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On merger in a collusive Stackelberg market

Marc Escrihuela-Villar
Universitat de les Illes Balears

Abstract

This note shows that the profitability of a merger between a leader and a follower in a Stackelberg market crucially depends on the degree of collusion among leaders. When leaders cut production in order to raise the price, followers have lower incentives to merge with the leaders since by standing alone they can free ride on the output-reducing effort of the cartel formed by the leaders. As a consequence, one might expect that followers will only be absorbed by leaders if the competition among leaders is sufficiently intense.

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Contact: Marc Escrihuela-Villar - marc.escrihuela@uib.es.

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1 Introduction

In a symmetric linear Cournot oligopoly setting with homogenous goods, Salant, Switzer and Reynolds (1983) showed that mergers are generally not profitable since the minimum profitable merger involves at least 80 percent of the firms in the industry. Unprofitability comes from the fact that non-merging firms react to the merger by increasing their output. Mergers, therefore, create an incentive to free ride as outsiders often benefit from the merger more than participants.[1] Many papers have subsequently tried to solve this paradox by changing some of the original assumptions. For instance, in the Stackelberg model with linear demand and symmetric cost functions, Daughety (1990) showed that the merger of two followers resulting in a leader firm is potentially profitable, and Huck, Konrad and Müller (2001) (henceforth, HKM) showed that mergers between a leader and a follower are unambiguously profitable. Another example is Heywood and McGinty (2007) who show that with convex costs mergers between leaders and followers are profitable. In some cases, thus, the leadership assumption has been sufficient to solve the merger paradox. This literature, however, leaves out the pre-merger competitive intensity and assumes Cournot behavior among firms of the same group. In this paper, the standard linear Stackelberg model is modified to allow for the possibility of collusive behavior among the leaders to study to what extent the competitive intensity is a crucial determinant of merger profitability.

We develop a multi-period oligopoly model with homogeneous and quantity-setting firms an exogenous subset of which are assumed to collude. The remaining (fringe) firms choose their output levels non-cooperatively after having observed the cartel output. We use subgame perfect Nash equilibria (henceforth, SPNE) as solution concept. It is well known that this repeated game setting exhibits multiple SPNE collusive agreements. Therefore, to select among those equilibria and following Verboven (1997) and Escrihuela-Villar (2008), we adopt the particular criterion of (i) restricting strategies to grim "trigger strategies", and (ii) choosing the cartel firms' profit maximizing allocation for each possible value of the discount factor, which means that leaders may coordinate their output even when (given their discount factor) the unrestricted joint profit maximization agreement does not correspond to a SPNE of the repeated game. We show that in a Stackelberg

[1] This well known result has been sometimes called the "merger paradox". In fact, the profitability of horizontal merger depends on the degree of concavity of cost and demand functions (see for instance Perry and Porter 1985).

model a leader-follower merger is only profitable if the degree of collusion among the leaders is not too high. The intuition behind is that, by colluding, cartel firms reduce their output and hence fringe firms expand theirs having consequently fewer incentives to be absorbed by cartel firms and become a leader. This result is consistent with the fact that it has been quite common for cartels to take reprisals against unwilling outsiders (like the "exclusive trading" clauses) instead of buying-up competing firms (see Bos 2009).

From an empirical point of view quite a few real-world examples of cartels distill several stylized facts that support the assumptions we made. These examples suggest for instance that (i) cartels are often not all-inclusive, (ii) incomplete cartels often comprise the larger firms in the industry[2] and (iii) cartels may have successfully restricted competition, but at the same time failed to set joint profit-maximizing prices.[3] On the other hand, and from a theoretical point of view, the assumption of cartel leadership is justified by the fact that an endogenous sequence of play between a stable cartel and a Cournot fringe will assign a leader's role to the cartel and a follower's role to the fringe (see Shaffer (1995)).

2 Model and result

We consider an industry with N firms. Each firm produces a quantity of a homogeneous product and we normalize production costs to zero. The industry inverse demand is given by the piecewise linear function, $p(Q) = \max\{0, 1 - Q\}$ where Q is the industry output and p is the output price. We assume that $K \in \{2, 3, ...N\}$ firms (henceforth, cartel firms) behave cooperatively so as to maximize their joint profits. The remaining $(N - K)$ firms constitute the fringe and choose their output in a non-cooperative way.[4] We assume that firms compete repeatedly over an infinite horizon with complete information and discount the future using a discount factor $\delta \in [0, 1)$. As mentioned before, we follow the cartel and fringe literature assuming that in each period the cartel behaves as a

[2] As an example, three North-American and five European firms in the citric acid industry were fined for fixing prices and allocating sales in the worldwide market. Their joint market share was around 60 percent. The rest of the producers included a variety of minor companies based in Eastern Europe, Russia and China (see Levenstein and Suslow 2006).

[3] See the study conducted by Porter (1983) about a cartel known as the Joint Executive Committee.

[4] We take K as exogenously fixed. This assumption is based on the fact that cartels often involve an agreement between firms which can easily coordinate with each other (e.g. because they are based in the same country or have a common corporate culture). The fringe consists of foreign firms or new entrants that could not coordinate their behavior with the cartel firms even if they wish so.

Stackelberg leader with respect to the fringe.[5] Following Friedman (1971), we restrict our attention to the case where each cartel firm is only allowed to follow grim trigger strategies. In words, these strategies are such that cartel firms adhere to the collusive agreement until there is a defection, in which case they revert forever to the static non-cooperative Stackelberg equilibrium with K leaders and $(N-K)$ followers. Regarding fringe firms, their optimal response consists of maximizing their current period's payoff, in such a way that if each cartel firm produces q, then the output produced by each fringe firm, that we denote by q_f, is $q_f = \max\{0, \frac{1-Kq}{N-K+1}\}$. The profit function of cartel and fringe firms are given respectively by $\Pi^c(N,K,q) = (1-Kq-(N-K)q_f)q$ and $\Pi^f(N,K,q) = (1-Kq-(N-K)q_f)q_f$. As shown by Friedman (1971), cartel firms producing q in each period can be sustained as a SPNE of the repeated game if and only if for given values of N, K and δ, the following condition is satisfied

$$\frac{\Pi^c(N,K,q)}{1-\delta} \geq \Pi^d(N,K,q) + \frac{\delta\Pi^s(N,K)}{1-\delta} \tag{1}$$

where $\Pi^d(N,K,q)$ denotes the profits attained by an optimal deviation from a collusive output q, and $\Pi^s(N,K)$ denotes the non-cooperative Stackelberg equilibrium profits for the leaders. Multiplicity of equilibria is obtained since condition (1) is satisfied for different collusive outputs. To select among such equilibria, we follow Verboven (1997) and Escrihuela-Villar (2008) choosing the profit maximizing allocation for the cartel (i.e. the allocation that solves the problem: $\max_q \Pi^c(N,K,q)$ subject to (1)). Then, if δ exceeds a certain critical level, (1) is not a binding constraint, and the distribution of output in the cartel is the symmetric distribution of the output of a unique Stackelberg leader ($q = \frac{1}{2K}$). Let us denote this critical level of the discount factor by $\bar{\delta}$. It is a standard exercise to verify that $\bar{\delta} = \frac{(1+K)^2}{1+K(6+K)}$. Then, if $\delta < \bar{\delta}$, (1) is a binding constraint and the distribution of output is the solution to the equality constraint in (1). In this case the equilibrium quantities and profits depend on δ and the discount factor can be interpreted as the degree of collusion of the market.[6] Since the present model encompasses the HKM case if $\delta = 0$, we can check whether their results are sensitive to the assumption of pre-merger competitive behavior. We consider a merger of one cartel and one fringe firm that

[5] The seminal papers in this literature are Selten (1973) and d' Aspremont et al. (1983) in a static model, and Martin (1993) in a dynamic setting.

[6] We note that in a collusive equilibrium cartel firms are willing to produce less than in the standard Stackelberg equilibrium ($\frac{\partial q}{\partial \delta} < 0$) and one can also check that profits of cartel firms are enhanced by cartelization ($\frac{\partial \Pi^c}{\partial \delta} > 0$).

becomes a leader.[7] We denote their incentive to merge by

$$\Pi^c(N-1, K, q(N-1, K, \delta)) - \Pi^f(N, K, q(N, K, \delta)) - \Pi^c(N, K, q(N, K, \delta)). \qquad (2)$$

As shown in the appendix,[8]

Proposition 1 *Merger between a cartel and a fringe firm is only profitable if* $\delta < \delta^* \equiv \frac{1+K(2+K)}{K(6+K-4K^2)+4N(K^2-1)-3}$.

The result can be interpreted using HKM title's metaphor; one big fish eats one small fish but only whenever the big fish is big enough. The intuition is the following. Obviously cartel firms always have an incentive to absorb fringe firms in order to shift residual demand upwards. On the other hand, if the degree of collusion among cartel firms increases, cartel firms cut production and fringe firms react by expanding their production. Consequently, followers have fewer incentives to become a leader through the merger. In other words, the followers' incentive to free ride on the effort of cartel firms to cut production is reinforced if the degree of collusion increases rendering unprofitable the type of merger considered here. Interestingly, for the merger to be unprofitable it is not necessary that cartel firms produce less than fringe firms, that is to say, $q(N, K, \delta) > q_f(N, K, \delta)\ \forall \delta \in [0, \delta')$ with $\delta' > \delta^*$ where δ^*, as defined in Proposition 1, is the maximum possible value of the discount factor for the merger to be profitable.

3 Concluding comments

The purpose of this note is to analyze the effect of the degree of collusion on merger profitability between leaders and followers in the Stackelberg model a problem that, to the best of our knowledge, has not been considered. We show that merger in Stackelberg markets between a leader and a follower is not always profitable when the leaders have the

[7]We assume that if a leader merges with a follower the new firm will stay a leader mainly for two reasons: (i) the merged firm can still use the old commitment technology of the former leader firm and (ii) it can be verified that the merged firm would always rather be leader than follower.

[8]Admittedly, discount factors are primitives and although we build a direct link to collusive behavior, the reader might feel more comfortable when such link is made explicit and based on behavioral assumptions. To that extent, we prove in the appendix that our result also holds in a static model where the leaders strategy set is $q \in [\frac{1}{2K}, \frac{1}{K+1}]$ (a quantity in the interval between full collusion and the quantity produced by leaders in the standard Stackelberg model).

possibility to collude among themselves. The point is that when leaders cut production in order to raise the price, followers have fewer incentives to become a leader. That is to say, a follower's value if integrated in a collusive leader firm may not exceed its value as a stand-alone firm since in this case the follower is able to free ride on the effort of the leaders to cut production. In this regard, a stylized fact of the empirical cartel literature suggests (see for instance Bos 2009) that incomplete cartels tend to lose market share over time. The present note thus highlights that even though cartel firms could have incentives to absorb fringe firms, it is precisely the success of collusion what could prevent these mergers from taking place.

One question this note does not address is the extension to a wider range of cost functions. Following the logic of Perry and Porter's (1985), however, it seems clear that if costs were convex mergers between leaders and followers would be all the more profitable. In an asymmetric and linear cost function setting, Escrihuela-Villar and Faulí-Oller (2008) have already shown that a merger between a leader and several followers is always profitable regardless of the degree of cost asymmetry. On the other hand, mergers among firms of the same subset (either leaders or followers) are not considered. The reason is that cartel and fringe firms basically compete in quantities against each other facing a residual demand, and Rodrigues (2001) and Escrihuela-Villar (2008) have already shown that, in this case, the unprofitability of mergers is intensified by the degree of collusion. Finally, the limited context of the present model is acknowledged: to analyze real-world cases of collusion a wider range of demand functions or capacity constraints should also be considered.

Appendix

Proof of Proposition 1. It is a standard exercise to verify that

$$q(N,K,\delta)=\begin{cases}\frac{K(2+K)(\delta-1)-3\delta-1}{(K-1)^2(1+K)\delta-(1+K)^3} & \text{if } \delta<\bar{\delta}\\ \frac{1}{2K} & \text{if } \delta\geq\bar{\delta}\end{cases}$$

$$q_f(N,K,\delta)=\begin{cases}\frac{(1+K)^2+(K-1)(1+3K)\delta}{(1+K)(-1+K-N)((K-1)^2\delta-(1+K)^2)} & \text{if } \delta<\bar{\delta}\\ \frac{2-K^2}{2(N-K+1)} & \text{if } \delta\geq\bar{\delta}\end{cases}.$$

If we replace $q(N,K,\delta)$ and $q_f(N,K,\delta)$ in the profit functions of cartel and fringe firms, we obtain in (2) the incentive to merge: a merger is profitable if $\frac{[(1+K)^2+(K-1)(1+3K)\delta][(1+K)^2+(K-1)\delta(3(K-1)+4K^2-4(1+K)N)]}{(1+K)^2(N-K)(1-K+N)^2[(1+K)^2-(K-1)^2\delta]^2}>0$. Note that when $\delta=0$, the last expression boils down to $\frac{1}{(1+K)^2(N-K)(1-K+N)^2}$ reproducing Proposition 2 of HKM. We can check that the unique root in δ of (2) is given by $\delta^* = \frac{1+K(2+K)}{K(6+K-4K^2)+4N(K^2-1)-3}$ where it is tedious but straightforward to show that $\bar{\delta}-\delta^* = \frac{4(1+K)^3(1-K(N-K+1)+N)}{(K-1)(1+K(6+K))(3(K-1)-4K(N-K)-4N)} > 0$. ∎

We consider here a static model where the strategy set of cartel firms is $q \in [\frac{1}{2K}, \frac{1}{K+1}]$. Hence, we reproduce a situation where cartel firms maximize joint profits subject to a certain exogenous constraint so that they might only be able to partially collude. Then, if cartel firms' choice is such that $q \longrightarrow \frac{1}{2K}$ we obtain the leaders' unconstrained joint profit maximizing allocation (full collusion) and as $q \longrightarrow \frac{1}{K+1}$ the model reproduces the HKM case where the leaders compete among themselves à la Cournot. Then, since the best reaction function of fringe firms is $q_f = \frac{1-Kq}{N-K+1}$, profit functions of cartel and fringe firms are given respectively by $\Pi^c(N,K,q) = \frac{q(1-Kq)}{N-K+1}$ and $\Pi^f(N,K,q) = \frac{(-1+Kq)^2}{(N-K+1)^2}$. Observe that Π^c decreases with q in the range considered and it is maximized at $q = \frac{1}{2K}$. Note also that in the Stackelberg model, regardless of whether leaders collude or not, the quantity produced by them does not depend on the number of followers. Therefore, the incentive to merge is given by $\Pi^c(N-1,K,q)-\Pi^f(N,K,q)-\Pi^c(N,K,q) = \frac{(1-Kq)((N-K)(q(1+K)-1)+q)}{(N-K)(N-K+1)^2}$. This expression is positive if $q > \frac{N-K}{(1+K)(N-K)+1}$ where $\frac{1}{2K} < \frac{N-K}{(1+K)(N-K)+1} < \frac{1}{K+1}$ $\forall 1 \leq K \leq N-1$. Finally, we can verify that this result is exactly equivalent to Proposition 1 as long as $q(N,K,\delta^*) = \frac{N-K}{(1+K)(N-K)+1}$.

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