

A Theory of Strategic Mergers*

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Abstract

Past empirical studies find that merger intensity is related to industry-wide economic, technological, and regulatory shocks. In this paper we examine how industry demand shocks affect firms' strategic incentives to merge horizontally. Using a real options approach, we show that mergers following from strategic considerations are consistent with the abnormally high takeover intensity during periods of especially high and low demand. This result is driven by the interaction among firms in output markets and it holds in the absence of any technological and financial benefits of mergers. Consistent with the model, we find empirical evidence of a U-shaped relation between demand shocks, as proxied by industry sales growth, and the propensity of firms to merge, even when non-strategic incentives to merge are controlled for. This relation is driven by horizontal mergers within relatively concentrated industries. Our theoretical and empirical results shed some light on the determinants of merger waves.

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1 Introduction and related literature

Recent years have witnessed an explosion of research on mergers, in particular investigations of the reasons for and the timing of mergers and takeovers. We have satisfactory answers for some merger-related questions, for example those about the effects of mergers on bidders' and targets' values. However, as Andrade, Mitchell and Stafford (2001) note in their survey paper, "on the issue of why mergers occur, research success has been more limited."

Various reasons for why firms merge have been proposed. The list includes efficiency-related gains, disciplining target management, spreading new technology, and changes in industry structure. While there is a debate about the merits and deficiencies of each of the proposed explanations of mergers, there seems to be a consensus on some important aspects of merger activity: mergers happen in waves and, within each wave, they tend to cluster by industry.¹ Yet, why this is the case remains an open question. Brealey, Myers and Allen (2006) go so far as to suggest that why merger waves occur is one of ten most important unresolved questions in corporate finance.

Several theories have been put forward to explain merger waves. Lambrecht (2004) examines mergers motivated by operational synergies and predicts pro-cyclical mergers. In his model mergers are likely to happen in periods of economic expansion. Maksimovic and Phillips (2001) show that mergers and asset sales are more likely following positive demand shocks, causing pro-cyclical merger and acquisition waves in perfectly competitive industries. The mechanism in their paper that gives this result is that higher quality firms buy lower quality ones when the marginal returns from adding capacity are great enough to outweigh decreasing returns to managerial skill. In Lambrecht and Myers (2006), takeovers serve as a mechanism to force disinvestment in declining industries. Their arguments lead to takeover transactions occurring mostly in industries that have experienced negative economic shocks.

A few recent papers link takeover activity to stock market misvaluation. In Shleifer

¹See Harford (2005), Rhodes-Kropf and Viswanathan (2004), Mitchell and Mulherin (1996), and Melicher, Ledolter and D'Antonio (1983) for discussions of empirical evidence of merger waves.

and Vishny (2003), rational managers exploit the misvaluation of less-than-rational investors. Rhodes-Kropf and Viswanathan (2004) and Rhodes-Kropf, Robinson and Viswanathan (2006) show theoretically and empirically that merger activity is correlated with high market valuations, causing overvalued bidders to make stock bids that are more likely to be accepted by targets.

We extend the merger literature by proposing a model that links takeovers with the industry competitive structure and investigates strategic incentives to merge. Firms merge for various reasons, and strategic considerations are only one of the reasons to merge. However, to highlight the relation between the industry structure and takeover activity, we purposely abstract from potential operational or financial synergies and focus on purely strategic motives for mergers. While the papers discussed above propose different motives for merging in periods of economic expansions and recessions, we show that within oligopolistic industries strategic incentives can lead to horizontal mergers occurring *both* in periods of rising and declining demand.

The intuition behind this result is rather simple. *Ceteris paribus*, a horizontal merger increases the combined value of the merging firms, due to the post-merger collusion in output markets. However, the reduced competitiveness of the industry following the merger also increases the value of a potential entrant to the industry and its incentives to enter.² Potential entry reduces the value of the incumbents and, thus, affects their incentives to combine operations.

When an industry is in expansion, the value of the entry option is high regardless of the industry structure, and the incumbents can not deter entry by not merging. When an industry is in recession, entry is unprofitable regardless of the incumbents' decision whether to merge or to stay separate. Thus, at the two extremes, the incumbents' decision to merge has a limited effect on the entry decision, and the effect of increased merging firms' combined value as a result of post-merger collusion dominates the decision to merge. In intermediate states, the merger decision affects the profitability

²This effect of merger on the value of potential entrant is not only a clear result of an oligopolistic competition model, but has been documented empirically by Berger, Bonime, Goldberg and White (2004) and Eckbo (1983). See the discussion below.

of potential entry, and the incumbents can be better off not merging in order to deter entry.

The main contribution of this paper to the theoretical merger literature is an introduction of a new motive for merging horizontally and of a new link between the shocks to industry demand and firms' incentives to merge. In our model, mergers are driven by purely strategic considerations, as opposed to technological or financial ones. Importantly, the relation between demand shocks and merger waves in our model is obtained without relying on costly mergers (as in Lambrecht (2004)) or on leverage and golden parachutes (as in Lambrecht and Myers (2006)).

The prediction of the model that mergers are more likely to occur in periods of extreme (both positive and negative) shocks is consistent with the existence of merger waves and their industry clustering. As long as firms in an industry are subject to correlated shocks, their incentives to initiate mergers would be similar, and we would observe industry clustering of mergers. Also, as long as different industries are subject to correlated shocks, we would observe economy-wide merger waves.

Our model adopts a continuous time real options framework and relates to several models of takeovers that are developed in a similar setting. Morellec and Zhdanov (2005) develop a real options model that focuses on abnormal returns around merger announcements and incorporates imperfect information and competition among bidding firms. Leland (2005) examines the role of purely financial synergies in motivating mergers. Magsiri, Mello and Ruckes' (2005) dynamic model accounts for both takeover transactions and internal growth.

Several articles examine entry into an industry within a dynamic setting. However, they do not incorporate the possibility of a merger initiated by incumbents. Dixit (1989) studies the optimal entry and exit strategies of firms in a duopoly setting. Baldursson (1998) and Grenadier (2002) examine the case of continuous investments in an oligopoly by focusing on symmetric Nash Equilibrium strategies. Lambrecht (2001) and Fries, Miller and Perraudin (1997) examine the interaction of the dynamic entry into an industry and firms' financing strategies.

Other papers develop theoretical models, which examine the links between incumbents' incentives to merge and outsiders' incentives to enter the industry. However, they typically do not examine the dynamics of industry shocks and their impact on the strategic incentives to merge. Consequently, they do not generate implications on merger waves in both declining and rising industries. Examples include Cabral (2003), Marino and Zájbojník (2006), Toxvaerd (2004), and Werden and Froeb (1998).³

We contribute to the empirical merger literature by showing that the existing evidence of the relation between economic shocks and merger intensity, documented in Mitchell and Mulherin (1996), Andrade and Stafford (2004), and Harford (2005), is partially driven by the effect of demand shocks on firms' incentives to merge horizontally. We demonstrate that the U-shaped relation between horizontal merger intensity and shocks to industry demand is present in relatively concentrated industries and is absent in relatively competitive ones. This evidence is consistent with our model, which predicts that, *ceteris paribus*, horizontal mergers within oligopolistic industries are more likely to occur in times of high and low demand relative to times of intermediate demand.

The remainder of the paper is organized as follows. The next section presents the model and its empirical implications. Section 3 discusses our sample of mergers and acquisitions and presents some empirical tests that aim at distinguishing the competitive-structure-based explanation of the relation between industry shocks and merger intensity from the traditional technology-based explanations. Section 4 summarizes our theoretical and empirical results and concludes. All proofs are provided in Appendix 1. Appendix 2 presents an extension of the model to the case of a different type of product market competition and demonstrates that the results are robust to the choice of the type of competition.

³See also Erard and Schaller (2002) for a model in which acquisitions are treated as an alternative way of obtaining capital goods and Gowrisankaran (1999) for a model in which merger, investment, exit, and entry are jointly determined in a perfectly competitive equilibrium.

2 The model

2.1 Setup

In order to incorporate the dynamics of mergers, we model firms' merger and entry decisions in continuous time. The model is based on the following assumptions.

Assumption 1 There are two incumbents in the industry. Each incumbent is endowed with capital, K . In addition to the two incumbents, an entry by one firm is allowed, with the amount of capital K as well. The firms' production functions are of the Cobb-Douglas specification with two factors:

$$q_i = \sqrt{KL_i}, \quad (1)$$

where q_i is the instantaneous quantity produced by firm i , and L_i is the amount of labor employed by firm i .

The cost of one unit of labor is denoted p_l . The amount of capital is fixed, hence labor is the only variable input.⁴ At any given instant, each firm can costlessly adjust its labor input to produce any output quantity. Since firms are not able to alter the level of capital, firm i 's variable cost of producing q_i units is

$$C_i(q_i) = \frac{q_i^2}{K} p_l. \quad (2)$$

Assumption 2 The firms are subject to the heterogenous-products Bertrand-type competition.

We depart from the common homogenous-products Cournot competition setting in order to make the model more realistic. Cournot setting corresponds to competition in perfect substitutes. Thus, if taken literally, the results of a model with Cournot competition would only apply to industries in which products are perfect substitutes. The heterogenous-products Bertrand competition, on the other hand, can accommo-

⁴This assumption does not drive any of the results. With two adjustable factors all the conclusions of the models are intact. We discuss the intuition behind this result below (see footnote 7).

date different degrees of substitutability among products.⁵ This is the reason for choosing the heterogenous-products Bertrand setting. However, we emphasize right at the outset that the logic and the results of the model are insensitive to the choice of the type of product market competition. To show that, in Appendix 2 we re-examine the model under the assumption of Cournot competition with homogenous products and show that the qualitative results and the empirical predictions are robust to the choice of the form of competition in product markets.

Assumption 3 The demand-side of the industry is characterized by a representative consumer with quadratic utility function

$$U(\vec{q}) = \sqrt{x}\alpha \sum_{i=1}^n q_i - \frac{1}{2} \left[\beta \sum_{i=1}^n q_i^2 + 2\gamma \sum_{j \neq i} q_i q_j \right], \quad (3)$$

where α , β , and γ are the parameters of the utility function, q_i is consumption of good i , n is the number of active firms in the industry, and, thus, the number of available products, and x is the stochastic shock to the representative consumer's utility.⁶ We further assume that x follows a geometric Brownian motion

$$dx_t = \mu x_t dt + \sigma x_t dW_t,$$

where W_t is a standard Wiener process on a filtered probability space (Ω, F, P) .

The conditions that we impose are $\alpha > 0$ and $\beta > \gamma > 0$. These conditions are standard (see Vives (2000)). $\gamma > 0$ implies that the goods produced are substitutes, which is a reasonable assumption for products of firms competing in the

⁵In addition, the homogenous-products competition can sometimes result in unrealistic effects of a horizontal merger on the merging firms' and their product market rivals' optimal strategies and equilibrium profits, if the merged firm's production function is assumed to be the same as the one of its stand-alone rivals. In the homogenous-products setting, a merger can create a competitive disadvantage that results in lower combined profit of the merging firms relative to the sum of their pre-merger profits in all cases except a merger for monopoly (see, for example, Stigler (1950), Salant, Switzer and Reynolds (1983), and Farrell and Shapiro (1990)). On the other hand, Perry and Porter (1985) demonstrate that accounting for the larger combined capital of the merging firms relative to that of its stand-alone rivals (as in our model) can sometimes be sufficient for a horizontal merger to increase the merging firms' combined profits in the homogenous-products Cournot setting.

⁶It is shown in Vives (2000) that the assumption of a representative consumer is not necessary for the analysis.

same industry. $\alpha > 0$ and $\beta > \gamma$ imply that the utility function is concave in each of its arguments. The assumption about the specific functional form of the relation between the utility and the state of the stochastic shock, x , is made for analytical convenience. As shown below, \sqrt{x} in the linear term of the utility function translates into a linear relation between \sqrt{x} and the intercept of the demand function. (It is common in the industrial organization literature to assume that shocks to demand manifest themselves as changes in the intercept of the demand function.) The latter relation, in turn, translates into a linear relation between x and firms' instantaneous profits.

Equalizing the marginal utility that the representative consumer obtains from consuming each product to its respective price and solving the resulting system of n equations in n unknowns (quantities), results in the demand function for each of the products as a function of the product's own price and other products' prices:

$$D_i(\vec{p}) = \sqrt{x}a - bp_i + c \sum_{j \neq i} p_j, \quad (4)$$

where

$$\begin{aligned} a &= \frac{\alpha}{\beta + [n - 1]\gamma}, \\ b &= \frac{\beta + [n - 2]\gamma}{[\beta + [n - 1]\gamma][\beta - \gamma]}, \\ c &= \frac{\gamma}{[\beta + [n - 1]\gamma][\beta - \gamma]}. \end{aligned} \quad (5)$$

Assumption 4 The two incumbents are endowed with an option to initiate one merger attempt. The merger attempt has no out-of-pocket costs. Once initiated, a merger attempt results in a successful merger with probability p .

A merger attempt can be unsuccessful for various reasons, for example the opposition by antitrust authorities and/or difficulties in the negotiation process. Empirically, far from all merger bids are successful. For instance, in Eckbo's (1983) sample of 191 horizontal mergers that occurred between 1963 and 1978, 65 were challenged by either the Justice Department or the Federal Trade Commission. Boone and Mulherin (2006) report that only 27% of potential bidders that sign a confidentiality

agreement and only 78% of bidders that submit a private written offer succeed in acquiring their target. Schwert (2000) reports that about 20% of deals in his sample of 2,346 takeover contests involved an auction among multiple bidders.

The assumption that the two incumbents are endowed with an option to initiate only one merger attempt is made for analytical tractability. Unlike Lambrecht (2004), we assume that merging is costless in the sense that there is no direct cost associated with the merger. However, as discussed below, there is an indirect cost of the merger following from the resulting change in the industry structure. A successful merger attempt can induce entry to the industry and, thus, erode the profits of the incumbents.

In our model, which is based on Bertrand competition, there are no technological (production) synergies. The reason is that, because of the symmetry of the utility function and the production functions, the equilibrium production quantities of the two merged firms are the same, $q_1 = q_2 = q$. Under the assumption of the same level of capital of the two merged firms, the cost of producing q_1 and q_2 separately, $\frac{q_1^2}{K}p_l + \frac{q_2^2}{K}p_l = \frac{2q^2}{K}p_l$, is the same as the cost of producing the same quantities while joining capital: $\frac{(q_1+q_2)^2}{2K}p_l = \frac{2q^2}{K}p_l$.⁷ Thus, we intentionally abstract from the production (efficiency)-based reason for merging and focus exclusively on strategic motives for merging horizontally. The merger allows the incumbents to coordinate their pricing strategies, thus enhancing their joint value. This leads to the following intuitive result:

Lemma 1 *Regardless of the presence of a third firm (the entrant), the combined instantaneous profit of the two incumbents is always higher if they merge than if they stay separate, ceteris paribus.*

Lemma 1 shows that conditional on the potential entrant's decision regarding whether to enter the industry or not, merging increases the incumbents' combined

⁷If two inputs were costlessly adjustable, the cost of producing q_1 and q_2 separately would be $2[q_1 + q_2]\sqrt{p_l p_k}$, where p_k denotes the cost of one unit of capital. The cost of producing $q_1 + q_2$ while joining operations would be the same. Moreover, with two adjustable inputs, there would be no technological synergies even if the incumbent firms were not symmetric.

instantaneous profit. Yet, this result does not take into account that the entrant's instantaneous profit (and therefore its decision to enter) is not independent of the merger decision:

Lemma 2 *The entrant's instantaneous profit is higher when the two incumbents operate as one entity than when they stay separate.*

The intuition behind Lemma 2 is simple. When the two incumbents merge, they charge higher prices than the prices of the stand-alone firms because they internalize the effect of raising one product's price on the quantity sold of the other product. This benefits the entrant and increases its instantaneous profit.

While this result clearly follows from the static model of oligopolistic competition, it can be argued that in a dynamic setting, a merger can create the opposite effect on the value of future entrants. By merging, the incumbents can be more credible in threatening potential entrants with charging lower prices upon entry in order to drive the entrants out of the industry.

The relative magnitude of the two effects determines whether a merger is beneficial or detrimental for future entrants, and is an empirical question. Empirical evidence seems to suggest that the positive static effect of mergers on the of existing and potential competitors dominates the negative dynamic effect. For example, Berger, Bonime, Goldberg and White (2004) show using data on mergers in the banking industry that mergers and acquisitions are associated with increases in the probability of future entry. Eckbo (1983) reports that horizontal rivals of merging firms earn positive abnormal returns around merger announcements. This evidence points in the direction of mergers being beneficial for potential entrants, as in our model.

Given that the incumbents' decision to merge affects the outsider's entry decision, we need to determine whether the incumbents' combined profit is higher in the case of merger than in the case of no merger:

Lemma 3 *The incumbents' combined instantaneous profit is higher in the case of no merger and no entry than in the case of a merger and subsequent entry.*

Combining Lemmas 1 and 3 enables us to establish the following relations among the combined instantaneous profits of the incumbents under the four different scenarios (merger/ no merger combined with entry/ no entry):

$$\begin{aligned} \pi_{incumbents}(\text{no entry, merger}) &> \pi_{incumbents}(\text{no entry, no merger}) > \\ &> \pi_{incumbents}(\text{entry, merger}) > \pi_{incumbents}(\text{entry, no merger}). \end{aligned} \quad (6)$$

This is an important result. The first and the third inequalities show that taking the presence/absence of the entrant in the industry as given, the incumbents are better off merging, since they are able to charge higher prices by internalizing the positive effect that increasing the price of product 1 has on the demand for product 2, and vice versa. The second inequality is the heart of our analysis. The incumbents are better off in the case of no merger and no entry than in the case of merger and entry. The reason is that the entrant's profit and its willingness to enter the market are higher when the incumbents have merged. Thus, the incumbents may be better off not merging, if doing so deters potential entry.

Note that absent any threat of new entry into the industry, the optimal strategy of the two incumbents would be to initiate a merger attempt immediately, regardless of the current state of the stochastic shock. Since the merger attempt is assumed costless and the incumbents are able to increase their combined profit by merging (see Lemma 1), it is always optimal to merge. The presence of the potential entrant into the industry makes the problem more realistic and interesting. Entry affects the profits of the incumbents. On the other hand, the entrant's profit depends on whether or not the incumbents have merged.

Assumption 5 Upon the successful consummation of a merger, the shareholders of each incumbent receive a 50% stake in the combined equity of the merged entity.

While we established the relation between the incumbents' combined instantaneous profits under different scenarios, the decision to merge is affected by the division of the merger surplus between the incumbents. In order for the two incumbents to be willing to merge, each of them has to benefit from the merger. Since in the model the two incumbents are identical in all respects, one way to ensure that is to

assume that the value of the merged entity is split evenly between the shareholders of the two merging firms.

Our model incorporates both cash and stock mergers. In our setting it is not important whether the medium of exchange is cash or stock, as long as the capital markets are efficient and securities are correctly priced by investors. We do not analyze the misvaluation-based incentives to merge, as in Rhodes-Kropf and Viswanathan (2004) or in Shleifer and Vishny (2003). What is important is that upon the merger consummation the shareholders of both incumbent firms receive the value equivalent to the value of the right to the perpetual entitlement to the half of the cash flows of the merged entity.

Assumption 6 In order to enter the industry the outsider has to incur a fixed irreversible entry cost, I .

This assumption precludes immediate entry for low realizations of the stochastic shock.

Assumption 7 We normalize the amount of installed capital of each firm, K , the cost of labor, p_l , and the quadratic coefficient of the utility function, β , to one.

This assumption is made for analytical convenience only. Normalizing β to one is innocuous. In addition, it is straightforward to show that the general version of the model with K and p_l that are different from one produces the same conclusions as the more restrictive model we are examining here.⁸ Before proceeding to the formal solution of the model, it is worth discussing the structure of the strategic game and providing the basic intuition behind the results.

2.2 Basic intuition

In our setup, there are two optimization problems that must be solved simultaneously. First, the potential entrant makes its entry decision by trading off the present value of its expected profits against the cost of entry, I . The expected profits depend on the

⁸This extension of the model is available upon request.

strategy of the incumbents (see Lemma 2). In particular, a successful merger alters the industry's competitive structure and leads to an increase in the instantaneous profits of the entrant, and makes earlier entry optimal.

The second optimization problem is the one of the incumbents. They make their decision of whether or not to initiate a merger attempt by trading off the cost and the benefit of merging. The benefit of merging is the increase in instantaneous profits due to greater market power. The cost stems from the increased incentive of the new firm to enter the industry due to its changed competitive structure. After entry, the incumbents' combined instantaneous profit falls below its pre-merger value (see Lemma 3).

The optimal merging decision depends, of course, on the current realization of the stochastic shock, x . If x is relatively high (the industry is in expansion), then entry into the industry becomes attractive regardless of whether the incumbents have merged. In this case, it is no longer possible for the incumbents to deter entry by not merging. Therefore, the strategic disincentive to merge disappears, and we observe a merger attempt. On the other hand, when x is relatively low (the industry is in recession), the industry profits are low regardless of the incumbents' decision to merge, and entry is always unattractive. In this region, the incumbents find it optimal to attempt a merger to increase their market power. The outsider is not going to enter until the state of the industry improves, so there is no substantial strategic disincentive to merge. Finally, when the economy is in transition, and x is neither too high nor too low, the incumbents may optimally decide to postpone their merger to deter entry.

2.3 Analysis

We now proceed to the formal analysis of the model. In what follows, we incorporate the derivations of the firms' instantaneous profits under different industry structures, found in the proofs of Lemmas 1 and 2 in Appendix 1, and introduce the following simplifying notation for the firms' instantaneous profits under different scenarios:

$$\pi_{inc}^{ne,nm} = \frac{1}{2x} \pi_{incumbents}(\text{no entry, no merger}) = \frac{\alpha^2 [2 - \gamma^2]}{[4 + \gamma - \gamma^2]^2}, \quad (7)$$

$$\pi_{inc}^{ne,m} = \frac{1}{2x} \pi_{incumbents}(\text{no entry, merger}) = \frac{\alpha^2}{4[2 + \gamma]}, \quad (8)$$

$$\pi_{inc}^{e,m} = \frac{1}{2x} \pi_{incumbents}(\text{entry, merger}) = \frac{\alpha^2[4 + 3\gamma - 3\gamma^2]^2[2 + \gamma - 2\gamma^2]}{4[1 + \gamma]^2[8 + 4\gamma - 9\gamma^2 + 2\gamma^3]^2}, \quad (9)$$

$$\pi_{inc}^{e,nm} = \frac{1}{2x} \pi_{incumbents}(\text{entry, no merger}) = \frac{\alpha^2[1 + \gamma][1 + \gamma - \gamma^2]}{2[2 + 3\gamma]^2}, \quad (10)$$

$$\pi_{ent}^{nm} = \frac{1}{x} \pi_{entrant}(\text{no merger}) = \frac{\alpha^2[1 + \gamma][1 + \gamma - \gamma^2]}{2[2 + 3\gamma]^2}, \quad (11)$$

$$\pi_{ent}^m = \frac{1}{x} \pi_{entrant}(\text{merger}) = \frac{2\alpha^2[2 - \gamma^2]^2[1 + \gamma - \gamma^2]}{[1 + \gamma][8 + 4\gamma - 9\gamma^2 + 2\gamma^3]^2}. \quad (12)$$

We first examine the optimization problem of the entrant. Time does not enter the optimization problem explicitly, and the optimal entry decision takes the form of an upper threshold, such that it is optimal to enter at the first passage time of the stochastic shock x to the threshold. There are three possible states of the industry, leading to three optimal entry thresholds:

- 1) the incumbents have not yet exercised their merger option (but they can do it in the future);
- 2) the incumbents have initiated a merger attempt but it did not succeed (and no future attempts are feasible);
- 3) the incumbents have successfully merged.

We denote the optimal entry thresholds in these three cases by x_u (an upper threshold), $x_{e,nm}$ (entry, no merger is feasible), and $x_{e,m}$ (entry at a time when the incumbents have already merged), respectively. (The notation will become clear below.) We start by establishing the optimal thresholds $x_{e,m}$ and $x_{e,nm}$, corresponding to the cases in which the incumbents have already attempted a merger, either successfully or not. These thresholds are determined by the following proposition:

Proposition 1 *If the incumbents have already exercised their option to attempt a merger and have not succeeded, then the optimal entry threshold is given by*

$$x_{e,nm} = \frac{I[r - \mu]}{\pi_{ent}^{nm}} \frac{\beta_1}{\beta_1 - 1}, \quad (13)$$

where β_1 is the positive root of the quadratic equation $\frac{1}{2}\sigma^2\beta(\beta - 1) + \mu\beta - r = 0$,

$$\beta_1 = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left[\frac{1}{2} - \frac{\mu}{\sigma^2}\right]^2 + \frac{2r}{\sigma^2}}. \quad (14)$$

If the incumbents have successfully merged, then the optimal entry threshold is

$$x_{e,m} = \frac{I[r - \mu]}{\pi_{ent}^m} \frac{\beta_1}{\beta_1 - 1}. \quad (15)$$

Note that $\pi_{ent}^m > \pi_{ent}^{nm}$ implies that $x_{e,nm} > x_{e,m}$, and a successful merger speeds up new entry. The optimal entry threshold, x_u , corresponding to the situation in which the option to merge is still open, must be found by jointly examining the optimization program of the incumbents and that of the new entrant. Since there is uncertainty with respect to the outcome of a potential merger attempt, new entry into the industry in which the incumbents have not yet merged (even if they have not yet exercised their merger option) is not as attractive as in the case in which the incumbents have successfully merged. Therefore, in this case the decision to enter must be supported by higher instantaneous profits, and the following inequality must hold: $x_u > x_{e,m}$. Similarly, new entry into the industry in which a merger attempt has not been initialized yet is more attractive than in the case in which an unsuccessful merger attempt has occurred: $x_u < x_{e,nm}$.

When the current state of the stochastic shock is such that $x_u > x > x_{e,m}$, the incumbents would never want to attempt a merger. A successful merger attempt in this region would immediately attract new entry (since $x > x_{e,m}$) and, therefore, lead to a decline in the incumbents' combined profits (see Lemma 3). For values of x slightly below $x_{e,m}$ a successful merger would not result in an immediate entry but would increase its probability in the near future. As x further decreases, this probability declines. When x is sufficiently lower than $x_{e,m}$, the expected loss in the value of the incumbents due to an earlier future potential entry is fully offset by the increase in their value due to immediate higher instantaneous post-merger profits. At a certain critical lower threshold, x_l , the incumbents become exactly indifferent between attempting a merger or staying separate. For the values of x below x_l , it is always optimal to make a merger attempt.

On the other hand, when x reaches x_u , new entry inevitably occurs. The profits in the industry are so high that the incumbents are not able to keep the potential entrant aside by maintaining the current industry structure and not attempting to merge. Regardless of the incumbents' decision to initiate a merger attempt, new entry occurs. Note, however, that the sequence of events in which new entry precedes the merger attempt is never optimal from the perspective of both the incumbents and the potential entrant. Both parties are better off if the merger attempt is initiated first. The reason is that by initiating the merger the incumbents provide the potential entrant with the opportunity to observe its outcome. This opportunity eliminates inefficient entry in the case of an unsuccessful merger attempt and increases the value of both the incumbents and the potential entrant.

Indeed, if the merger attempt turns out unsuccessful, then it is optimal for the outsider not to enter immediately as the current state of x_u is below $x_{e, nm}$, the optimal entry threshold corresponding to the case of a failed merger attempt. It will enter later, at a stopping time upon reaching the corresponding threshold $x_{e, nm}$. This option to wait increases the value of the new entrant. On the other hand, the incumbents (should the merger attempt not succeed) will be entitled to higher instantaneous profits, $x\pi_{inc}^{ne, nm} > x\pi_{inc}^{e, nm}$, while x stays below $x_{e, nm}$. Therefore, if x_u is a critical value of x high enough to attract entry even if the incumbents do not attempt to merge (they will do so immediately upon the outsider's entry), then the optimal policy of the incumbents is to initiate a merger attempt when x first reaches the value of $x_u - \varepsilon$, where $\varepsilon > 0$ is arbitrarily small. They cannot keep the outsider from entering anymore, but they can give it a chance to see the outcome of the merger attempt and to postpone its entry in the case it is not successful. That way the incumbents increase both their own value and the value of the outsider, so neither party has incentives to deviate from this strategy. Since ε is arbitrary small, it is valid to say that a merger attempt is initiated at the first passage time of x to x_u .

To summarize, we only observe merger attempts when x either falls to x_l or rises to x_u . No merger attempts are made if $x_l < x < x_u$. As argued above, we need to look at the two optimization programs simultaneously. The program of the incumbents

that have not attempted a merger yet can be formalized as follows:

$$\begin{aligned}
V_{inc}(x) = & \sup_{T_{x_l} > 0} \mathbb{E}^x \left[\int_0^{\min(T_{x_l}, T_{x_u})} e^{-rt} \pi_{inc}^{ne, nm} x dt + \right. \\
& + 1_{T_{x_u} < T_{x_l}} \left[p \int_{T_{x_u}}^{\infty} e^{-rt} \pi_{inc}^{e, m} x dt + [1 - p] \left[\int_{T_{x_u}}^{T_{x_{e, nm}}} e^{-rt} \pi_{inc}^{ne, nm} x dt + \int_{T_{x_{e, nm}}}^{\infty} e^{-rt} \pi_{inc}^{e, nm} x dt \right] \right] + \\
& + 1_{T_{x_l} < T_{x_u}} \left[p \int_{T_{x_l}}^{T_{x_{e, m}}} e^{-rt} \pi_{inc}^{ne, m} x dt + p \int_{T_{x_{e, m}}}^{\infty} e^{-rt} \pi_{inc}^{e, m} x dt + \right. \\
& \left. + [1 - p] \int_{T_{x_l}}^{T_{x_{e, nm}}} e^{-rt} \pi_{inc}^{ne, nm} x dt + [1 - p] \int_{T_{x_{e, nm}}}^{\infty} e^{-rt} \pi_{inc}^{e, nm} x dt \right], \quad (16)
\end{aligned}$$

where x_l is the lower (merging) threshold, x_u is the upper (entry) threshold, which coincides with the upper merger threshold. T_{x_l} (T_{x_u}) is the first passage time of x to the lower (upper) merging threshold, $x_{e, m}$ and $x_{e, nm}$ are the entry thresholds after a successful and unsuccessful merger attempts respectively, given in (15) and (13), $T_{x_{e, m}}$ ($T_{x_{e, nm}}$) is the first passage time of x to the entry threshold conditional on a successful (unsuccessful) merger attempt. $\pi_{inc}^{ne, nm}$, $\pi_{inc}^{e, m}$, $\pi_{inc}^{ne, m}$, and $\pi_{inc}^{e, nm}$ are each incumbent's instantaneous profit conditional on the state of the world, given in (7)-(10), and $1_{T_{x_u} < T_{x_l}}$ ($1_{T_{x_l} < T_{x_u}}$) is an indicator equalling one if the upper merging threshold is reached before (after) the lower merging threshold, and zero otherwise.

The first term in (16) refers to the present value (PV) of each incumbent's instantaneous profits before reaching any of the merging thresholds. The terms in the second line provide the PV of the profits to be received after reaching the upper threshold x_u , conditional on x_u being reached before x_l . Similarly, the remaining terms provide the PV of the profits to be received after reaching the lower threshold, x_l , if it is reached before x_u . The terms in the third (fourth) line correspond to the case of a successful (unsuccessful) merger attempt upon reaching x_l .

Note that the incumbents maximize their values by optimally choosing the lower merging threshold, x_l . However, they cannot unconditionally choose the upper merging threshold, x_u . As argued above, x_u is determined as the outcome of the optimization program of the potential entrant corresponding to the case in which new entry

would precede the merger attempt. The entrant's optimization program reads:

$$V_{ent}^{nm}(x) = \sup_{T_{x_u} > 0} \mathbb{E}^x [1_{T_{x_u} < T_{x_l}} [p \int_{T_{x_u}}^{\infty} e^{-rt} \pi_{ent}^m x dt + [1 - p] \int_{T_{x_u}}^{\infty} e^{-rt} \pi_{ent}^{nm} x dt + \\ + 1_{T_{x_l} < T_{x_u}} [p \int_{T_{x_{e,m}}}^{\infty} e^{-rt} \pi_{ent}^m x dt + [1 - p] \int_{T_{x_{e,nm}}}^{\infty} e^{-rt} p \pi_{ent}^{nm} x dt], \quad (17)$$

where π_{ent}^m and π_{ent}^{nm} are given in (12) and (11) respectively, and the rest of the variables are defined as above. The first two terms in (17) refer to the case in which the upper merging threshold is reached before the lower one, and entry occurs immediately upon reaching x_u . The third and fourth terms refer to the situation in which x_l is reached before x_u , and entry occurs at the first passage time of x to $x_{e,m}$ ($x_{e,nm}$) if the merger attempt is successful (unsuccessful).

The solution to the optimization problems in (16) and (17) determines the equilibrium values of the incumbents together with the optimal merging thresholds, x_l and x_u . We first take a closer look at the optimization problem of the entrant (corresponding to the case in which entry precedes a merger attempt), given in (17), and then move to the problem of the incumbents, given in (16). The following two propositions provide a set of equations for solving (16) and (17):

Proposition 2 *If x is between the optimal lower merging threshold, x_l , and the optimal upper merging threshold, x_u , then the potential entrant's value is given by*

$$V_{ent}^{nm}(x) = Ax^{\beta_1} + Bx^{\beta_2}, \quad (18)$$

where A and B are constants to be determined below, and β_2 is the negative root of the quadratic equation $\frac{1}{2}\sigma^2\beta(\beta - 1) + \mu\beta - r = 0$,

$$\beta_2 = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left[\frac{1}{2} - \frac{\mu}{\sigma^2}\right]^2 + \frac{2r}{\sigma^2}}. \quad (19)$$

The following conditions must hold at the upper and lower thresholds, x_l and x_u :

$$Ax_u^{\beta_1} + Bx_u^{\beta_2} = \frac{1}{r - \mu} [p\pi_{ent}^m x_u + [1 - p]\pi_{ent}^{nm} x_u] - I, \quad (20)$$

$$\beta_1 Ax_u^{\beta_1 - 1} + B\beta_2 x_u^{\beta_2 - 1} = \frac{1}{r - \mu} [p\pi_{ent}^m + [1 - p]\pi_{ent}^{nm}], \quad (21)$$

and

$$Ax_l^{\beta_1} + Bx_l^{\beta_2} = p \left[\frac{x_l}{x_{e,m}} \right]^{\beta_1} \left[\frac{\pi_{ent}^m x_{e,m}}{r - \mu} - I \right] + [1 - p] \left[\frac{x_l}{x_{e,nm}} \right]^{\beta_1} \left[\frac{\pi_{ent}^{nm} x_{e,nm}}{r - \mu} - I \right]. \quad (22)$$

Equations (20) and (22) are the value matching conditions, which stipulate that the values of the entrant at the two optimal merger thresholds be exactly equal to their respective expected post-merger-attempt values. (These values are the weighted averages of the values conditional on a successful and unsuccessful merger attempts.) Equation (21) is the smooth-pasting condition that ensures the optimality of the outsider's entry decision. Note that it clearly follows from (20) that the case in which entry precedes the merger attempt is not optimal from the perspective of the potential entrant. It enters at x_u even if the merger attempt turns unsuccessful, but in the latter case the optimal entry threshold is $x_{e,nm} > x_u$.

Proposition 2 provides us with three equations in four unknowns (two constants, A and B , and the optimal merging thresholds, x_u and x_l). Thus, we need additional conditions in order to solve for the optimal merging thresholds. The remaining conditions come from the optimization program of the incumbents in (16). These conditions are derived in the following proposition:

Proposition 3 *If x is between the optimal lower merging threshold, x_l , and the optimal upper merging threshold, x_u , then the value of each incumbent is given by*

$$V_{inc}(x) = Cx^{\beta_1} + Dx^{\beta_2} + \frac{\pi_{inc}^{ne,nm} x}{r - \mu}, \quad (23)$$

where C and D are constants to be determined together with A , B , x_u , and x_l . The following conditions must hold at the upper and lower merging thresholds, x_l and x_u :

$$Cx_u^{\beta_1} + Dx_u^{\beta_2} + \frac{\pi_{inc}^{ne,nm} x_u}{r - \mu} = p \frac{\pi_{inc}^{e,m} x_u}{r - \mu} + [1 - p] \left[\frac{\pi_{inc}^{ne,nm} x_u}{r - \mu} + \left[\frac{x_u}{x_{e,nm}} \right]^{\beta_1} \frac{[\pi_{inc}^{e,nm} - \pi_{inc}^{ne,nm}] x_{e,nm}}{r - \mu} \right], \quad (24)$$

$$\begin{aligned}
Cx_l^{\beta_1} + Dx_l^{\beta_2} + \frac{\pi_{inc}^{ne,nm} x_l}{r - \mu} = \\
p \left[\left[\frac{x_l}{x_{e,m}} \right]^{\beta_1} \frac{[\pi_{inc}^{e,m} - \pi_{inc}^{e,nm}]x_{e,m} + \frac{\pi_{inc}^{ne,m} x_l}{r - \mu}}{r - \mu} + \frac{\pi_{inc}^{ne,m} x_l}{r - \mu} \right] + \\
+ [1 - p] \left[\left[\frac{x_l}{x_{e,nm}} \right]^{\beta_1} \frac{[\pi_{inc}^{e,nm} - \pi_{inc}^{ne,nm}]x_{e,nm} + \frac{\pi_{inc}^{ne,nm} x_l}{r - \mu}}{r - \mu} + \frac{\pi_{inc}^{ne,nm} x_l}{r - \mu} \right], \quad (25)
\end{aligned}$$

$$\begin{aligned}
\beta_1 Cx_l^{\beta_1-1} + \beta_2 Dx_l^{\beta_2-1} + \frac{\pi_{inc}^{ne,nm}}{r - \mu} = \\
= p \left[\frac{\beta_1 x_l^{\beta_1-1}}{(x_{e,m})^{\beta_1}} \frac{[\pi_{inc}^{e,m} - \pi_{inc}^{ne,m}]x_{e,m} + \frac{\pi_{inc}^{ne,m}}{r - \mu}}{r - \mu} + \frac{\pi_{inc}^{ne,m}}{r - \mu} \right] + \\
+ [1 - p] \left[\frac{\beta_1 x_l^{\beta_1-1}}{(x_{e,nm})^{\beta_1}} \frac{[\pi_{inc}^{e,nm} - \pi_{inc}^{ne,nm}]x_{e,nm} + \frac{\pi_{inc}^{ne,nm}}{r - \mu}}{r - \mu} + \frac{\pi_{inc}^{ne,nm}}{r - \mu} \right]. \quad (26)
\end{aligned}$$

In (23) the term $\frac{\pi_{inc}^{ne,nm} x}{r - \mu}$ refers to the present value of each incumbent's perpetual entitlement to instantaneous profits if no structural changes in the industry occur, i.e. if the incumbents never merge and the outsider never enters. The remaining terms, $Cx^{\beta_1} + Dx^{\beta_2}$, account for the change in each incumbent's value due to the option to merge and the threat of new entry.

Equations (24) and (25) are the value-matching conditions for each incumbent's optimization problem, while (26) is the smooth-pasting condition that must obtain at the lower merging threshold. The first term on the right-hand side in (25) is the post-merger value of an incumbent if the merger attempt is successful, and the second term is the value of the incumbent in case of an unsuccessful merger attempt. Note that the expression on the right hand side of (24) (unlike that of (20)) accounts for the fact that the merger attempt would actually precede entry, so the new entrant is able to postpone its entry decision if the merger attempt is unsuccessful. On the contrary, (20) does not have the same term in the right hand side because the upper merger threshold is determined as the one that makes entry optimal even if the potential entrant is not able to anticipate the result of the merger attempt.

Propositions 2 and 3 provide the necessary set of conditions to determine the optimal merger thresholds together with the equilibrium values of the incumbents.

In particular, equations (20)-(22) and (24)-(26) present a system of six equations in six unknown variables. This system has to be solved numerically.

Note that $V_{ent}^{nm}(x)$ in (17) is not the true value of the potential entrant. Rather, it provides its hypothetical value that would have been realized if the incumbents did not preempt new entry, and entry occurred at a time when the option to merge were still open. As argued above, this is never optimal for the incumbents as well as for the entrant, so the incumbents will initiate a merger attempt first. This leads to an increase in the values of both the incumbents and the potential entrant. Thus, the final quantity to be found is the true value of the potential entrant, $V_{ent}(x)$, corresponding to the equilibrium strategy in which the merger attempt occurs first. As discussed above, the following inequality must hold: $V_{ent}(x) > V_{ent}^{nm}(x)$, where $V_{ent}^{nm}(x)$ is the pseudo-value of the entrant, obtained if entry occurred before the merger attempt, given in (17). The true value of the potential entrant is given by

$$V_{ent}(x) = Fx^{\beta_1} + Gx^{\beta_2},$$

where the pair of constants (F,G) is given by the (numerical) solution of the following system of equations:

$$Fx_u^{\beta_1} + Gx_u^{\beta_2} = p \left[\frac{\pi_{ent}^m x_u}{r - \mu} - I \right] + [1 - p] \left[\frac{x_u}{x_{e,nm}} \right]^{\beta_1} \left[\frac{\pi_{ent}^{nm} x_{e,nm}}{r - \mu} - I \right], \quad (27)$$

$$Fx_l^{\beta_1} + Gx_l^{\beta_2} = p \left[\frac{x_l}{x_{e,m}} \right]^{\beta_1} \left[\frac{\pi_{ent}^m x_{e,m}}{r - \mu} - I \right] + [1 - p] \left[\frac{x_l}{x_{e,nm}} \right]^{\beta_1} \left[\frac{\pi_{ent}^{nm} x_{e,nm}}{r - \mu} - I \right]. \quad (28)$$

Note that while the value-matching condition at the lower threshold (28) has the same form as the corresponding condition (22), the value-matching condition at the upper threshold (27) accounts for the possibility to observe the outcome of the merger attempt prior to making the entry decision, and is, therefore, different from the corresponding condition (20).

The next subsection presents the solutions for the optimal thresholds and the discussion of the implications of the model.

2.4 Results and empirical predictions

This section presents comparative statics results for the solutions to the optimization problems (16) and (17). Figure 1 presents the optimal merging thresholds as functions of the volatility of cash flows, σ . Figure 2 provides the merging thresholds as functions of the entry cost, I . Figure 3 depicts the merging thresholds as functions of the extent of competition in the product market, γ . The following values of the input parameters were used to produce Figures 1 - 3: $\alpha = 1$, $\mu = 0.01$, $r = 0.05$, $\sigma = 0.2$ (except in Figure 1), $I = 5$ (except in Figure 2), and $\gamma = 0.7$ (except in Figure 3). The shape of Figures 1 - 3 is insensitive to the choice of parameter values.

Insert Figures 1-3 here

Figure 1 reveals positive relations between the merging thresholds, x_u and x_l , and the volatility parameter, σ . This result is explained by analyzing the problem of the potential entrant. Volatility is positively related to the value of the outsider's option to wait and is, thus, negatively related to its incentive to enter the industry. Hence, higher volatility leads to a higher entry threshold, which is the upper merging threshold, x_u . It also increases the optimal entry thresholds in the two cases in which the incumbents have already initiated a merger attempt, $x_{e,nm}$ and $x_{e,m}$. Therefore, an increase in volatility reduces the strategic disincentive to merge for relatively low states of x . The higher the volatility, the higher the value of x for which the incumbents can afford to merge, and the higher the value of x corresponding to the lower merging threshold, x_l .

Similar intuition applies to the merging thresholds in Figure 2. Higher entry cost deters new entry and, therefore, raises the optimal merger thresholds. In Figure 3, the lower the γ , the less the entrant's decision is affected by those of the incumbents, and vice versa. This is because γ measures the degree of substitutability among the three firms' products. When $\gamma = 0$, the products are completely unrelated with each other. Consequently, the entrant's value is independent of the incumbents' merger decision, and the incumbents' values are not affected by the outsider's entry decision, so the two thresholds coincide. The gap between the two thresholds widens with γ . Similar to Figures 1 and 2, the entrant's instantaneous profit is decreasing in γ ,⁹

⁹This can be easily verified by differentiating the entrant's instantaneous profit for the cases of

moving the upper merging threshold, and consequently the lower merging threshold, upwards.

The most important result of the model that is demonstrated in Figures 1 - 3 is that there are two distinct merger thresholds. Firms merge either when things are good and the realization of the demand shock passes the upper merging threshold from below, or when things are bad and the realization of the shock passes the lower merging threshold from above. Thus, the main prediction of the model is that we are likely to observe more horizontal mergers in industries subject to positive and negative demand shocks. Moreover, because the model is based on the strategic incentives to merge, present within oligopolistic industries, the U-shaped relation between the state of demand and the horizontal merger intensity is expected to be more pronounced in relatively concentrated industries. This prediction also follows from the fact that the wedge between the two merger thresholds is increasing with γ , which measures the extent to which the firms' pricing decisions affect the demand for their output market rivals' products.

3 Empirical tests

In this section we examine the relation between the merger intensity within an industry and the state of its demand.

3.1 Data

We collect our sample of mergers and acquisitions from the Securities Data Company's (SDC) database of U.S. targets. The sample period is 1981 - 2004. To be included in our sample we require that a deal offer satisfies the following criteria:

- 1) the acquirer is a U.S.-based publicly traded company in one of the three major U.S. exchanges (NYSE, NASDAQ, and AMEX);
- 2) the acquiring firm owns less than 50% of the target firm's equity on the announcement date;

merger and no merger in (40) and (39) respectively with respect to γ . Intuitively, the higher the γ , the tougher the product market competition, and the further away firms are from a monopolistic setting.

- 3) the acquiring firm ultimately owns more than 50% of the target's equity;
- 4) the deal value is available from SDC.

We impose the first restriction to allow the matching of acquiring firms from SDC with the COMPUSTAT (see below), which we use to define industries and to obtain industry characteristics. We exclude foreign bidders because their incentives to cross-list their equity may be related to factors other than their desire to gain access to U.S. product markets. It is not obvious, then, that foreign cross-listed acquires actively compete in U.S. product markets, and have the same strategic incentives as U.S. firms.¹⁰

The second restriction is meant to reflect the fact that the control over managerial decisions and, thus, the output/pricing decisions, is more relevant for our model and empirical tests than the legal status of the target. The third restriction eliminates unsuccessful bids from the sample. In our model, the probability of an attempted merger being successful is fixed, and the predictions of the model could, in principle, be tested using both a sample of attempted mergers and a sample of completed mergers. Empirically, however, it is often the case that multiple bidders make offers for the same target. To the extent that the degree of competition among bidders is different across industries, using all attempted mergers might bias the results. We base our measure of merger intensity on deal values, hence the fourth restriction.

We obtain firm-level accounting data and SIC codes from the COMPUSTAT Annual Industrial files. We follow Harford (2005) and define industries based on Fama and French's (1997) classification, which combines four-digit SIC codes into 49 broader industries. The sample selection criteria discussed above, together with the COMPUSTAT matching requirement for acquiring firms result in the sample of 21,245 completed mergers. Our model predicts a U-shaped relation between the state of the industry's demand and firms' incentives to merge horizontally. We classify a merger as horizontal if the bidder and target operate in the same Fama-French

¹⁰In particular, access to U.S. supply of capital and benefits of complying with U.S. regulation with regard to shareholder protection are widely cited as potential advantages of cross-listing (e.g., Stulz (1999), Reese and Weisbach (2002), Doidge, Karolyi, and Stulz (2004), and Lins, Strickland and Zenner (2005)).

industry.¹¹ There are 12,269 horizontal mergers in our sample.

3.2 Merger intensities

We measure horizontal merger intensity within an industry during year t as the sum of the values of all horizontal deals involving bidders belonging to the industry in year t divided by the sum of end-of-year market values of all firms belonging to the industry in year $t - 1$. A firm's market value is defined as the sum of the market value of its equity, COMPUSTAT data item 24 times item 25, and the book value of its liabilities, item 181. Most of our empirical analysis is concerned with horizontal mergers. However, we also examine the relation between overall merger intensity and the state of demand because the definition of a "horizontal merger" is not straightforward, both theoretically and empirically. On the theory side, our model allows for different values of the parameter measuring the substitutability among firms' products, thus not requiring the products to be perfect substitutes. On the empirical side, our definition of industries, which is based on SIC codes is far from being perfect.¹² Our measure of the overall industry-year merger intensity is the sum of the values of all deals involving bidders from the industry divided by the sum of previous-year-end market values of all firms in the industry.

Table 1 reports the characteristics of the absolute and scaled measures of merger intensity for the sample of all mergers and for the sample of horizontal mergers.

Insert Table 1 here

Panel 1 presents the summary statistics for all industries and years. The mean (median) annual number of mergers within an industry is 17 (7), out of which 10 (3) are horizontal. These numbers correspond to the mean (median) merger intensity of 2.45% (1.08%) for all mergers and 1.17% (0.35%) for horizontal mergers. Panel 2 presents the mean merger intensities for the five most active industries: candy and

¹¹In the case of private targets we obtain the industry classification codes from SDC.

¹²See Dunne, Roberts and Samuelson (1984) for a discussion of the deficiencies of SIC industry classification as a measure of economic markets.

soda, health care, shipbuilding and railroad equipment, coal, and banking.¹³ Panel 3 lists the years with the highest merger intensities. Consistent with the stylized fact, the second part of the nineties has experienced a surge of merger activity. Overall, the fact that merger intensity within most active industries and during most active years is three to fifteen times higher than within a typical industry-year is consistent with the existence of merger waves and their industry clustering.

3.3 Demand shocks and control variables

We proxy for the state of industry demand by the median annual sales growth within the industry. Specifically, for each firm-year we calculate annual sales growth, defined as the difference between the firm's annual sales, COMPUSTAT item 12, and its previous year's sales, scaled by the previous year's sales. Then we calculate the median sales growth for each industry each year.

Following recent studies of merger waves and industry-level merger activity (e.g., Mitchell and Mulherin (1996), Andrade, Mitchell and Stafford (2004), and Harford (2005)), we control for other determinants of firms' incentives to merge. The control variables, which are measured at lagged values, are as follows.

Median market-to-book ratio and its standard deviation. Both the misvaluation-based explanations of merger waves (see Rhodes-Kropf and Viswanathan (2004) and Shleifer and Vishny (2003)) and the neoclassical (shock-based) explanations posit that industry-level merger intensity is expected to be positively related to the industry market-to-book ratio, albeit for different reasons.¹⁴ Furthermore, both types of theories predict a positive relation between merger activity and the dispersion of market-to-book ratios within the industry (e.g., Jovanovic and Rousseau (2001, 2002) and Rhodes-Kropf and Viswanathan (2004)).¹⁵ We, thus, control for the industry-year median market-to-book ratio and its standard deviation in our tests. The market-

¹³Each of these five industries belongs to top-three based on either the mean overall merger intensity or the mean horizontal merger intensity.

¹⁴See Harford (2005) for a discussion of different theories of merger waves.

¹⁵On the other hand, Rhodes-Kropf and Robinson (2006) find that mergers are more likely between firms with similar market-to-book ratios.

to-book ratio is calculated as the ratio of the market value of the firm, item 24*item 25+item 181, and the book value of its assets. The book value of assets is the book value of equity plus liabilities, item 181. The book value of equity equals stockholder equity minus preferred equity plus investment tax credit, item 35, minus retirement benefit, item 330.¹⁶

Three-year median annual return. The misvaluation-based theories argue that past returns are expected to be positively related to overvaluation and to the resulting incentives to merge. The three-year annual return is defined as the sum of thirty six monthly returns, obtained from CRSP.¹⁷

Median property, plant, and equipment-to-assets ratio. Larger fixed assets may result in higher integration costs. Thus, we control for the proportion of tangible assets using the gross industry-year median property, plant, and equipment-to-book assets ratio, $\frac{\text{item 7}}{\text{item 6}}$.

Average commercial and industrial loans spread. Harford (2005) argues that mergers are more likely to occur in periods of high credit availability. We follow Harford and use the spread between the average commercial and industrial loans (C&I) rate and the Fed rate as an inverse proxy for credit availability. We obtain the C&I rate spread from <http://www.federalreserve.gov/releases/e2/e2chart.htm>.

Deregulation shocks. Demand shocks are not the only ones that can be related to merger intensity. Regulatory shocks may trigger unusual merger activity. To account for them, we identify a series of industry-specific deregulation events, in the spirit of Mitchell and Mulherin (1996) and Harford (2005), and construct a deregulation window dummy, which equals one during the year following the deregulation year and zero during other years. To conserve space, we do not report these deregulation events here; they can be found in Table 3 in Harford (2005).

¹⁶Stockholder equity is defined as item 216, or item 60 plus item 130, or item 6 minus item 181, in this order of availability. Preferred equity is defined as item 10, or item 56, or item 130, in this order of availability.

¹⁷Using market-adjusted returns instead of raw returns, or buy-and-hold returns instead of cumulative returns does not change any of the results.

Other non-demand shocks. Harford (2005) argues that the economic shocks to an industry operating environment can be captured by the following factors: cash flow margin, $\frac{\text{item 13} - \text{item 14}}{\text{item 12}}$, asset turnover, $\frac{\text{item 12}}{\text{lag}(\text{item 6})}$, research and development expenses, $\frac{\text{item 46}}{\text{lag}(\text{item 6})}$, capital expenditures, $\frac{\text{item 128} - \text{lag}(\text{item 128})}{\text{lag}(\text{item 6})}$, and return on assets, $\frac{\text{item 18}}{\text{lag}(\text{item 6})}$. Since some of these measures are highly correlated, we calculate the five median industry-year ratios above and define an economic shock as the first principal component of the absolute annual changes in these median industry characteristics.¹⁸ Following Harford, the economic shock measure enters the regressions below alone and interacted with a tight credit dummy, which takes the value of one during years in which either the median industry market-to-book ratio is below its time-series median or the C&I spread is above its median.

Table 2 presents the descriptive statistics of the annual sales growth and the control variables. It also reports the correlations of the control variables with sales growth.

Insert Table 2 here

Notably, while some of the correlations are statistically significant, none of them exceed 19%. This evidence is comforting, since our measure of the state of demand seems unlikely to proxy for other determinants of merger intensity. In some of the tests in the next section we split industries into more and less concentrated in order to examine whether the predictions of our model hold within subsamples of concentrated and competitive industries. We use two measures of industry concentration. The first one is an industry's Herfindahl index, defined as the ratio of the sum of firms' squared sales to the squared sum of their sales. The second measure is the number of firms competing in the industry. There is a large variation in both the Herfindahl index and the number of firms, which ranges between 2 and 962.

¹⁸Harford also includes a measure of sales growth in the economic shock index. We use sales growth as a measure of demand shock and, thus, exclude it from the non-demand shock index.

3.4 Regression Analysis

In order to examine whether the relation between merger intensity and demand shocks is U-shaped, we estimate the following regression:

$$\begin{aligned} \text{Merger intensity}_{it} = & \alpha + \beta_1(\text{Sales growth}_{it}) + \beta_2(\text{Sales growth}_{it})^2 + \quad (29) \\ & + \delta' X_{it} + \theta(\text{Industry}_i) + \varepsilon_{it}, \end{aligned}$$

where X_{it} is the vector of control variables, discussed in the previous section and Industry_i are industry dummy variables, aimed at capturing industry-specific fixed effects. Our main hypothesis is that $\beta_1 < 0$ and $\beta_2 > 0$, which would correspond to a U-shaped relation between merger intensity and the state of industry demand.¹⁹ The results of estimating (29) for different samples of mergers using OLS are presented in Panel 1 of Table 3.²⁰

Insert Table 3 here

While our model is concerned with the strategic motives for merging horizontally, identifying horizontal mergers is not straightforward. Thus, we begin our analysis by estimating (29) where the dependent variable is the overall (combined horizontal and conglomerate) merger intensity. The results are presented in the first column of Table 3. Consistent with the predicted U-shaped relation between merger intensity

¹⁹Our model is silent regarding the precise shape of the non-monotonic relation between the merger intensity and the state of demand. Thus, in order not to force the quadratic specification, we also estimate the following piecewise-linear specification:

$$\begin{aligned} \text{Merger intensity}_{it} = & \alpha + \gamma_1 \text{Sales growth}_{it} + \gamma_2 (\text{Sales growth}_{it} - \text{Knot}) * 1_{\text{sales growth}_{it} > \text{knot}} + \\ & + \delta' X_{it} + \theta(\text{Industry}_i) + \varepsilon_{it}, \end{aligned}$$

where Knot takes the value of either the median annual sales growth across all industry-years (0.076, see Table 2), or the sales growth corresponding to the implied minimum merger intensity from (29). $1_{\text{sales growth}_{it} > \text{knot}}$ is an indicator that equals one if sales growth is above the knot. Our model predicts a negative relation between merger intensity and sales growth rank for low values of sales growth and a positive relation for high sales growth. Thus, we expect $\gamma_1 < 0$, and $\gamma_1 + \gamma_2 > 0$. The results of estimating the piece-wise linear specification are consistent with this prediction. They are available upon request.

²⁰Since the dependent variable is bounded between zero and one, we also perform Tobit estimation, which provides very similar results, available upon request.

and demand shocks, the coefficient on sales growth is negative and significant at the 10% level, while the coefficient on squared sales growth is significantly positive. The coefficients on the control variables are generally consistent with the underlying theories, although many of them are insignificant. Specifically, industries with abundant assets in place are characterized by lower merger intensities, as are industry-years with high C&I spread. Consistent with the neoclassical theories, the economic shock index is positively related to the propensity of firms to merge.

Panel 2 reports the economic significance of the U-shaped relation between merger intensity and sales growth. We first compute the level of sales growth that corresponds to the implied minimum merger intensity, given by $-\frac{\widehat{\beta}_1}{2\beta_2}$. Then we change the sales growth by one standard deviation (0.086, see Table 2) while holding everything else constant, and calculate the implied merger intensity. We report the difference between these two implied merger intensities in the first row of Panel 2. The second (third) row reports the change in the merger intensity above scaled by the mean (median) merger intensity from Table 1. Changing the sales growth by one standard deviation increases the merger intensity by 2% - 4.6% – hardly economically meaningful numbers.

While the evidence for the overall sample of mergers is generally consistent with our model (although economically insignificant), it is also consistent with the technology-driven models, such as Lambrecht (2004) and Lambrecht and Myers (2006), who predict extraordinary high merger activity in rising and declining industries respectively. Unlike the technology-based models, our model concentrates on industry structure. For this reason, in columns 2 and 3 we report the results of estimating (29) using horizontal merger intensity and conglomerate merger intensity respectively, as the dependent variable. Conglomerate merger intensity is defined as the difference between overall merger intensity and horizontal merger intensity.

The evidence using the sample of horizontal mergers supports our model. The U-shaped relation between merger intensity and sales growth is highly statistically significant and economically meaningful. Changing sales growth by one standard deviation from the implied minimum increases merger intensity by 6% - 20%. The results for conglomerate mergers are quite different. Conglomerate merger intensity is not related to the industry demand shocks. Thus, when the strategic motives to

merge are absent (as in the case of conglomerate mergers), the state of demand does not affect firms' propensity to merge.

To examine whether strategic forces are responsible for the U-shaped relation between horizontal merger intensity and the state of demand further, we split the sample of horizontal mergers into subsamples containing more and less concentrated industries. The driving forces of our model are expected to be stronger in industries characterized by oligopolistic competition, and are less likely to be substantial in competitive industries. As mentioned above, we use two measures of industry concentration: the Herfindahl index and the number of firms in the industry.

Columns 4 and 5 present the results of estimating (29) for subsamples of industries with above-median and below-median Herfindahl indexes. For the subsample of relatively concentrated industries (with high Herfindahl indexes) the relation between horizontal merger intensity and sales growth is significantly negative, while its association with squared sales growth is positive and highly significant. Moreover, the economic significance of the U-shaped relation is even slightly larger than within the full sample of horizontal mergers: changing sales growth by one standard deviation increases the implied merger intensity by 7% - 22%. In the subsample of industries with low Herfindahl indexes, on the other hand, there is no significant relation between merger intensity and demand shocks.

Similar picture arises when the sample of horizontal mergers is split into industries with above-median and below-median number of firms. Within the subsample of relatively concentrated industries, the relation between horizontal merger intensity and the state of demand has a clear U-shape, while within the sample of relatively competitive industries the relation seems to be absent. Overall, the results for the subsamples of relatively concentrated and competitive industries are consistent with our model. The U-shaped relation between merger intensity and demand shocks holds only within the subsamples of relatively concentrated industries – a result supporting the model, whose predictions are based on the assumption of oligopolistic competition.

To conclude this section, we believe that the evidence lends support to our model's prediction regarding the U-shaped relation between horizontal merger activity and

the state of industry's demand. The statistical and economic significance of our results suggests that firms' incentives to engage in horizontal mergers are affected by strategic considerations.

4 Conclusions

We presented a real-options model that highlights the strategic motives for horizontal mergers. The model endogenizes firms' merger and entry decisions and demonstrates that firms' propensity to merge horizontally is the highest during periods of especially high and especially low demand. This result follows from the strategic interaction among the existing firms (incumbents) and the potential entrant. The incumbents' merger decision is driven by the following trade-off. On the positive side, a merger increases the incumbents' combined profits and their value by allowing them to collude in product markets. On the flip side, this collusion results in higher prices and higher potential outsider's profits, raising the likelihood of future entry, which would erode the incumbents' profits. During periods of high demand, the incumbents can not prevent entry, and their strategic incentives not to merge disappear. During periods of low demand, entry would not occur in a foreseeable future regardless of the incumbents' merger decision, and they are better off merging. On the other hand, in intermediate states, the incumbents decide not to merge in order to deter entry. The model's conclusions are robust to the type of competition in product markets.

This paper is the first to a) endogenize firms' merger and entry decisions in a dynamic framework, and b) demonstrate that strategic considerations are consistent with the higher propensity of firms to merge horizontally in periods of positive and negative demand shocks. Importantly, to highlight the strategic motives to merge, the model assumes away operating and financial benefits of mergers. While we believe that technological, financial, and regulatory considerations are also primary drivers of merger activity, the focus of our model is on the strategic reason to merge. Our model's prediction of a higher merger intensity during periods of positive and negative demand shocks is consistent with the existence of merger waves and their industry clustering, as long as firms' and industries' demand shocks are correlated.

We complement our model by examining the relation between merger intensity

and demand shocks empirically while controlling for non-demand shocks and industry characteristics. The evidence is consistent with the model. First, there seems to be a U-shaped relation between merger intensity and industry sales growth, proxying for demand shocks. Second, this relation is driven by horizontal mergers and is absent in the sample of conglomerate mergers. Third, within the sample of horizontal mergers, the U-shaped relation is present in relatively concentrated industries and is absent in relatively competitive ones. The evidence supports the notion that strategic considerations are an important factor in firms' decisions to engage in horizontal mergers.

There are numerous potential avenues for further developing the link between merger activity and the competition in product markets and firms' strategic considerations. On the theory side, it would be interesting to extend our model to allow for more than two incumbents and more than one potential entrant. This would allow examining firms' strategic motives for mergers within different industry structures and during different stages of industry life cycle. Also, it would be useful to examine the effects of strategic mergers in different states of industry demand on the total (firms' and consumers') welfare. Such an analysis could be useful in the antitrust authorities' decision making process. On the empirical side, it would be interesting to test various comparative statics results of the model. In addition, a detailed industry-specific evidence on the relation between merger activity and demand conditions could significantly enhance our understanding of the strategic motives to merge.

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Appendix

Appendix 1 – Proofs

Proof of Lemma 1

Assume first that a potential entrant has stayed out of the industry. Then, under the assumptions that $K = 1$, $p_l = 1$, and $\beta = 1$, the instantaneous profit function of each of the two incumbents is

$$\pi_i = q_i p_i - q_i^2, \quad (30)$$

where $i \in \{1, 2\}$. Substituting the demand for product i in (4) into q_i , partially differentiating the profit function of each firm with respect to its own price, equalizing the resulting two expressions to zero, and solving the resulting system of two first-order conditions gives the equilibrium profits of the two incumbents. Their combined profit in the case of no merger is given by

$$\pi_{incumbents}(\text{no entry, no merger}) = \frac{2x\alpha^2 [2 - \gamma^2]}{[4 + \gamma - \gamma^2]^2}. \quad (31)$$

If the two firms merge, their combined profit is

$$\pi_{incumbents} = q_1 p_1 + q_2 p_2 - q_1^2 - q_2^2, \quad (32)$$

assuming separate production (no technological synergies), or

$$\pi_{incumbents} = q_1 p_1 + q_2 p_2 - \frac{[q_1 + q_2]^2}{2}, \quad (33)$$

assuming joint production (technological synergies). As discussed in the body of the paper, the two specifications lead to identical results. Substituting the demand in (4) into q_1 and q_2 , and partially differentiating (32) or (33) with respect to p_1 and p_2 produces a system of two first order conditions. Solving the resulting system leads to the following equilibrium profit of the joint firm:

$$\pi_{incumbents}(\text{no entry, merger}) = \frac{x\alpha^2}{2[2 + \gamma]}. \quad (34)$$

Subtracting (31) from (34) gives

$$\begin{aligned} \pi_{incumbents}(\text{no entry, merger}) - \pi_{incumbents}(\text{no entry, no merger}) &= \\ &= \frac{x\alpha^2 \gamma^2 [1 + \gamma]^2}{2[2 + \gamma][4 + \gamma - \gamma^2]^2} > 0. \end{aligned} \quad (35)$$

We now consider the case in which the third firm has decided to enter the industry. The entrant's profit function, given in (30), results in a third first-order condition, similar to those of the incumbents. Solving the system of three first order conditions

for the merger case and the no-merger case provides the following equilibrium profits of the incumbents:

$$\pi_{incumbents}(\text{entry, no merger}) = \frac{x\alpha^2[1+\gamma][1+\gamma-\gamma^2]}{[2+3\gamma]^2}, \quad (36)$$

and

$$\pi_{incumbents}(\text{entry, merger}) = \frac{x\alpha^2[4+3\gamma-3\gamma^2]^2[2+\gamma-2\gamma^2]}{2[1+\gamma]^2[8+4\gamma-9\gamma^2+2\gamma^3]^2}. \quad (37)$$

Subtracting (36) from (37) gives

$$\begin{aligned} & \pi_{incumbents}(\text{entry, merger}) - \pi_{incumbents}(\text{entry, no merger}) = \\ & = \frac{x\alpha^2\gamma^2[1-\gamma][2\gamma+1][8+52\gamma+88\gamma^2+\gamma^3-81\gamma^4-10\gamma^5+26\gamma^6-4\gamma^7]}{2[1+\gamma]^2[2+3\gamma]^2[8+4\gamma-9\gamma^2+2\gamma^3]^2}. \end{aligned} \quad (38)$$

Given that $0 < \gamma < \beta = 1$, both the numerator and the denominator of (38) are clearly positive. ■

Proof of Lemma 2

Solving the system of three third-order conditions, as in Lemma 1, provides the following equilibrium instantaneous profits of the entrant conditional on whether the incumbents have merged:

$$\pi_{entrant}(\text{no merger}) = \frac{x\alpha^2[1+\gamma][1+\gamma-\gamma^2]}{2[2+3\gamma]^2}, \quad (39)$$

and

$$\pi_{entrant}(\text{merger}) = \frac{2x\alpha^2[2-\gamma^2]^2[1+\gamma-\gamma^2]}{[1+\gamma][8+4\gamma-9\gamma^2+2\gamma^3]^2}. \quad (40)$$

Comparing (40) and (39) results in the following expression:

$$\begin{aligned} & \pi_{entrant}(\text{merger}) - \pi_{entrant}(\text{no merger}) = \\ & = \frac{x\alpha^2\gamma^2[1-\gamma][1+2\gamma][1+\gamma-\gamma^2][16+24\gamma-9\gamma^2-13\gamma^3+2\gamma^4]}{2[2+3\gamma]^2[1+\gamma][8+4\gamma-9\gamma^2+2\gamma^3]^2}. \end{aligned} \quad (41)$$

Both the numerator and the denominator of (41) are positive for $0 < \gamma < 1$. ■

Proof of Lemma 3

Comparing the incumbents' joint instantaneous profit in the case of merger and subsequent entry, given in (37), with their combined profit when they do not merge and no entry occurs, given in (31), leads to the result. ■

Proof of Proposition 1

Once the option to attempt a merger has been exercised, the entry problem of the outsider becomes equivalent to the standard problem of investment under uncertainty. Denote the instantaneous profit of the outsider upon entry by π , where $\pi = \pi_{ent}^m$ if the merger attempt is successful and $\pi = \pi_{ent}^{nm}$ otherwise. Then it can be easily shown (see, for example, McDonald and Siegel (1986) or Dixit and Pindyck (1994)) that the optimal entry threshold is given by

$$x^* = \frac{I[r - \mu]}{\pi} \frac{\beta_1}{\beta_1 - 1}, \quad (42)$$

where β_1 is given in (14). ■

Proof of Proposition 2

In this proof we refer to the “value of the potential entrant” $V_{ent}^{nm}(x)$ as the value realized in the case when entry precedes the merger attempt. Using standard arguments, it can be shown that the pre-investment value of the potential entrant satisfies the following ODE:

$$\frac{1}{2}x^2\sigma^2V_{entxx}^{nm}(x) + \mu xV_{entx}^{nm}(x) - rV_{ent}^{nm}(x) = 0, \quad (43)$$

where V_{entx} and V_{entxx} refer to the first and second derivatives of the entrant’s value with respect to x respectively. The solution to (43) is given in (18).

The value-matching condition (20) equates the pre-investment value of the potential entrant with its value immediately after the exercise of the entry option. The latter is given by the weighted average of its value in the case in which the merger attempt that follows entry is successful and in the case in which it fails. Since the (upper) entry threshold, x_u , is optimally chosen by the outsider (and not by the incumbents), the appropriate smooth-pasting condition in (21) must hold for x_u to ensure the optimality of the upper merging threshold.

Finally, at a stopping time upon reaching the (lower) merging threshold the incumbents exercise their option to attempt a merger. Again, the value of the potential entrant is a weighted average of its values in the case of successful merger attempt and the case of an unsuccessful merger attempt. This value is found on the right-hand side in the value-matching condition (22). ■

Proof of Proposition 3

Similarly to the value of the entrant, the pre-merger value of each incumbent satisfies the following ODE:

$$\frac{1}{2}x^2\sigma^2V_{incxx}(x) + \mu xV_{incx}(x) - rV_{inc}(x) + \pi_{inc}^{ne,nm}x = 0, \quad (44)$$

where V_{inc_x} and $V_{inc_{xx}}$ refer to the first and second derivatives of the incumbent's value with respect to x respectively. The solution to (44) is given in (23). To ensure optimality, the value-matching conditions (24) and (25) together with the smooth-pasting condition (26) are imposed. ■

Appendix 2 – Cournot competition with homogenous products

In order to demonstrate that the results of the model are robust to the choice of the type of product market competition, we now show that the qualitative conclusions of the static model are exactly the same for the case of Cournot competition with homogenous goods as for the case of Bertrand competition with heterogenous goods. Since the results of the static model are used as inputs into the dynamic model, the qualitative results of the dynamic entry and merger model remain unchanged.

For the case of Cournot competition, the representative consumer's utility function becomes

$$U(q) = \sqrt{x}\alpha q - \frac{1}{2}\beta q^2. \quad (45)$$

Differentiating (45) with respect to q and equalizing the resulting expression to p provides the following inverse demand function:

$$p(q) = \sqrt{x}\alpha - \beta q. \quad (46)$$

In the case of no merger, each of the incumbents' and the entrant's profit functions are given in (30). In the case of merger, the merged firm's profit function becomes

$$\pi_i = q_i p_i - q_i^2/2, \quad (47)$$

because now each incumbent's firm's capital is used to produce only half of the total output of the merged firms, reducing the total cost of production in half given the Cobb-Douglas specification.

Solving the systems of appropriate first-order conditions for the cases of entry/no entry and merger/no merger results in the following equilibrium combined incumbents' instantaneous profits:

$$\pi_{incumbents}(\text{no entry, no merger}) = \frac{4}{25}x\alpha^2, \quad (48)$$

$$\pi_{incumbents}(\text{no entry, merger}) = \frac{1}{6}x\alpha^2, \quad (49)$$

$$\pi_{incumbents}(\text{entry, no merger}) = \frac{1}{9}x\alpha^2, \quad (50)$$

$$\pi_{incumbents}(\text{entry, merger}) = \frac{27}{242}x\alpha^2 \quad (51)$$

Comparing (48)-(51) results in the same relations among the combined incumbents' profits for the four different scenarios as in the case of Bertrand competition with heterogenous products:²¹

$$\begin{aligned} \pi_{incumbents}(\text{no entry, merger}) &> \pi_{incumbents}(\text{no entry, no merger}) > \\ &> \pi_{incumbents}(\text{entry, merger}) > \pi_{incumbents}(\text{entry, no merger}). \end{aligned} \quad (52)$$

In addition,

$$\pi_{entrant}(\text{merger}) = \frac{18}{121}x\alpha^2, \quad (53)$$

$$\pi_{entrant}(\text{no merger}) = \frac{1}{18}x\alpha^2, \quad (54)$$

and

$$\pi_{entrant}(\text{merger}) > \pi_{entrant}(\text{no merger}). \quad (55)$$

Since the relations in (52) and (55) are the same as in the heterogenous-product Bertrand setting, the qualitative results of the dynamic model are insensitive to the type of product market competition.

²¹In the case of three firms operating in an industry, this result is different from the known result that merger reduces the merging firms' profits in an oligopoly when marginal costs of production are constant. Here, similar to Perry and Porter (1985), the effect of reduced production costs outweighs the competitive disadvantage from merging in the homogenous Cournot setting.

Figure 1. Optimal merging thresholds as functions of σ

This figure presents the merging thresholds as functions of the volatility of the stochastic shock, σ , for the following set of input parameters: $\alpha = 1$, $\mu = 0.01$, $r = 0.05$, $I = 5$, $\gamma = 0.7$.

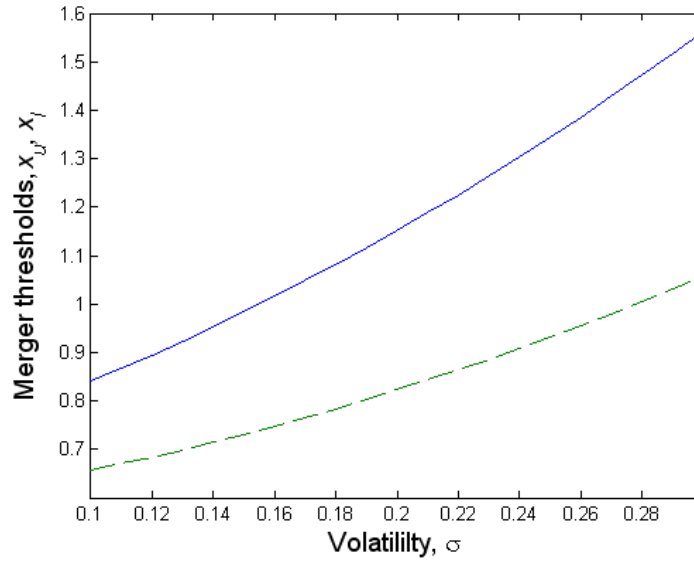


Figure 2. Optimal merging thresholds as functions of I

This figure presents the merging thresholds as functions of the entry cost, I , for the following set of input parameters: $\alpha = 1$, $\mu = 0.01$, $r = 0.05$, $\sigma = 0.2$, $\gamma = 0.7$.

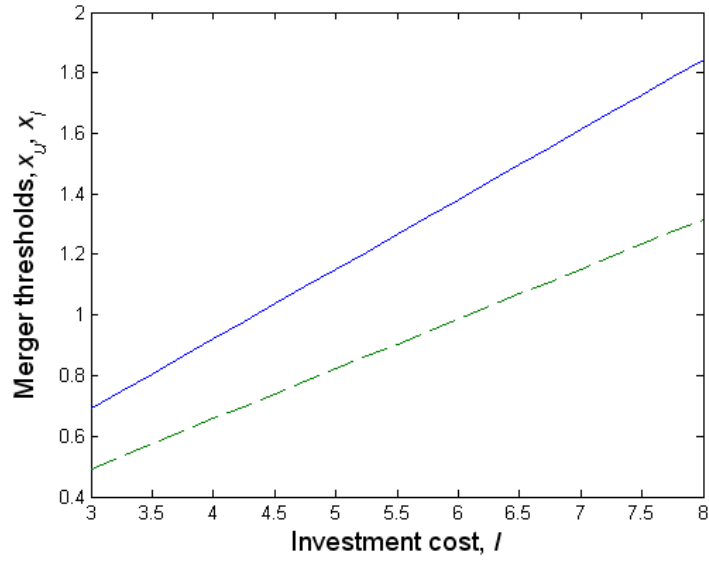


Figure 3. Optimal merging thresholds as functions of γ

This figure presents the merging thresholds as functions of the utility function substitution parameter, γ , for the following set of input parameters: $\alpha = 1$, $\mu = 0.01$, $r = 0.05$, $\sigma = 0.2$, $I = 5$.

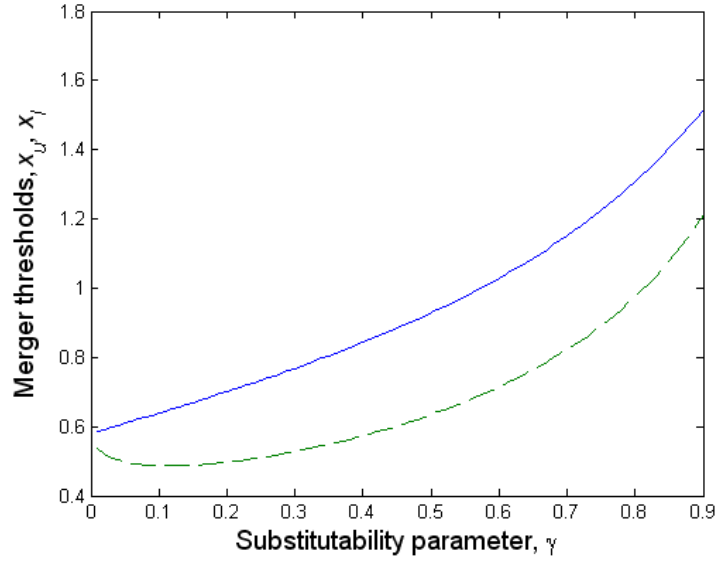


Table 1. Merger intensities

Panel 1 presents the summary statistics of the number of mergers and merger intensities for all industry-years. The sample period is 1981 - 2004. Industries are defined according to Fama and French (1997) classification. Merger intensity for all (horizontal) mergers is defined as the sum of the values of all deals involving bidders from an industry divided by the sum of previous-year-end market values of all firms in the industry. Panel 2 presents the time-series mean number of mergers and merger intensities for five industries with the highest merger intensities. Panel 3 presents the annual mean merger intensities for four years with the highest merger intensities.

	Number of mergers per industry-year		Industry-year merger intensity	
	All mergers	Horizontal mergers	All mergers	Horizontal mergers
Panel 1 -- All industries and years				
Min	0	0	0%	0%
Median	7	3	1.08%	0.35%
Max	391	229	70.51%	43.05%
Mean	17.08	9.86	2.45%	1.17%
Std	33.80	22.88	4.63%	2.50%
Panel 2 -- Most active industries				
3 -- Candy and soda	1.42	1.17	5.45%	5.20%
11 -- Healthcare	25.46	20.58	3.06%	2.69%
25 -- Shipbuilding, railroad equipment	1.83	0.38	5.91%	0.52%
29 -- Coal	0.58	0.17	7.07%	1.30%
45 -- Banking	111.88	95.71	3.15%	2.69%
Panel 3 -- Most active years				
1996	31.55	18.65	4.25%	1.96%
1998	44.39	23.33	4.90%	2.98%
1999	34.10	19.51	4.25%	2.25%
2000	31.73	17.76	3.78%	2.18%

Table 2. Sales growth and control variables

This table presents the summary statistics of variables that are expected to be related to merger intensity and their correlation with sales growth. The sample period is 1981 - 2004. Industries are based on Fama-French (1997) definition. Market-to-book is industry median ratio of the sum of the market value of equity and the book value of debt to the book value of assets. Std (market-to-book) is the annual industry-wide standard deviation of market-to-book. Three-year RET is the three-year median industry return prior to the year of the observation, calculated as the sum of thirty six monthly returns. PP&E-to-assets is the ratio of PP&E to the book value of assets. C&I spread is obtained from <http://www.federalreserve.gov/releases/e2/e2chart.htm>. Deregulatory event is a dummy variable, taking the value of one if an industry experiences a deregulation event in the previous year. The deregulation dummies are from Harford (2005). See Section 3 for the definition of the economic shock index. Tight capital is a dummy variable taking the value of one during years in which either the median industry market-to-book ratio is below its time-series median or the C&I spread is above its median. Sales growth is the ratio of the difference between sales in a given year and sales in the previous year to sales in the previous year. Herfindahl index is the ratio of the sum of firms' squared sales to the squared sum of their sales. Number of firms refers to Fama-French industries. The last column reports Pearson correlations between each variable and sales growth. P-values are reported in parentheses. Bold values indicate significance at the 5% level.

	Min	Median	Max	Mean	Std.	Correlation with sales growth
Market-to-book	0.755	1.212	4.663	1.314	0.410	0.190 (0.000)
Std (market-to-book)	0.074	1.261	4.338	1.360	0.793	0.106 (0.000)
Three-year RET	-2.050	0.176	1.628	0.094	0.541	0.035 (0.230)
PP&E-to-assets	0.000	0.506	1.310	0.527	0.256	-0.127 (0.000)
C&I rate spread	0.800	1.530	2.500	1.558	0.360	-0.076 (0.010)
Deregulatory event	0	0	1	0.016	0.124	0.004 (0.898)
Economic shock index	-2.127	-0.283	15.972	0.023	1.415	-0.016 (0.582)
Econ shock index * tight capital	-2.127	0.000	9.069	-0.107	1.095	-0.030 (0.311)
Sales growth	-0.918	0.076	1.133	0.074	0.086	
Herfindahl index	0.013	0.089	0.896	0.138	0.132	0.002 (0.945)
Number of firms	2	92	962	127.260	130.880	0.080 (0.006)

Table 3. Regressions of merger intensity

Panel 1 presents the regressions of merger intensities on sales growth and control variables, estimated according to (29). See Table 2 for variable definitions. In column 1 the independent variable is overall merger intensity. In column 2 (3) it is horizontal (conglomerate) merger intensity. Column 4 (5) presents the regression of horizontal merger intensity for industries with Herfindahl indexes above (below) the sample median. Column 6 (7) presents the regression of horizontal merger intensity for industries with below (above) median number of firms. P-values are in parentheses. Bold values indicate significance at the 5% level. Panel 2 presents the economic significance of the results. We first compute the level of sales growth that corresponds to the implied minimum merger intensity. Then we change the sales growth by one standard deviation (0.086) and calculate the implied merger intensity. We report the difference between these two implied merger intensities in the first row. The second (third) row reports the change in the merger intensity above scaled by the mean (median) merger intensity from Table 1. In the columns in which the economic significance is not reported, there is no implied minimum merger intensity.

	All mergers	Horizontal	Conglomerate	High Herfindahl	Low Herfindahl	Low number firms	High number firms
Panel 1 - Regressions of merger intensity on sales growth and its square							
Intercept	8.141 (0.001)	4.086 (0.000)	4.054 (0.021)	3.272 (0.025)	3.408 (0.001)	3.176 (0.056)	2.363 (0.001)
Market-to-book	0.149 (0.804)	0.077 (0.805)	0.071 (0.888)	-0.048 (0.914)	0.288 (0.525)	-0.138 (0.804)	0.405 (0.263)
Std (market-to-book)	-0.094 (0.733)	0.089 (0.534)	-0.183 (0.432)	0.168 (0.386)	-0.058 (0.804)	0.258 (0.203)	-0.240 (0.259)
Three-year RET	0.074 (0.817)	0.333 (0.045)	-0.259 (0.336)	0.497 (0.032)	-0.176 (0.514)	0.423 (0.094)	0.079 (0.722)
PP&E-to-assets	-5.743 (0.006)	-2.546 (0.020)	-3.198 (0.072)	-1.288 (0.392)	-2.502 (0.153)	-0.817 (0.607)	-4.134 (0.017)
C&I rate spread	-1.330 (0.001)	-0.639 (0.001)	-0.691 (0.033)	-0.278 (0.373)	-0.885 (0.001)	-0.431 (0.203)	-0.671 (0.004)
Deregulatory event	0.026 (0.981)	0.235 (0.686)	-0.208 (0.825)	0.666 (0.641)	0.055 (0.921)	-0.049 (0.823)	0.279 (0.560)
Economic shock index	0.307 (0.082)	0.288 (0.002)	0.020 (0.896)	0.235 (0.045)	0.578 (0.002)	0.209 (0.095)	0.506 (0.002)
Econ shock index * tight capital	-0.195 (0.334)	-0.185 (0.080)	-0.101 (0.953)	-0.186 (0.216)	-0.317 (0.043)	-0.113 (0.495)	-0.243 (0.080)
Sales growth	-3.109 (0.074)	-4.098 (0.000)	0.990 (0.503)	-6.828 (0.000)	2.779 (0.107)	-6.455 (0.000)	2.227 (0.175)
Sales growth squared	6.753 (0.028)	9.859 (0.000)	-3.105 (0.233)	10.653 (0.000)	-1.843 (0.773)	10.344 (0.000)	1.339 (0.822)
# industry-years	1,176	1,176	1,176	590	586	579	597
Adj. R squared	6.52%	12.17%	6.08%	15.17%	9.93%	11.91%	14.30%
Panel 2 - Economic significance							
Change in merger intensity from implied minimum if sales growth changes by one std.	0.050%	0.072%	--	0.078%	--	0.076%	--
Relative-to-mean change in merger intensity	2.02%	6.19%	--	6.69%	--	6.49%	--
Relative-to-median change in merger intensity	4.59%	20.69%	--	22.35%	--	21.71%	--