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Intra-firm Coordination and Horizontal Merger

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We look at an industry of *Cournot* oligopolists each of which consists of production facilities which enjoy some degree of freedom in deciding their output quantities and that way influence the total output of a firm. This structure can be motivated e.g. the existence of profit centers or by the specifics of a cooperative firm. The extent of coordination inside the firms is captured in a simple way, and market equilibrium is derived for potentially asymmetric firms using the concept of a replacement function. We use this model to address the question of profitability of horizontal mergers and of the welfare consequences of such mergers. Contrary to the standard literature, we find a wide range of potentially profitable mergers without having to refer to cost synergies. This result is driven by the effect of size in terms of the number of production facilities and by the strategic consequences of intra-firm decentralization. A number of seemingly conflicting results from the literature can be considered special cases of our model.

Key words: merger, oligopoly, organization, vertical coordination

JEL classification: L22, L13

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1 Introduction

Following the seminal work of *Salant, Switzer* and *Reynolds (1983)* there has been a long debate in theoretical industrial economics about the profitability of horizontal mergers in *Cournot* oligopolies. Basically, theorists find it hard to identify sound eco-

nomic reasons for such mergers.[1] According to *Salant, Switzer* and *Reynolds (1983)* horizontal mergers which do not generate economies of scale or scope are only profitable if all or almost all competitors merge. Later work identified a number of – rather specific – conditions under which horizontal mergers could be profitable for the firms participating. Sufficient convexity of costs, for example, can guarantee economic benefits from a bilateral horizontal merger *(Perry* and *Porter 1985)*. *Farrell* and *Shapiro (1990)* looked at synergies as a necessary condition for profitable mergers. *Cheung (1992)* and *Faulí-Oller (1997)* analyzed mergers using more general forms of the demand function and showed that mergers may be profitable if the combined market share of insiders exceeds 50%. More recently, *Huck, Konrad* and *Müller (2001)* examined mergers in a *Stackelberg* framework, finding out that a merger between a leader and a follower is beneficial. *Gonzalez-Maestre* and *López-Cunat* (2001) and *Neus (2002)* considered the role of strategic management compensation for the profitability of mergers. Moreover, *Ziss (2001)* analyzed mergers with strategic delegation and compensation schemes.

In this paper we look at mergers from yet another angle: We model oligopolistic firms as consisting of several production facilities (called "factories" or "profit centers") which may enjoy some scope for deciding their outputs and thereby influencing the total output of a firm. It turns out that the degree of (de-)centralization in such firms is a crucial determinant for the oligopoly equilibrium, and it also has important consequences for the profitability of mergers in an industry consisting of such firms. Recent work of *Creane* and *Davidson* (2004), who also stress the role of internal organization, can be considered a special case of our analysis. These authors emphasize that a merger offers possibilities of strategic organization which cannot be implemented by separated firms. They argue that in the new firm there may be a pecking order inside the firm consisting of divisions which were formerly independent firms. *Creane* and *Davidson* model this hierarchy between the divisions in a *Stackelberg* framework inside the firm. As a result, mergers may be profitable, if not too many firms participate. In contrast to the models mentioned above, a profitable merger hurts outsiders, and welfare increases. This is consistent with *Levin (1990)* who finds that mergers including less than 50 percent of the total market raise welfare.

Our research and our approach were motivated initially by our theoretical thinking about cooperatives. A marketing cooperative, for example, can be considered an extremely decentralized firm, where members produce whatever quantity they choose, and the cooperative sells these outputs in the market. In such a framework the interaction of members becomes important for the conduct of the cooperative as a whole. It is then interesting to know how such a decentralized firm interacts with a vertically integrated firm with centralized decision making. *Higl (2003)* generalizes an approach of *Albæk* and *Schultz (1998)* to this kind of competition. In a duopoly framework he highlights the strategically motivated choice of an optimal level of (de-)centralization. In the pre-

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[1] We mention only in passing that the empirical literature also expresses a considerable scepticism towards the mergers that managers seem to pursue with a lot of money and management capacity. At least 50% of all mergers seem to face a negative judgement ex post despite all the euphoria ex ante.

sent paper we extend this previous work in several directions: 1. We treat firms as being on a continuum of different organisational forms, from perfect vertical integration to no central decision making at all. 2. We look at an oligopoly. 3. We analyze mergers and the relationship between internal organization in the sense of coordination of the production facilities and the profitability of such mergers. 4. We use the technique of a replacement function as initially suggested by *Selten (1970, 1973)* and more recently propagated by *Cornes* and *Hartley (2000, 2003)* as a simple and elegant tool for analyzing an oligopoly with asymmetric firms. This turns out to be particularly helpful, if we want to allow for firms with different organizational structures and different sizes in terms of the number of factories.

Our main result is that the range of profitable mergers can be much larger than described by *Salant, Switzer* und *Reynolds (1983)* once size (number of factories) and intra-firm organization (extent of decentralization) are taken into account. In a way our paper is a complement to *Perry* and *Porter (1985)* in that it allows that a merged firm may differ in size from other firms. In addition, we model the extent of coordination within a firm in a simple and stylized way.

The plan of the paper is as follows: In section 2 we present the basic model, introduce the idea of a replacement function, and derive the equilibrium of the asymmetric *Cournot* oligopoly. Section 3 deals with the analysis of mergers in this industry. In section 4 we sum up.

2   Basic Model

We consider an oligopoly of K firms indexed by $k = 1, \ldots, K$, producing a homogeneous good and competing in quantities. Each firm consists of n_k identical production facilities $i_k = 1, \ldots, n_k$ which we also call factories. We treat the number of factories as given. In such a vertical structure different degrees of integration and centralized decision making may exist. Imagine the case of a perfectly vertically integrated firm where output quantities of all factories are set by headquarters. As the opposite extreme case think of a firm where each factory is free to determine its production quantity. A marketing cooperative, where members produce and the cooperative just takes to the market whatever quantities its members supply, is an example for this case of virtually no vertical integration. *Grosskopf (1990, p. 37)* mentions the right to produce and sell to the cooperative at will as a prime motive for joining a cooperative. Usually, the different entities of a firm will enjoy some decision rights on their own while being coordinated by a centralized planning unit in other parts of their business. E.g., the organizational structure and the accounting procedures in profit centers stress the responsibility of each unit. In the sequel, the term "factory" should not be taken too literally. We can also imagine a financial services firm, like a bank, where branches decide on loans, or bond, or currency traders decide on buying financial assets for the firm. They will typically enjoy a certain degree of freedom for their "production" decisions. In our framework we want to capture the whole continuum between the two extreme cases of fully centralized decision making and totally decentralized decision making and find out whether this aspect of internal organization, i.e., the degree of production autonomy on the factory

level, has an impact on the profitability of mergers. A coordination parameter will be used to represent different degrees of centralization in our model.

Firm k receives quantity y_{ik} from its factory i_k and sells it in its oligopolistic market. Notice that we could also interpret the y_{ik}'s as an intermediate product which producer k turns into a final product and sells. In this case we would be using the simplifying assumption that one unit of the intermediate product is transformed into one unit of the final product. Total output of firm k is then given by

$$Y_k = \sum_{i=1}^{n_k} y_{ik} \quad , \tag{1}$$

total industry output is the sum over all firm output

$$Y = \sum_{k=1}^{K} Y_k \tag{2}$$

Demand for the homogeneous product is modelled in the most simple way as $p = 1 - Y$. Production on the factory level causes a constant unit and marginal cost c, where we assume $0 \leq c \leq 1$. Costs in headquarters (or for producing the final product) are normalized to zero to keep the model and its notation as simple as possible.

Consider now the internal structure and decisions of a firm in more detail:

We think of firm k's factories as individually setting their output quantities. Behaving this way, production facility i_k to some extent takes into account the behaviour of k's other factories. We can interpret this either as some degree of control by headquarters or as factory i_k looking beyond its own, narrow area of immediate responsibility. A factory's behaviour can be influenced or controlled for example with production quotas, distribution of decision competences or with an internal compensation scheme. No matter which interpretation we use, the level of coordination will be modelled in a stylized fashion by a simple coordination parameter.

Production facilities are rewarded by firm k in two different ways, First, they receive a price p_k for the product which may, as you recall, be interpreted as intermediate product. Second, they receive a share of the firm's profit. Because we focus on the role of the individual factory, it will be useful for comparisons to assume that all profits are distributed to the factories. We offer two interpretations for this profit distribution implying the same structure of the theoretical analysis: one, capturing in a stylized way the notion of a cooperative firm, and another, referring to strategic compensation schemes in business.

First, we assume that production facilities get a share of the firm's profit in relation to the number of output units they supply. This is the most natural reward scheme in the case of a cooperative, but would also fit quite well the examples from financial services mentioned above. If the price in the oligopolistic market of the K firms is p, costs at the firm level are zero, and factories are rewarded as described, production facility i_k receives a price p_{ik} for one unit of its output, which is equal to the equilibrium price in the oligopoly

$$p_{ik} = p_k + \frac{\Pi_k}{Y_k} = p_k + \frac{Y_k(p - p_k)}{Y_k} = p, \tag{3}$$

where Π_k denotes firm k's profit. Each production facility i_k maximizes a profit function

$$\pi_{ik} = py_{ik} - cy_{ik} = \left(1 - Y_k - Y_{-k}\right)y_{ik} - cy_{ik}, \tag{4}$$

where Y_{-k} is equal to the sum of all of k's competitors' outputs Y_l, $l \neq k$, i.e., $Y_l = Y - Y_k$. The notion of each factory maximizing its own profit π_{ik} again represents the idea that these units enjoy some degree of independence and/or face an incentive scheme based on their own economic success. Maximization with respect to y_{ik} requires

$$1 - \left(Y_k + \frac{dY_k}{dy_{ik}}y_{ik}\right) - \left(\sum_{l \neq k}Y_l + \frac{d\sum_{l \neq k}Y_l}{dY_k}\frac{dY_k}{dy_{ik}}y_{ik}\right) - c$$

$$= 1 - Y_k - \frac{dY_k}{dy_{ik}}y_{ik} - Y_{-k} - \frac{dY_{-k}}{dY_k}\frac{dY_k}{dy_{ik}}y_{ik} - c = 0 \tag{5}$$

We assume that the K oligopolists play a *Cournot* game and decision makers in all production facilities are aware of this fact. This implies $dY_{-k}/dY_k = 0$ and simplifies the first-order condition (5) accordingly.

We now introduce a parameter

$$\gamma_k = \frac{dY_k}{dy_{ik}} = \sum_{j=1}^{n_k}\frac{dy_{jk}}{dy_{ik}} \tag{6}$$

which expresses the change of firm k's total output corresponding to a change in the output of factory i_k as expected by this factory's decision maker. Using γ_k we can rewrite the first-order condition (5) as

$$1 - Y_k - Y_{-k} - \gamma_k y_{ik} - c = 0 \tag{7}$$

γ_k can be seen as capturing the degree of central decision making in firm k in a stylized way and is therefore interpreted as a measure of internal organization.

Before we look at the influence of γ_k in detail, we show that this parameter is consistent with an incentive-based compensation scheme. Assume, a production facility gets its internal transfer price based on firm revenue and output:

$$p_{ik} = \frac{Y_k p}{Y_k} + g_k y_{ik} \tag{8}$$

For budget balance of the firm, the factory pays a fixed internal transfer fee T. A factory therefore maximizes

$$\pi_{ik} = (1 - Y_K - Y_{-K} + g_k y_{ik})y_{ik} - T - cy_{ik} \tag{9}$$

Using the *Cournot* assumption $dY_K/dy_{ik} = 1, dY_{-K}/dy_{ik} = 0$, the first-order condition is

$$1 - Y_K - Y_{-K} - (1 - 2g_k)y_{ik} - c = 0 \tag{10}$$

A comparison to (7) shows that the coordination parameter γ_k introduced before can also be used in the model with the incentive scheme by replacing $(1 - 2g_k)$ with γ_k.[2]

Let us now take a closer look at the values of the coordination parameter. $\gamma_k = n_k$, for example, represents a situation where production facilities behave in a perfectly parallel way. All the effects of their actions on the firm's output are taken into account. This is the case of a fully vertically integrated firm. A value of $\gamma_k = 0$ stands for a situation where a single production facility believes to have no influence at all on total output of the firm. Therefore the factory expects that the price p will remain unchanged as it changes y_{ik}. This is like a situation of optimally adjusting to a given price, since optimal behaviour now calls for $p = c$. Production facilities act as if they were under perfect competition in the market for the final product. Hybrid cases exist for γ_k between the two extreme values, i.e. for $0 < \gamma_k < n_k$. For $\gamma_k = 1$, for example, a factory is only aware of the impact of its own output on total output. It neglects any (re-) actions from the other factories of firm k.[3]

For our further analysis of the model a normalization of the organization or coordination parameter γ_k turns out to be helpful. We therefore introduce

$$\Gamma_k = \frac{\gamma_k}{n_k} \tag{11}$$

which is defined on the interval $[0,1]$ given that we confine our interest to $\gamma_k \in [0, n_k]$. $\Gamma_k = 1$ describes perfect vertical integration, $\Gamma_k = 0$ full autonomy of the production facilities. Γ_k is a measure of centralization or coordination within the firm, expressing the ratio of coordination per factory. $(1 - \Gamma_k)$ represents the degree of autonomy the factories enjoy.[4]

Since all factories of a firm are identical, we have $y_{1k} = \ldots = y_{ik} = \ldots = y_{nk} := y_k$ and $Y_k = n_k y_k$.[5] A representative factory's best reply then is $y_k = (1 - c - Y_{-k})/(n_k + \gamma_k)$, implying

$$Y_k = \frac{n_k (1 - c - Y_{-k})}{n_k + \gamma_k} = \frac{1 - c - Y_{-k}}{1 + \Gamma_k} \tag{12}$$

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[2] The second order condition $g_k < 1$ holds for all expected values of γ_k.

[3] This corresponds to the case analyzed by *Albæk* and *Schultz (1998)* in a model of duopolistic competition between a cooperative and an investor-owned firm.

[4] There is clearly a formal resemblance of this parameter of intra-firm coordination and the concept of conjectural variations in the theoretical literature on oligopoly (see e.g. *Martin, 2002*). *Dixit (1986)* suggested to treat conjectures as proxies for different kinds of oligopolistic interactions. Similarly, we want to use the γ_k's here as parameters capturing the extent of internal coordination in the firm in the most simple way.

[5] Notice that the degree of internal organization may differ between firms, as does the number of production facilities.

as best reply function of firm k in the oligopoly. Notice that decentralization - a lower Γ_k - makes the firm more aggressive in the sense of standard oligopoly theory. [6]

This is an insight which corresponds to results by *Fershtman (1985)*, *Fershtman* and *Judd (1987)*, and *Sklivas (1987)* who had shown that employing a manager and giving him an objective function different from the owner's makes a *Cournot* duopolist more aggressive. Whereas in this earlier literature a manager's "autonomy" was expressed by an objective function deviating from pure profit-maximizing (by putting a non-zero weight on sales), in our case a factory's autonomy can also concern its expected influence on total firm output because of the distribution of decision rights inside the firm. Notice that our specification of γ_k in the incentive scheme for the factories (8) directly corresponds to this literature: For $\gamma_k = 1$, i.e., $g_k = 0$, the factories are rewarded solely on the basis of their revenues. For lower values of γ_k ($1/2 > g_k > 0$) they behave more aggressively getting an extra reward on sales, while for a higher γ_k ($g_k < 0$) they are less aggressive. The latter corresponds to an objective function combining revenue and profit as used e.g. in *Fershtman* and *Judd (1987)*. Notice that the pecking order model of *Creane* and *Davidson (2004)* can also be integrated into our approach. Leaders (L) inside the firm have a coordination parameter

$$\gamma_k = 1 + \frac{dr_{kF}(Y_{kL})}{dY_{kL}}$$

which is influenced by the reaction of the followers (F) inside the firm to the leaders' output decisions. In case of competition in quantities the reaction function has a negative slope, and therefore $\gamma_k < 1$, i.e., the firm behaves more aggressively in the framework of *Creane* and *Davidson (2004)*.

Now we analyze the oligopoly using *Selten*'s *(1970,1973)* notion of a replacement function which has become popular only recently through work of *Cornes* and *Hartley (2000, 2003)*. The replacement function is a useful tool to solve for the *Nash* equilibrium of an oligopoly of asymmetric firms.

Inserting the definition of Y_{-k} into (12) and solving for Y_k yields the replacement function of firm k as

$$Y_k = \frac{1}{\Gamma_k}(1 - Y - c) \tag{13}$$

This indicates that at a lower level of intra-firm coordination the firm will produce a higher output relative to industry output. $\Gamma_k = 1$, which indicates perfect vertical integration, implies the lowest output, $\Gamma_k \to 0$ the highest. We introduce

$$M_k = \frac{n_k}{\gamma_k} = \frac{1}{\Gamma_k} \in [1, \infty] \tag{14}$$

as an indicator of firm k's production exceeding the level $1 - Y - c$ of the perfectly vertically integrated firm. This surplus production occurs because the n_k production

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[6]   *Higl (2003)* interpreted this insight in the context of strategic moves.

facilities of firm k do not fully internalize the external effects of their output decisions if $\gamma_k < n_k$. The degree of the surplus production is influenced by size and organizational structure of the firm.

Summing up the K replacement functions leads to

$$Y = \sum_{k=1}^{K} M_k (1 - Y - c) \tag{15}$$

and to a *Cournot-Nash* equilibrium output

$$Y = \frac{M(1-c)}{1+M}, \tag{16}$$

where M is defined as

$$M = \sum_{k=1}^{K} M_k \tag{17}$$

$M \in [K, \infty[$ is then a multiplicative measure of excess production of the whole industry over an oligopoly with perfectly integrated firms. Under perfect integration M equals K. Solving for the other equilibrium values, we get

$$p = \frac{1 + cM}{1 + M} \qquad Y_k = M_k \frac{(1-c)}{1+M}$$

$$\pi_k = \frac{M_k}{n_k} \left(\frac{1-c}{1+M} \right)^2 \tag{18}$$

$$\Pi_k = M_k \left(\frac{1-c}{1+M} \right)^2$$

where because of the symmetry of the factories we used π_k instead of π_{ik} to denote a single production facility's equilibrium profit level.

Notice an interesting property of the equilibrium solution which will be useful for further interpretations: The weight of a single firm M_k in the industry's total surplus production indicated by M corresponds to the firm's market share in equilibrium:

$$\frac{M_k}{M} = \frac{Y_k}{Y} \tag{19}$$

We are now in a position to use these results to take a look at mergers in this industry of firms with potentially differing degrees of internal coordination.

3   Merger Analysis

The base model presented and developed in the previous section can be applied to analyze merger in this industry. At least since the seminal work of *Salant, Switzer* and *Reynolds (1983)*, industrial economists have had a hard time finding and understanding reasons for horizontal mergers to be advantageous. Horizontal mergers which do not generate economies of scale or scope are only profitable if all or almost all competitors merge. Only sufficient convexity of costs can guarantee economic benefits from a bilat-

eral horizontal merger *(Perry* and *Porter 1985)*. Many of the arguments of this debate about the "merger puzzle" can be found e.g. in *Scherer (2002)* or *Neus (2002)*. What we want to do here is examine the impact of the internal structure of merging firms on the profitability of a merger. It turns out that horizontal mergers become more attractive than previously suggested by the standard results in the literature.

We now modify our notation slightly. Firms $f = 1,\dots,F$, $F \leq K$ are the ones which participate in a horizontal merger, whereas firms $k = F+1,\dots,K$ do not merge and remain independent oligopolists. We call the newly merged firm producer F^* which now competes in a $(K-F+1)$-firm oligopoly. The merged firm absorbs all factories of the participating merging firms, i.e.,[7]

$$n_F^* = \sum_{f=1}^{F} n_f \tag{20}$$

With regard to internal organization, the newly merged firm F^* chooses a new level of coordination γ_F^*. Mergers typically create opportunities to reorganize the merging firms. The structure is adapted to the new circumstances, for example processes are re-examined and often reorganized, but also production targets and quotas are set anew. Objectives and incentives inside the merged firm may differ from the ones used before merger.

As in most of the literature, we ignore potential cost effects of the merger, thereby considering a reference case. Instead, we focus on the impact of size – number of factories – and internal organization – degree of coordination of the factories – on the equilibrium.

If F firms merge, the factor M which affects all equilibrium values changes to M^*:

$$M^* = M - \sum_{f=1}^{F} M_f + M_F^* = M - \sum_{f=1}^{F} M_f + \frac{1}{\Gamma_F^*} \tag{21}$$

$\Gamma_F^* = \gamma_F^*/n_F^*$ is influenced both by the aggregate number of factories which we assume to be unaffected by the merger, and by the newly merged firm's level of internal coordination γ_F^* which it is free to choose at the occasion of the merger. For ease of notation we denote the aggregated parameters M_f of the F merging firms (the "insiders") by M_I.

If the new firm F^* adapts a very decentralized structure, $M^* > M$. With a more centralized organization we get $M^* < M$. Let ΔM denote the change in M as result of the merger, i.e.,

$$\Delta M = M_F^* - M_I = \frac{\sum_{f=1}^{F} n_f}{\gamma_F^*} - \sum_{f=1}^{F} \frac{n_f}{\gamma_f} \tag{22}$$

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[7] We do not claim that mergers will necessary leave the number of factories unchanged. However, since we are interested in the consequences of internal coordination, we treat the number of factories as given. Especially in case of cooperatives it seems plausible, that the total number of members remains unchanged.

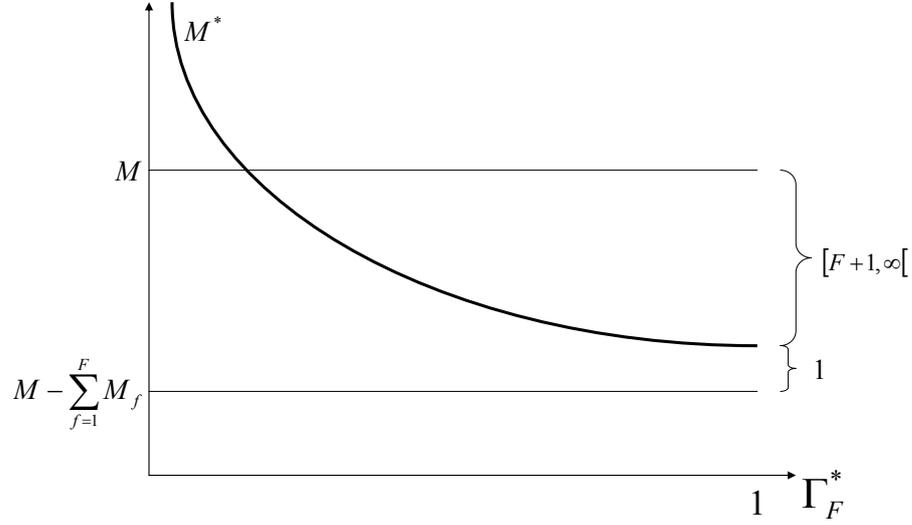Figure 1 exhibits the consequences of re-organizing a newly merged firm.

Figure 1: Impact of re-organization on M^*

We can now illustrate some stylized cases of mergers:

□ Merger between F perfectly vertically integrated firms ($M_f = 1$, $f = 1,\dots,F$) which create one new such firm. This is the typical case examined in the theoretical literature on horizontal mergers (see e.g. *Salant, Switzer* and *Reynolds 1983*). It implies $\Delta M = 1 - F < 0$.

□ Merger of F firms the production facilities of which initially have the same coordination parameter ($\gamma_1 = \dots = \gamma_F$) and still use the same parameter after the merger ($\gamma_F^* = \gamma_F$). This will leave M unchanged:

$$\Delta M = \frac{\sum_{f=1}^{F} n_f}{\gamma_F} - \sum_{f=1}^{F} \frac{n_f}{\gamma_F} = 0 \tag{23}$$

This should not be interpreted as keeping the old kind of organization in place. Instead, this only says that factories in the new, larger firm expect the same aggregate output reaction as before in a smaller, pre-merger firm. Notice that the merged firm indeed has a new parameter $\Gamma_F^* = \gamma_F/n_F$ which is below the parameter of each of the merging firms.

□ Merger of F firms having identical γ_f/n_f ($\Gamma_1 = \dots = \Gamma_F$). These firms then also had identical pre-merger factors M_f. Firms with identical numbers of factories in this setting have the same level of internal coordination, firms with a lower (higher) number of factories are more decentralized (centralized) in their output decisions. For the change in M we get

$$\Delta M = \frac{1}{\Gamma_F^*} - \frac{F}{\Gamma_F} \tag{24}$$

which may be greater or less than zero. More specifically,

$$\Delta M \begin{cases} < 0 & \text{if} \quad \dfrac{\Gamma_F}{\Gamma_F^*} < F \\[2ex] = 0 & \text{if} \quad \dfrac{\Gamma_F}{\Gamma_F^*} = F \\[2ex] > 0 & \text{if} \quad \dfrac{\Gamma_F}{\Gamma_F^*} > F \end{cases} \tag{25}$$

If the merger leads to a strong increase in decentralization, M will rise.

☐ Merger between only two firms (firms 1 and 2) with $\gamma_1/n_1 \neq \gamma_2/n_2$ ($\Gamma_1 \neq \Gamma_2$) where the merged firm adopts one of the two initial structures, e.g. firm 1's,

$$\Delta M = \frac{1}{\Gamma_1} - \frac{1}{\Gamma_1} - \frac{1}{\Gamma_2} < 0 \tag{26}$$

No matter which organizational structure is chosen, M will be lower after the merger.

To summarize, we state that in most cases a merger will be followed by a reduction in M. There are, however, exceptions if the merger coincides with a strong increase in decentralized decision making.

Let us now use our stylized representation of intra-firm organization and of mergers in an oligopolistic sector and look for implications of mergers for outsiders, i.e., firms not participating, insiders, and factories of the insiders. Recall that in the classical paper by *Salant, Switzer* and *Reynolds (1983)* outsiders always benefit from a merger, whereas insiders can only benefit, if almost the whole industry merges.

From (16) and the equilibrium price presented in (18) we know that Y and p in the market are only influenced by M for given cost and demand conditions. If a merger leads to a lower M ($\Delta M < 0$) which we consider the most likely case, output will decrease and price will go up:

$$\frac{dY}{dM} = \frac{1-c}{(1+M)^2} > 0 \qquad \frac{dp}{dM} = -\frac{1-c}{(1+M)^2} < 0 \tag{27}$$

If, however, M remains unchanged in a merger, there will be no price and output change. An increase of M corresponds to a significantly more decentralized firm, implying a welfare increase as result of the merger as in *Levin (1990)*.

If we look at outsiders, i.e., at those firms $k = F+1,\ldots,K$ which do not participate in the merger, we see that they are affected by a change in M, despite the fact that their internal parameters γ_k, n_k and M_k remain the same. A factory i_k of an outsider firm k faces a profit change

$$\frac{\partial \pi_k}{\partial M} = -\frac{2(1-c)^2}{\gamma_k (1+M)^3} < 0, \quad k = F+1,\ldots,K \tag{28}$$

as result of the merger of firms $1,\ldots,F$. This can immediately be aggregated into a statement on the profit of firm k as a whole. For $\Delta M < 0$ this is in line with the *Salant, Switzer* and *Reynolds (1983)* result. For a merger leading to significant decentralization ($\Delta M > 0$), however, outsiders may suffer from the merger, because the new firm under its loose organizational structure floods the market with additional output.

Turning to insiders, i.e., the firms $f = 1,\ldots,F$ participating in the merger, we first take a look at the firms themselves, before we compare their profits to those of the outsiders. In order to evaluate the profitability of a merger, we compare the profit of the merged firm F Π_F^* to the sum of all pre-merger profits Π_f, $f = 1,\ldots,F$.[8] The change in profit is given by

$$\Delta\Pi_F = \Pi_F^* - \sum_{f=1}^{F}\Pi_f = (1-c)^2\left(\frac{M_F^*}{(1+M+\Delta M)^2} - \frac{\sum_{f=1}^{F}M_f}{(1+M)^2}\right) \tag{29}$$

which after inserting (22) can be written as

$$\Delta\Pi_F = (1-c)^2\left(\frac{M_F^*}{(1+M+M_f^*-M_I)^2} - \frac{M_I}{(1+M)^2}\right) \tag{30}$$

Inspection of this term shows that a merger is profitable ($\Delta\Pi_F > 0$), if the merged firm's structural parameter Γ_F^* is between the two bounds defined by

$$\underline{\Gamma}_F^* = \frac{1}{M_I} \quad\Leftrightarrow\quad M_F^* = M_I \tag{31}$$

and

$$\overline{\Gamma}_F^* = \begin{cases} \dfrac{M_I}{(1+M-M_I)^2} & \text{if } \overline{\Gamma}_F^* < 1 \\[2mm] 1 & \text{else} \end{cases} \tag{32}$$

The change in profit reaches its maximum for

$$\widetilde{\Gamma}_F^* = \frac{1}{1+M-M_I} \tag{33}$$

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8   We do not consider issues of distribution of profits within the new firm. There can be a conflict between merger profitability from the perspective of headquarters and merger profitability as seen from the angle of a factory manager (or member of a marketing cooperative). I.e., a merger can be beneficial for the merged firm and still be disadvantageous for the production facilities of some merging firms due to different organisational structures and size. Without side payments, production facilities having a lot of control like members of cooperatives will prevent a merger. We call a merger profitable if gains for all factories can be implemented by redistribution of profits.

By choosing Γ_F^*, i.e., its degree of (de-)centralization, appropriately, the newly merged firm can ensure the economic success of the horizontal merger. Lack of consideration for the internal organization of firms can therefore be considered one more reason why the *Salant, Switzer* and *Reynolds (1983)* result is too pessimistic about the profitability of a horizontal merger. Mergers can be made profitable even without synergies.

Notice some important implications of our analysis:

The profitable area where $\Delta\Pi_F > 0$ is influenced by the total production multiplier M and the weight of insiders M_I and outsiders $(M - M_I)$.

A closer look at the bounds (31) and (32) shows, that at $\underline{\Gamma}_F^*$, M remains unchanged, i.e. $\Delta M = 0$. The second bound $\overline{\Gamma}_F^*$ coincides with $\underline{\Gamma}_F^*$ and $\widetilde{\Gamma}_F^*$ at

$$M_I = \frac{1+M}{2} \tag{34}$$

Using (19), this can be rearranged to

$$\frac{Y_I}{Y} = \frac{1}{2} + \frac{1}{2M} \tag{35}$$

The results differ depending on the initial market share Y_I / Y of the merging firms. The "critical" market share (35) of these firms depends on excess production M as previously defined. For low values of M the critical value is high, for "wide" markets it converges to 50 percent.

If the initial market share of the merging firms is sufficiently high, $\overline{\Gamma}_F^*$ is the upper bound of the profitable area. Profitable mergers then go along with less aggregate output, i.e., $\Delta M < 0$. From (28) we know that in this case outsiders will also enjoy gains from the merger.

If the market share of the merging firms is lower than (35), $\overline{\Gamma}_F^*$ is smaller than $\underline{\Gamma}_F^*$. In this case, a profitable merger implies $\Delta M > 0$. The merged firm floods the market and gains additional profits at the expense of outsiders, while consumer surplus rises.

(33) implies that perfect vertical integration is only optimal for a monopoly. The smaller the merging firms' share of the total market (measured by M), the more decentralized their decision making ought to be.

We also observe that the lower bound is always greater than zero. A behaviour of factories analogous to price-taking can therefore never be optimal. It always pays to introduce some extent of coordination.

There are two potential reasons for mergers to be beneficial from the insiders' perspective: First, for mergers reducing aggregate output significantly, coordination within the firm is advantageous. Second, for small-scale mergers increased decentralization can induce a more aggressive behaviour, leading to a defensive reaction of competitors and to a higher profit. If we look at *Salant, Switzer* and *Reynolds (1983)*, we only find the first effect because they do not consider the internal structure of firms. If we assume only perfectly vertically integrated firms, i.e., $\Gamma_k = 1$, $M = K$, and $M_I = F$, in our

model, we get the same condition for a profitable merger as *Salant, Switzer* and *Reynolds (1983)* which is $(1+K)^2 > (2+K-F)^2 F$.

If a firm is perfectly vertically integrated, under our assumption of constant marginal costs its behaviour is not affected by the number of production facilities. However, if factories have their own say in production decisions and can affect total output of the firm, their number matters. This effect becomes stronger, as the number of production facilities rises: M_F^* increases in n_F^* for $\Gamma_F^* < 1$. There is an advantage to size which creates a motivation for mergers. Mergers are therefore more often profitable than suggested by the model of *Salant, Switzer* and *Reynolds (1983)*. For all parameter constellations a potential for the merged firm to generate a profit higher than the aggregate of pre-merger profits by choosing an appropriate level of decentralization exists.

We conclude that mergers which are mainly driven by the desire to create market power in the traditional sense can be beneficial for both insiders and outsiders. The more mergers take into account the strategic effects of decentralization, the more insiders will benefit at the expense of outsiders.

Let us now compare outsiders to insiders. The literature suggests, that outsiders are always better off than participating firms. The result is driven by the fact, that in *Cournot* oligopoly merging firms lower their output, while outsiders react with a (smaller) output increase (*Farrell* and *Shapiro 1990*, p. 111). In our model a second force operates in favour of insiders: With reorganization the merged firm can adjust to the new market conditions and may gain at the expense of outsiders due to a strategic effect.

To compare the profit consequences, we assume that the new firm chooses its optimal organizational level $\widetilde{\Gamma}_F^*$. Inserting (33) in (29) yields

$$\Delta\widetilde{\Pi}_F = \frac{(1-c)^2(1+M-2M_I)^2}{4(1+M)^2(1+M-M_I)} \tag{36}$$

The profitability of a merger for insiders is shown for a given M by the bold line in figure 2.

The difference between outsiders' aggregate profits before and after the merger is

$$\Delta\Pi_K = (1-c)^2\left(\frac{M+\Delta M - M_F^*}{(1+M+\Delta M)^2} - \frac{M-M_I}{(1+M)^2}\right) \tag{37}$$

From (33) and (22) we get

$$\Delta\widetilde{\Pi}_K = (1-c)^2(M-M_I)\left(\frac{1}{(2+2M-2M_I)^2} - \frac{1}{(1+M)^2}\right) \tag{38}$$

The profitability for outsiders $\Delta\Pi_K^*$ for a given M is represented by the dashed line in figure 2.
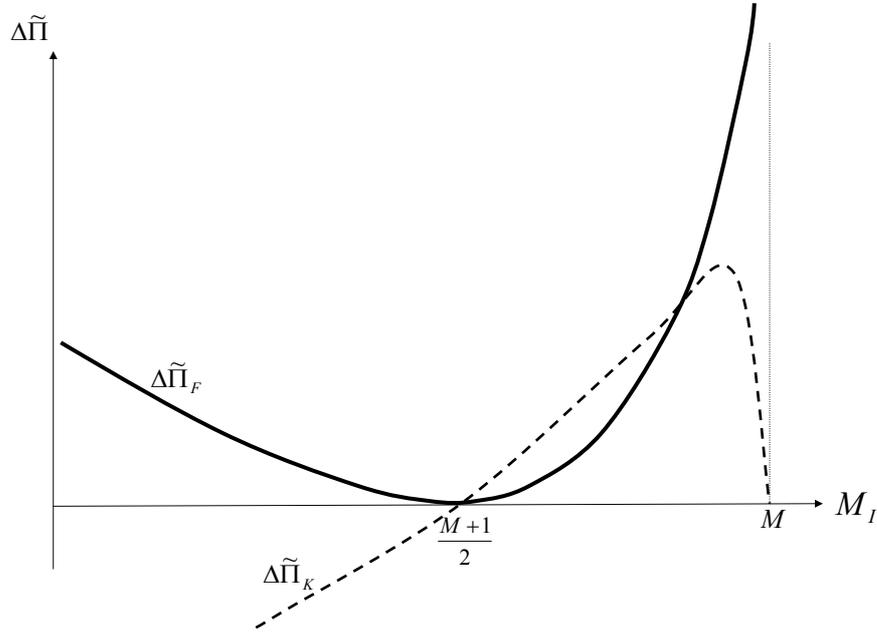
Figure 2: Profitability of mergers depending on the weight of the merging firms

Insiders' and outsiders' profits depend on the initial market shares of the merging firms. For

$$\frac{1+M}{2} \leq M_I \leq \frac{3}{4} + M - \frac{1}{4}\sqrt{5+4M} \tag{39}$$

$$\Leftrightarrow \quad \frac{1+M}{2M} \leq \frac{Y_I}{Y} \leq \frac{3}{4M} + 1 - \frac{\sqrt{5+4M}}{4M} \tag{40}$$

profit gains of outsiders exceed insiders' advantages.

From (34) we know that at the lower bound of (39) M remains constant. Below, i.e., when mergers include a smaller market share, we already know that the merger takes place at the expense of outsiders.

If M_I exceeds the lower bound, outsiders always gain from merger. Their advantages exceed insiders' profit gains unless almost the whole market merges, i.e., the weight of merging firms exceeds the upper bound of (39).

To explain these results consider the two antipodal effects of a merger: output effects due to concentration, i.e. a lower number of firms after the merger, and decentralization due to reorganization. Between the two bounds (39) the concentration effect which is in favour of outsiders overcompensates the effect due to decentralization of the new firm. In the other cases, the new firm will gain additional profits due to the strategic effect of decentralization accompanied by disadvantages for outsiders.

Figure 3 summarizes our results and relates them graphically to important contributions in the literature. We have shown that a merger can always be profitable, if the new firm chooses an appropriate organizational design. Moreover, we are able to identify winners

and losers of a merger. Market size and market share of merging firms are crucial for these results: For a "big" merger (i.e., mergers in the areas I, II, and III of the diagram) all firms gain, while consumer surplus and total welfare decline. "Small" mergers, i.e., mergers in sectors IV and V, are welfare increasing at the expense of outsiders. Notice that mergers located in sector V are the ones identified as profitable by *Creane* and *Davidson (2004)* due to increased aggressiveness of the merged firm. For the regions labeled II and III in figure 3 outsiders will be better off. We also find a region of "large" mergers, where insiders are better off, denoted by I in figure 3. Notice that for the mergers in region I which are considered profitable as in the model of *Salant, Switzer* and *Reynolds (1983)* (SSR), we conclude that insiders gain more than outsiders which which differs from the standard SSR result. In figure 3 profitable mergers in sense of *Salant, Switzer* and *Reynolds* can be found in sectors I and II.
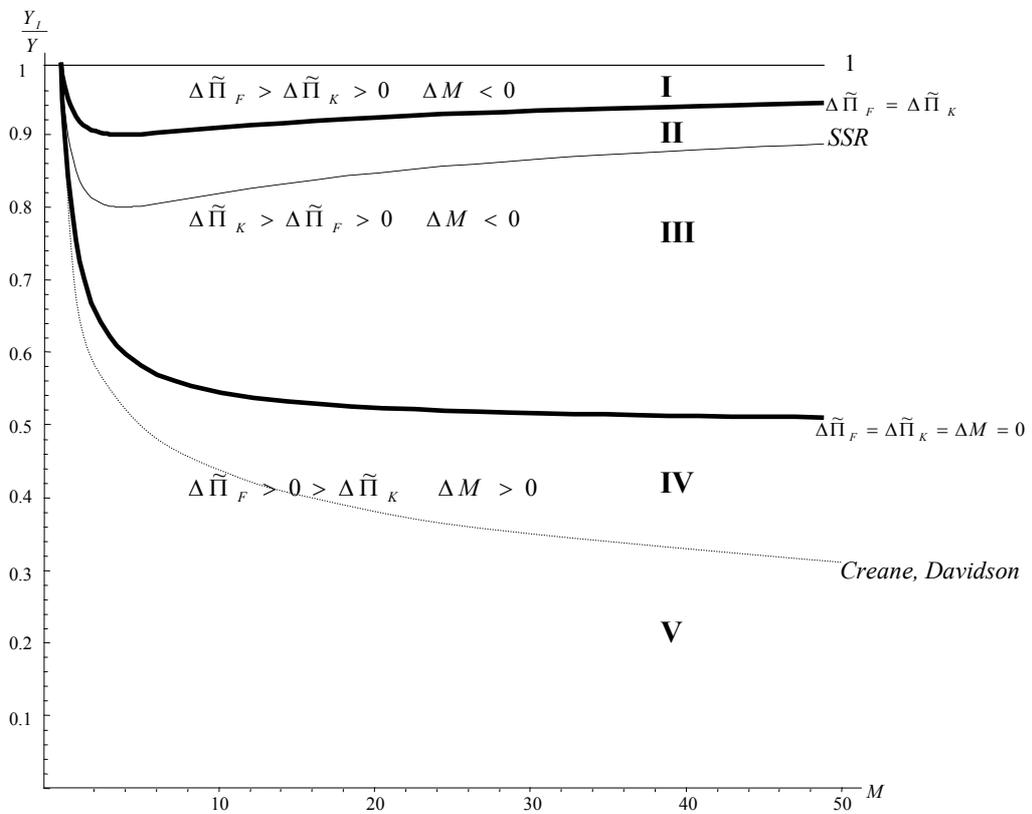

Figure 3: Profitability of mergers depending on of initial market share of merging firms

We conclude that the effects of a merger depend crucially of the choice of internal organization. Horizontal mergers can always be made profitable. By an appropriate choice of internal coordination. However, the extent of profitability and the relation of insiders' to outsiders' profits also depends on the size of a merger. This suggests an analysis of endogenous mergers which is beyond the scope of our present paper. It is apparent that outsiders in regions I, IV, and V of figure 3 have a strong incentive to join the merger, while in II and III insiders would rather leave the merger project. An analysis of endogenous mergers requires additional assumptions about the way mergers are created

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and about the informational structure of the game involved.[9] These questions will be left to further work.

4 Conclusion

We looked at the vertical structure of oligopolistic firms which may differ in size and in their intra-firm coordination of output decisions. Perfect vertical integration in this framework is not optimal from a strategic point of view. Nor is full decentralization. The optimal level of decentralization is to be found somewhere in-between at hybrid organizational forms. The model of asymmetric oligopolistic firms with a vertical structure was used to analyze mergers of any number of firms in an industry. Our results are driven by a strategic effect of a higher number of factories and of decentralization and by increased concentration in case of a merger. Using the concept of a replacement function as a tool to derive explicit equilibria for asymmetric oligopolies, we derived equilibrium values and evaluated the impact of a merger even if firms differed in their internal organization and/or size.

Horizontal mergers turned out to be profitable under much more general conditions than usually presented in the literature. The extent of intra-firm coordination which we captured by a simple parameter turned out to be very important for the evaluation of a merger project. Decentralization tends to make a merger more profitable and allows for mergers of only a small number of firms which were not considered viable in the previous literature. Our results support rules in competition policy which allow small-scale mergers but prevent large-scale mergers. Furthermore, our analysis suggests that internal organization matters for the economic effects of a merger. Decentralized decision making in merged firms reduces the danger of negative welfare consequences. This supports special exemptions for cooperative firms.

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[9] See e.g. *Kamien* and *Zang (1990)*, *Horn* and *Persson (2001)*, *Fridolfsson* and *Stennek (2000, 2004)*, *Nilssen* and *Sørgard (1998)*.

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