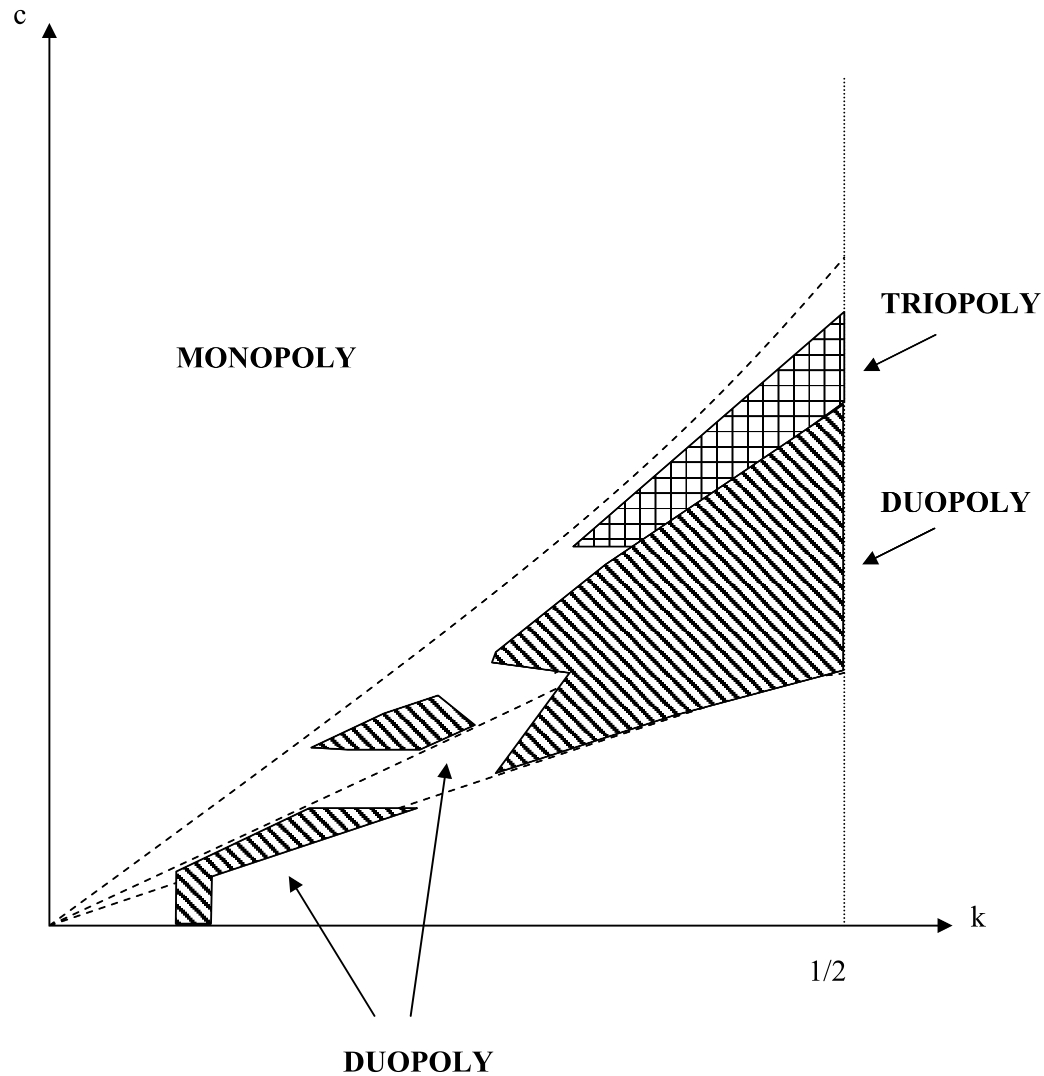

Figure 4: Stable market structures when
there is internal conflict

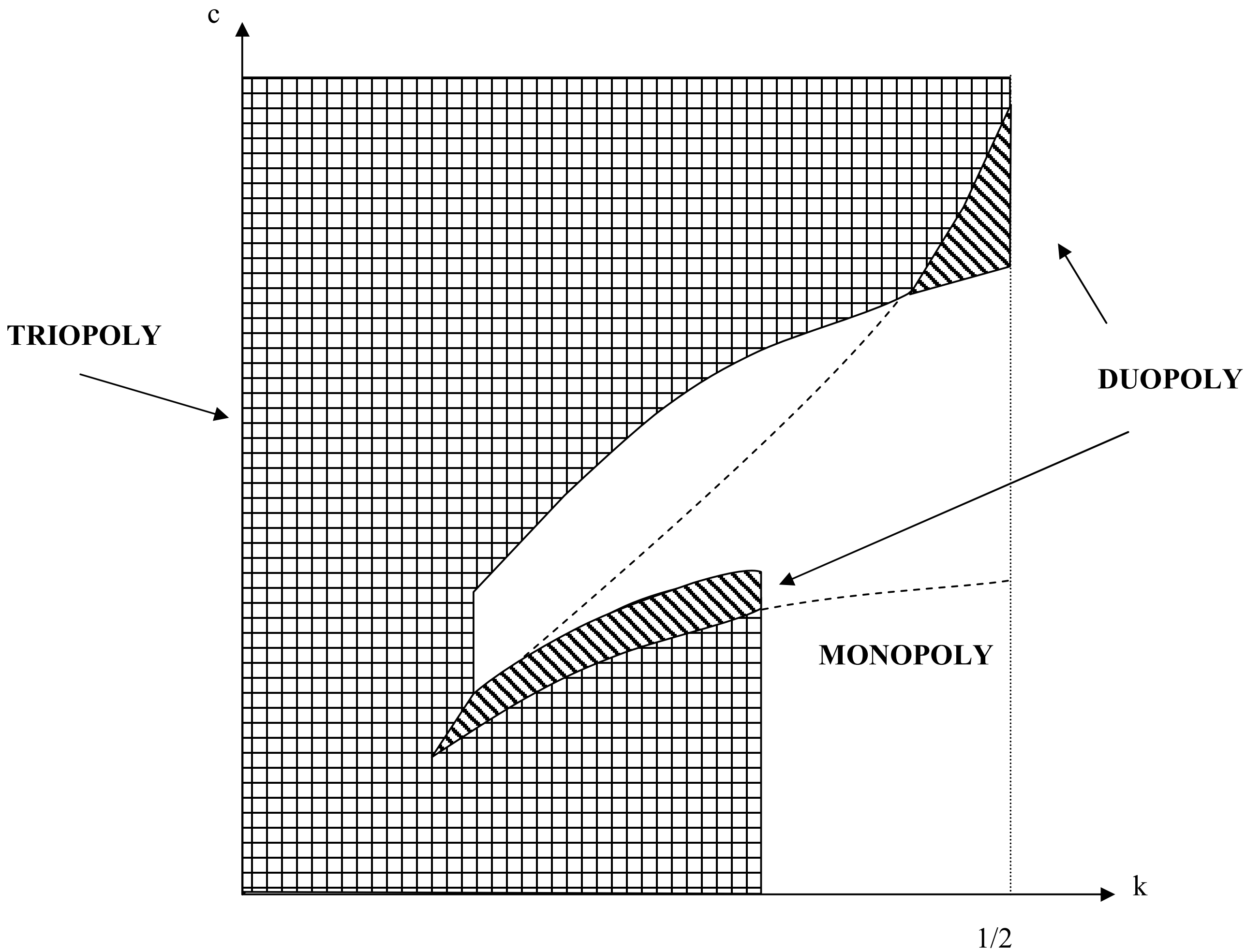

Figure 5: Consumer optimal market structures
when there is no internal conflict

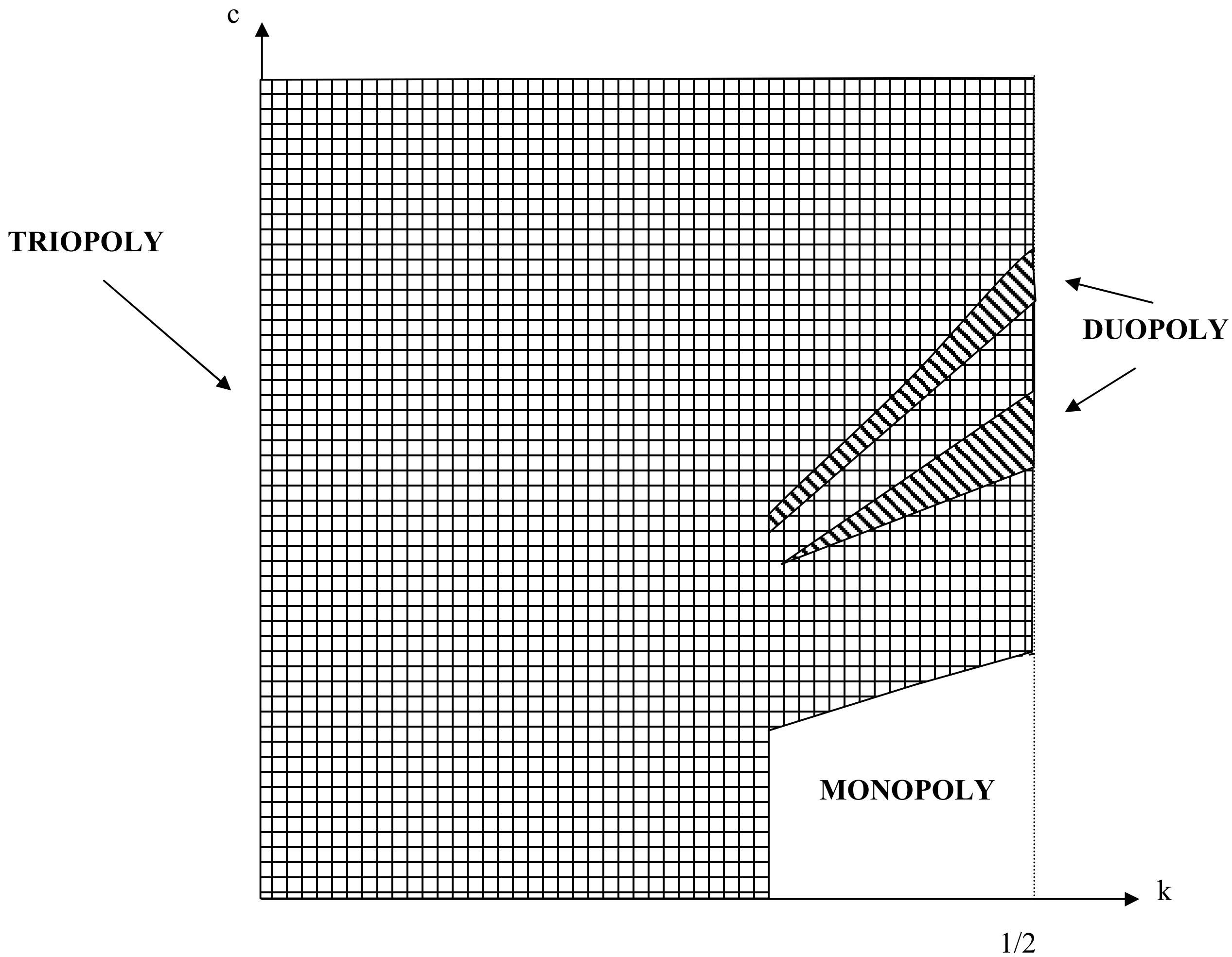

Figure 6: Consumer optimal market structures
when there is internal conflict