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Horizontal Mergers and Exit in Declining Industries*

Darren Filson and Bunchon Songsamphant
Horizontal Mergers and Exit in Declining Industries

Abstract:
Previous work on exit in declining industries has neglected mergers. We examine a simple model that predicts which declining industries experience horizontal mergers. Mergers are more likely if 1) market concentration is high; 2) the inverse demand curve is steep at high levels of output and flat at low levels of output; and 3) the industry declines slowly early on and rapidly later on. The conditions that make mergers privately profitable also tend to make them socially optimal. We test the model using U.S. manufacturing industries that declined during 1975-1995 and find some empirical support.

JEL Codes: L10: Market Structure, Firm Strategy, and Market Performance; G34: Mergers and Acquisitions; L41: Antitrust Policy, Horizontal Anticompetitive Practices

Keywords: takeover, restructuring, consolidation, industry dynamics, failing industries
1. Introduction

Interest in declining industries was sparked by Harrigan (1980), who analyzed several declining industries and provided a taxonomy of strategic behavior in such settings. Since Harrigan’s study, several game theorists have developed models to analyze exit behavior in declining industries (Ghemawat and Nalebuff, 1985, 1990; Reynolds, 1988; Whinston, 1988; Londregan, 1990; and King, 1998). However, most work to date focuses on a limited range of strategic behavior – firms either reduce capacity incrementally or shut down entirely. The analysis of other possible strategies, such as exit through mergers or acquisitions, has been neglected.¹

The goal of this paper is to incorporate the possibility of horizontal mergers (mergers between competitors) into a model of exit from a declining industry in order to predict which industries experience mergers. To do this in a simple way, in Section 2 we extend the basic duopoly model of Ghemawat and Nalebuff (1985) to allow for mergers. Though simple, our model provides insight into consolidation and the order of exit. Interestingly, the conditions that make mergers privately profitable also tend to make them socially optimal.

The model generates falsifiable hypotheses about which declining industries experience mergers.² Mergers are more likely if 1) market concentration is high; 2) the inverse demand curve is steep at high levels of output and flat at low levels of output; and 3) the industry declines slowly early on and rapidly later on. Result 1 can be tested directly. Results 2 and 3 imply that mergers are more likely when quantity reductions early on in the declining period are associated

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¹ One exception is Dutz (1989), who uses a Cournot-style model with linear demand and capacity constraints to analyze how the profitability and welfare implications of horizontal mergers are affected by the level of the intercept of the demand curve pre and post-merger.
² Much of the empirical work on declining industries has also neglected mergers (Baden-Fuller, 1989; Lieberman, 1990; Deily, 1991). One exception is Schary (1989), who finds that firm characteristics are insufficient for predicting the form of exit in the cotton textile industry 1924-40. Dutz (1989) also describes case studies of mergers
with larger increases or smaller decreases in price, while quantity reductions later on in the
declining period are associated with smaller increases or larger decreases in price. In Section 3
we test these hypotheses using data on four-digit SIC code U.S. manufacturing industries that
declined during 1975-1995. The results provide some empirical support for the model.

2. The Model

In this section we develop a simple duopoly model of exit from a declining industry. The
model extends the model developed by Ghemawat and Nalebuff (1985) to allow for mergers.
There are two firms, \(L\) and \(S\). Firm \(L\) has capacity \(K_L\) and firm \(S\) has capacity \(K_S\), where \(K_L > K_S\).
Both firms have the same unit cost of capacity \(c\). Production is all or nothing, so each period
each firm must produce at capacity or exit the market. Once a firm exits reentry is not possible.\(^3\)

The inverse demand at time \(t\) depends on the total industry output (which is identical to
the industry capacity) and an industrial decline function \(g(t)\) that determines how much demand
has declined. Assume that \(g(0) = 0\) and that \(g(t)\) is an increasing function – this implies that
when time increases, the inverse demand function decreases. If both firms are in the market

\[
P(t) = a - f(K_L + K_S) - g(t),
\]

where \(P(t)\) is the price in period \(t\) and \(a\) is a constant. If only firm \(i\) is in the market

\[
P(t) = a - f(K_i) - g(t).
\]

Each firm’s profit at time \(t\) is

\[
\pi_i(t) = [P(t) - c]K_i.
\]

\(^3\) The analysis of cyclical industries, where demand is expected to eventually rise again, would be much more
complicated because it would be important to allow for new entrants. Gowrisankaran (1999) begins to address these
complications by introducing a dynamic equilibrium model with mergers and entry in a stationary setting.
Assume that \( a - f(K_L + K_S) = c \). This implies that if both firms are in the market at time 0 then both earn zero profits. Because demand declines from then on, if both firms stay in the market then both earn losses. Therefore one must exit. After one firm exits, the other earns monopoly profits until it, too, exits. Given that \( c = a - f(K_L + K_S) \), the monopolist’s profit function is

\[
\pi_i(t) = [-g(t) - f(K_i) + f(K_L + K_S)]K_i.
\]

Expression (4) shows that profits, and therefore behavior, depend on only three things in the model: the firms’ capacities, the curvature of the inverse demand function as determined by \( f(.) \), and the shape of the decline function.

The monopolist exits when its profit falls to zero. By equation (4) this occurs when

\[
g(t) = -f(K_i) + f(K_L + K_S).
\]

Inverse equation (5) to obtain

\[
t_i = g^{-1}(f(K_L + K_S) - f(K_i)),
\]

where \( t_i \) is the period when firm \( i \) exits. Because \( K_L > K_S \) and \( g(.) \) is an increasing function, the large firm’s exit period is before the small firm’s: \( t_L < t_S \).

If mergers are not possible, then the model is a special case of the model described by Ghemawat and Nalebuff (1985). Ghemawat and Nalebuff (1985) show that in the unique subgame perfect Nash equilibrium (SPNE) the large firm exits first. The intuition for why this occurs is that when demand declines the small firm can last longer as a monopoly than the large firm. Recognizing this, the large firm does not get involved in a war of attrition it knows it cannot win – it exits immediately.\(^4\)

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\(^4\) Of course, if the large firm is large because it is more efficient than the small firm, the large firm may be able to outlast the small firm (see Fudenburg and Tirole (1986), for example). Several other authors have also concluded that small firms may have an advantage in declining industries (see Reynolds, 1988; Ghemawat and Nalebuff, 1990; and Londregan, 1990).
Note that Ghemawat and Nalebuff’s result does not refer to which firm is more *profitable* as a monopoly – the argument relies only on which firm can last longer. It is possible that cumulative industry profit over the declining period is higher if the small firm exits first. In this case, if mergers are permitted and transactions costs are sufficiently low, the large firm prefers to buy the small firm in period 0 and shut it down. That is, consolidation occurs when the large firm’s value as a monopoly is greater than that of the small firm.

The model yields a simple inequality that determines whether mergers occur. To derive this condition, the large and small firms’ values as monopolists must be computed. Integrate the profit function (eq. (4)) from period 0 to the firms’ exit period $t_i$:

$$V_i = [-G(t_i) - f(K_i) t_i + f(K_L + K_S) t_i] K_i,$$

where $G(t_i) = \int_0^{t_i} g(t) dt$. For simplicity discounting future payoffs is ignored. The ratio $V_L/V_S$ is

$$\frac{V_L}{V_S} = \frac{[-G(t_L) - f(K_L) t_L + f(K_L + K_S) t_L] K_L}{[-G(t_S) - f(K_S) t_S + f(K_L + K_S) t_S] K_S}$$

$$= \frac{[-G(t_L) + at_L - f(K_L) t_L - at_L + f(K_L + K_S) t_L] K_L}{[-G(t_S) + at_S - f(K_S) t_S - at_S + f(K_L + K_S) t_S] K_S}$$

$$= \frac{[-G(t_L) + t_L(P_L - P)] K_L}{[-G(t_S) + t_S(P_S - P)] K_S},$$

where $P_L = a - f(K_L) (P(0) \text{ when } L \text{ is a monopolist}); P_S = a - f(K_S) (P(0) \text{ when } S \text{ is a monopolist});$ and $P = a - f(K_L + K_S) (P(0) \text{ when both firms are in the market}).$

The large firm buys the small firm if $V_L/V_S > 1$. This condition holds if

$$\frac{K_L}{K_S} > \frac{-G(t_S) + t_S(P_S - P)}{-G(t_L) + t_L(P_L - P)}.$$

\(\)
Inequality (11) determines whether consolidation occurs. Partial derivatives show that mergers are more likely when \( K_L, P_L - P, G(t_s), \) and \( t_L \) are high and \( K_S, P_S - P, G(t_L), \) and \( t_S \) are low. In the following paragraphs we describe restrictions on the capacities, \( f(.) \), and \( g(.) \) that make these conditions hold. Our goal is to formulate testable hypotheses about conditions that lead to mergers in declining industries.

First, inequality (11) is more likely to hold when \( K_L \) is high and \( K_S \) is low. This suggests a testable hypothesis:

**Result 1:** Mergers are more likely in declining industries that are more concentrated.

We test this hypothesis below. The theoretical literature on horizontal mergers supports the claim that concentration makes mergers more profitable, and therefore more likely (Salant, Switzer, and Reynolds, 1983; Deneckere and Davidson, 1985; and Perry and Porter, 1985). Our model shows that this claim applies to declining industries as well. Barriers to entry and expansion are also important – empirical work on collusion shows that large market shares of the colluding group combined with barriers to entry and expansion make central coordination more likely to occur (Filson et al. 2001). Here we have assumed that since the industry is declining there is no entry or expansion.

The second condition is that inequality (11) is more likely to hold when \( P_L - P \) is high and \( P_S - P \) is low. This condition matters because the monopolist gets the markup \( P_l - P - g(t) \) throughout the declining period. The condition suggests the following result:
Result 2: Mergers are more likely in industries in which the inverse demand curve is steep at high levels of output and relatively flat at low levels of output (the $f(.)$ function is convex).

To see why Result 2 holds, note that if the inverse demand curve is steep at high levels of output then $P_L - P$ will be high. Further, if the inverse demand curve is relatively flat at low levels of output then $P_S - P$ will be low. Consider an extreme example where the inverse demand curve has a kink at $(K_L, P_L)$, as shown in Figure 1. Figure 1 shows how, for a given value of $P_L - P$, the degree to which the inverse demand curve flattens out at low levels of output affects $P_S - P$.

The third condition is that inequality (11) is more likely to hold when $G(t_S)$ and $t_L$ are high and $G(t_L)$ and $t_S$ are low. This suggests that the pattern of decline is important:

Result 3: Mergers are more likely in markets that experience a low rate of decline early on and a high rate of decline later on.

To see why Result 3 holds, consider an extreme case where $g(t) = 0$ for $t < t^*$, $g(t^* + 1) = a - f(K_L)$ and $g(t^* + 2) = a - f(K_S)$. The market does not decline until time $t^*$, and then it declines rapidly. Early on in the declining period, no decline occurs, so if firm $L$ is a monopolist it gets the benefit of a high $P_L$ for several periods. Further, $t_L = t^* + 1$ and $t_S = t^* + 2$, so firm $S$ gets only one extra period as a monopolist. If $P_S$ is very close to $P_L$ then the two firms’ markups are essentially the same, so if firm $L$ is sufficiently larger than firm $S$ then it must be the more profitable monopolist – firm $S$’s only advantage is that it lasts an extra period, but firm $L$’s advantage is that each period it produces much more output.
This is an extreme example, but real-world decline patterns could come close to it. Empirical studies of technology substitution, such as Norton and Bass (1987, 1992), suggest that the pattern of decline in declining industries is similar to the pattern of growth in new industries: both can be described using S-shaped diffusion curves. The rate of decline is initially low, then it accelerates, and then it diminishes once decline is substantially complete. If the initial period with a low rate of decline is long and the period of acceleration is short then a pattern like that described above would occur (see Figure 2).

Results 2 and 3 cannot be tested separately because it is not possible to distinguish the effects of output changes that cause movements along the inverse demand curve from the effects of decline that cause the curve to shift. However, taken together, the two results yield a testable hypothesis about when mergers are likely to occur: if the inverse demand curve is steep at high levels of output \( \text{and} \) the rate of decline is low initially, then we should observe a steep relationship between price and output early on in the declining period because the inverse demand curve is relatively stable. If the inverse demand curve is flat at low levels of output and the rate of decline is rapid later on in the declining period, then we should observe either a flat relationship between price and output or a positive relationship (price and output may decline together). Therefore, we should observe the following pattern when comparing industries: industries in which mergers occur should have a more negative or less positive relationship between price and output early on in the declining period and a less negative or more positive relationship later on in the declining period. We test this hypothesis below.

**Social Welfare**

In this subsection we show that the conditions that make mergers likely also tend to make them socially optimal. To see this, compare social welfare when \( L \) is a monopolist to when \( S \) is a
monopolist. Social welfare in period $t$ when $L$ is a monopolist is the area under the inverse demand curve above $c$, 

$$[a - g(t) - c]K_L - F(K_L), \quad (12)$$

where $F(K_L) = \int_0^L f(z)dz$. To obtain social welfare over the entire declining period when $L$ is a monopolist, integrate expression (12) from 0 to $t_L$:

$$W_L = [(a - c)t_L - G(t_L)]K_L - F(K_L)t_L \quad (13)$$

$$= [f(K_L + K_S)t_L - G(t_L)]K_L - F(K_L)t_L$$

$$= V_L + f(K_L)t_LK_L - F(K_L)t_L.$$ 

$W_S$ is defined similarly – simply replace $K_L$ and $t_L$ with $K_S$ and $t_S$. Given expression (13), if $V_L > V_S$, then a sufficient condition for $W_L > W_S$ is

$$[f(K_L)K_L - F(K_L)]t_L > [f(K_S)K_S - F(K_S)]t_S. \quad (14)$$

Figure 3 shows that $f(K_L)K_L - F(K_L) > f(K_S)K_S - F(K_S)$. The gap between the two expressions is shaded in Figure 3. Clearly the gap is increasing in the concavity of the inverse demand curve as determined by $f(.)$. Therefore, a concave inverse demand curve (a convex $f(.)$) makes it more likely that a merger is socially optimal. As noted in Result 2, this is also one of the conditions that makes a merger privately profitable. The only way expression (14) may not hold is that $t_S$ may be much larger than $t_L$, but as noted in the discussion of Result 3 this makes it less likely that a merger is privately profitable. Therefore, the conditions that make mergers privately profitable also tend to make them socially optimal.

**Oligopoly**

In this subsection we provide a brief analysis of mergers in the case of three firms to show that the model continues to yield the testable hypotheses described above. Assume that
regulators do not permit a merger unless industry profit is zero and one firm is about to exit. This is a reasonable rule because if industry profit is positive then social welfare is increasing in total industry capacity so mergers that involve capacity reductions would not be permitted. On the other hand, if industry profit is zero then it may be desirable to allow a merger in order to rationalize capacity reduction.

Given the assumption that mergers can occur only when industry profit is zero, if there are positive transactions costs of merging then only the largest firm in the market can find it optimal to purchase another firm. A smaller firm will not incur the expense to purchase the largest firm and shut it down because if no merger occurs the largest firm will exit on its own, and the smaller firm will not purchase and shut down a firm other than the largest because it is better off with the larger reduction in industry capacity that occurs when the largest firm exits (because the industry price rises more).

Given that only the largest firm can be an acquirer, we analyze conditions under which the largest of three firms finds it optimal to purchase and shut down one of the smaller firms. Index the firms by 1, 2, and 3, where 1 is the largest and 3 is the smallest. Assume that at time 0 industry profits are zero if all three firms are in the market. The formal analysis is quite tedious because a variety of cases must be considered. At time 0, firm 1 may exit, buy firm 2, or buy firm 3. In order to value each one of these options, future choices must be considered. For example, if firm 1 exits, does firm 2 buy firm 3 at some point in the future? If firm 1 buys firm 2, does firm 1 buy firm 3 later on? For brevity, we present a formal analysis of the simplest case in the appendix, and here we restrict ourselves to providing intuition. In the appendix we assume that firm 1 prefers exiting to buying firm 3. This implies that firm 1 compares exiting to buying firm 2. Further, we assume that no future mergers occur.
The intuitive explanation for why Results 1-3 continue to hold in the oligopoly case is as follows. If firm 1 buys one of the smaller firms and shuts it down then a smaller reduction in industry capacity occurs than would be the case if firm 1 exited. The relative profitability of each option (exit, buy firm 2, buy firm 3) depends on how much price rises in each case. For example, if the inverse demand curve is steep when output is greater than $K_1 + K_3$ and relatively flat when output is below $K_1 + K_3$ then, as in the duopoly case, the markup is similar whether firm 1 or 2 is shut down. Further, as in the duopoly case, if demand declines slowly early on then firm 1 benefits from a high markup for several periods, and the larger firm 1’s capacity, the more units of output the high markup is spread over. If demand declines rapidly around the time that firm 1 must exit then the exit periods of all of the firms are similar – the small firms do not benefit much from having a longer life. Thus, in the oligopoly case the three results obtained in the duopoly case continue to hold: mergers are more likely if firm 1 is large, the inverse demand curve is concave, and demand declines slowly early on and rapidly later on.

3. Empirical Analysis

Most of the empirical literature on declining industries uses a case study approach (pioneered by Harrigan, 1980, and employed by Ghemawat and Nalebuff, 1990, among others; Lieberman, 1990, is a notable exception). In contrast, we provide large sample results to test our model. There are advantages and disadvantages to our approach. An advantage is that we can be confident that our results are not specific to a few isolated cases. A disadvantage is that our data is not sufficiently detailed to examine many of the issues case studies address, such as the precise order of plant shutdowns. Given this, our empirical analysis focuses on the model’s testable implications for mergers and not on the order of exit.

Data
The data includes all of the four-digit SIC (Standard Industrial Classification) manufacturing industries in the United States that declined during the period 1975-1995. The four-digit SIC code industries are used because of the availability of data on concentration ratios, price, quantity, and mergers. Price and output measures are from the NBER Manufacturing Productivity Database (Bartelsman and Gray, 1996). Industry output was calculated by dividing the value of shipments in each industry by its price index. After computing output, the price indexes were deflated using the CPI to remove economy-wide inflation, and the deflated prices were used to compute the statistics reported below. The market concentration ratios are from the Census of Manufactures. Merger data is from the Lexis-Nexis database, which allows searches for mergers and acquisitions by SIC code.

From the 459 U.S. manufacturing industries in the NBER database, 104 declining industries were selected using the following criteria: an industry is defined as declining when the industry output begins declining in the 1975-85 period, declines over at least a five-year period, and then stays below its level at the first period of decline until at least 1995. These criteria are designed to exclude industries that decline due to cyclical fluctuations.

The declining industries are classified into two groups. There are 47 industries in the “no-merger group,” in which no horizontal mergers or acquisitions occur. There are 57 industries in the “merger group,” in which horizontal mergers occur. Because the theoretical model does not distinguish between mergers and acquisitions we do not distinguish between the two here. Firms in the no-merger group may be involved in vertical mergers (mergers with buyers or suppliers) or other types of mergers. We count only mergers between competitors that have significant operations in the U.S., and we include cases where a firm acquires a major division from a competitor. Thus, a merger need not involve the exit of a firm, although in most cases it does.
Before proceeding to the hypothesis tests we present summary statistics. Tables 1a and 1b summarize the declining periods and the rates of decline in the no-merger group and the merger group, respectively. For example, SIC code 2067, Chewing Gum, declined from 1979-1991, and output fell 18.7% during this period. By 1995 output had increased somewhat; output fell 6.1% from 1979-1995. The averages show that the average length of the declining period is higher in the merger group and the average rate of decline is lower in the merger group, but the differences are small and statistically insignificant.

Tables 2a and 2b list the number of firms in 1977 and 1992. The Census of Manufactures provides firm numbers every five years, and some SIC codes change over time (see fn. 5 below). The numbers in Tables 2a and 2b provide a rough measure of firm numbers before and after decline and the net exit rate. Net exit occurs in most industries, but in some cases net entry occurs. This suggests that future models might explore the implications of allowing entry to occur during the declining period, although as we noted above in fn. 3, this would complicate the analysis considerably. The results in the tables show that, on average, industries with mergers have more firms and less exit. Although the differences in the averages are large they are statistically insignificant because there is a high amount of variation in firm numbers and exit rates within each group.

**Hypothesis Tests**

The first hypothesis states that mergers are more likely to occur in markets that are more concentrated at the beginning of the declining period. Table 3a and 3b reports the share of the value of shipments of the four largest, eight largest, twenty largest, and fifty largest firms in 1977 (CR4, CR8, CR20, and CR50). The results show that, on average, there is not much difference

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5 Concentration ratios and firm numbers are available from the Census of Manufactures every five years. In a few cases (SIC 2111, 2823, and 3263), some of the concentration ratios were withheld to protect firms’ private
between the two groups. The industries in the merger group are more concentrated using the CR4 measure but less concentrated using the other measures, and the differences are very small and statistically insignificant. This appears to provide little support for the hypothesis.

However, one fact has not been considered: antitrust officials are less likely to allow large firms in more concentrated industries to merge. Taking this as given, if firms in more concentrated industries are neither more nor less likely to attempt mergers then what we should expect to see in Tables 3a and 3b is that average concentration is much higher in the no-merger group. Attempts would be equally likely regardless of concentration but firms in more concentrated industries would be blocked more often. The fact that we do not observe this pattern in Tables 3a and 3b suggests that firms in more concentrated industries are more likely to attempt mergers, and this supports our hypothesis.

The second hypothesis states that mergers are more likely to occur in industries where the relationship between price and quantity is more negative or less positive early on in the declining period and less negative or more positive later on. To test this hypothesis we look for evidence of a structural break in the price-output relationship during the declining period. We divide the declining period in each industry into two equal parts and investigate the price-output relationship in each part.

First, we look for evidence that prices rise more or fall less in the early part of the declining period in industries where mergers occur. Tables 4a and 4b show that, on average, prices fall less early on in the merger group than in the no-merger group. Further, prices fall at a

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information. In these cases we computed the minimum possible concentration ratio given the number of firms. In some other cases (SIC 2325, 2656, 2999, 3339, 3362, 3494, 3536, 3553, 3556, 3594, 3613, 3641, 3671, 3965) the composition of the SIC code had changed since 1977, and in those cases we computed firm numbers and concentration ratios using weighted averages of the old SIC codes. The weights are from the NBER web site in the materials provided by Bartelsman and Gray (1996).
higher rate later on in the merger group than in the no-merger group. These results support the hypothesis.

To proceed further, we regress the natural log of price on the natural log of output in each industry in each part of the declining period. Using logs removes the impact of units of measurement on the results. The OLS equation is

$$lp_t = \alpha_0 + \beta_0 lq_t + \epsilon_t,$$

where $lp_t$ is the log of the price series, $lq_t$ is the log of the output series, $\alpha_0$ and $\beta_0$ are coefficients, and $\epsilon_t$ is the error term.

The model predicts that changes in the steepness of the price-output curve over the declining period affect the likelihood of mergers. In industries where mergers occur, $\beta_0$ should be lower early on in the declining period and higher later in the declining period, where “lower” and “higher” are determined relative to the industries where mergers do not occur.

Tables 4a and 4b report the $\beta_0$ coefficients from OLS regressions when the declining period in each industry is divided in two. The results support the hypothesis of the model. The average $\beta_0$ over the first half of the declining period of the merger group (0.10) is lower than the coefficient of the no merger group (0.11), and the average $\beta_0$ over the second half of the declining period of the merger group (0.18) is higher than the coefficient of the no merger group (0.078). The difference between the early coefficients is statistically insignificant, but the difference between the late coefficients is significant at the 5% level.

Thus, the results suggest that the main effect driving mergers is that in the industries in which mergers occur, demand declines rapidly late in the declining period. In this case, small firms cannot survive much longer than large firms, so the large firms’ advantage from having higher profits in the short term makes the large firm more valuable.
4. Conclusion

This paper presents a theoretical model and an empirical analysis to investigate horizontal mergers in declining industries. Ghemawat and Nalebuff (1985) show that when production is all-or-nothing large firms exit before small firms in declining industries. Our simple extension of their model shows that large firms may be more valuable than small firms, and this implies that when mergers are allowed the large firms may buy the small ones and shut them down. The large and small firms’ values are determined by three factors: the firms’ capacities, the shape of the inverse demand function, and the rate of decline in demand (and how this rate changes over time). Mergers are more likely in industries where the pre-merger market is concentrated and where small capacity reductions early on in the declining period lead to larger increases in price. The empirical results conform to the model’s predictions.

Note that the model presented here is very simple, and it cannot explain all of the possible reasons for merging in a declining industry. One notable absence is that we have not considered efficiency advantages, which cannot be measured with our data but are probably important (see Dutz, 1989). Introducing efficiency advantages could affect many of our results. For example, in our model the acquiring firm is always larger than the acquired firm, but this need not be the case if efficiency differences exist. A small efficient firm may choose to buy a large inefficient firm’s capacity in order to use the capacity more effectively.

Future work on mergers in evolving industries could make several contributions. In addition to considering efficiency differences, the assumption of all-or-nothing production could be relaxed (as in Ghemawat and Nalebuff, 1990), and firms could be allowed to buy each other’s plants. Second, the analysis could consider entry and allow for the fact that while many industries decline, few disappear completely. Allowing for entry and incomplete decline would
allow the analysis to move beyond declining industries to consider industries at various stages in development. Recent work suggests that exploring how integration varies at different stages in an industry’s evolution would be useful: Franco and Filson (2001) show that horizontal mergers were an important form of exit in the disk drive industry during the 1980s and 1990s, and Filson (2001) shows that vertical integration occurred early in the personal computer industry’s life cycle and just prior to its shakeout in the early 1990s.
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Appendix: Formal Analysis of the Three-Firm Oligopoly

Whether firm 1 prefers to exit at time 0 or buy firm 2 and shut it down depends on which firm is more valuable as a duopolist competing with firm 3. If firm 1 exits at time 0 then firms 2 and 3 coexist until demand declines to the point where firm 2 must exit - denote this period by $t_2$. If firm 1 buys firm 2 and shuts it down at time 0 then firms 1 and 3 coexist until demand declines to the point where firm 1 must exit – denote this period by $t_1$. Using similar steps to those in the duopoly case the two firms’ values can be computed as follows:

$$V_i = [-G(t_i) - f(K_i + K_3)t_i + f(K_i + K_2 + K_3)t_i]K_i,$$  \hspace{1cm} (15)

where $i = 1, 2$. Again, following steps similar to those in the duopoly case, $V_1 > V_2$ if

$$\frac{K_1}{K_2} > \frac{-G(t_2) + t_2(P_2 - P_0)}{-G(t_1) + t_1(P_1 - P_0)},$$  \hspace{1cm} (16)

where $P_1 = a - f(K_1 + K_3)$ ($P(0)$ when 1 and 3 are duopolists); $P_2 = a - f(K_1 + K_2)$ ($P(0)$ when 2 and 3 are duopolists); and $P_0 = a - f(K_1 + K_2 + K_3)$ ($P(0)$ when all three firms are in the market).

Clearly, expression (16) is directly comparable to expression (11) obtained in the duopoly case, so the results obtained for the duopoly case apply to this case. For the sake of brevity we have not presented a variety of other cases with different future paths (for example, instead of exiting at $t_1$ firm 1 might prefer to buy firm 3 and shut it down), but note that even in the other cases the $V_i$ terms in expression (15) are part of each firm’s value, if not the entire value. Therefore, any factors that make expression (16) more likely to hold contribute towards making mergers more profitable.
Figure 1
Figure 2

g(t)

0  
t
### Table 1a: Decline in Output in the No-Merger Group

<table>
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<tr>
<th>SIC Code</th>
<th>Description</th>
<th>Period of Decline</th>
<th>Total Rate of Decline</th>
<th>Total Rate of Decline as of 1995</th>
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<td>Cigarettes</td>
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<td>1976-86</td>
<td>-41.4</td>
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<p>| Avg.     | (length)                                                  | -48.8              | -37.8                 |                    |
| S.D.     |                                                          | 4.0                | 20.7                  | 25.0               |</p>
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<th>Total Rate of Decline as of 1995</th>
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Table 2a: Firm Numbers in the No-Merger Group

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Avg.     | 235.1                                    | 182.0          | -14.0          |
S.D.     | 262.2                                    | 194.1          | 32.8           |
Table 2b. Firm Numbers in the Merger Group

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### Table 3a: Concentration in 1977 in the No-Merger Group

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Avg.  42.6  56.8  73.4  85.9  
S.D.  20.3  22.6  21.0  15.9
Table 4a: Price Changes and P-Q Curve Results for the No-Merger Group

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<td>Elevators and moving stairways</td>
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<td>-3.4</td>
<td>.30</td>
<td>.31</td>
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<td>3536</td>
<td>Hoists, cranes, and monorails</td>
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<td>-1.3</td>
<td>.050</td>
<td>.10</td>
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<tr>
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<td>Woodworking machinery</td>
<td>-0.2</td>
<td>-1.8</td>
<td>.004</td>
<td>-.034</td>
</tr>
<tr>
<td>3634</td>
<td>Electric housewares and fans</td>
<td>-2.0</td>
<td>-2.5</td>
<td>.52**</td>
<td>.36</td>
</tr>
<tr>
<td>3676</td>
<td>Electronic resistors</td>
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<td>1.4</td>
<td>.11</td>
<td>-.30**</td>
</tr>
<tr>
<td>3873</td>
<td>Watches, clocks, watchcases, and parts</td>
<td>-2.2</td>
<td>-1.8</td>
<td>.20***</td>
<td>.14</td>
</tr>
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<td>3951</td>
<td>Pens and mechanical pencils</td>
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<td>1.6</td>
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<td>-.096</td>
</tr>
<tr>
<td>3965</td>
<td>Fasteners, buttons, needles, and pins</td>
<td>-2.7</td>
<td>-1.8</td>
<td>.60***</td>
<td>.15***</td>
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</table>

| Avg.     | -1.2                                            | -1.0                             | 0.11***                      | 0.078       |
| S.D.     | 2.4                                             | 2.7                             |                              | 0.0010      |
| V(Avg.)  | 0.0010                                          | 0.0010                           |                              | 0.0010      |

* *, **, ***: Sig. at the 10%, 5%, and 1% levels. The null hypothesis in the “early slope” column is that the coefficient is equal to zero. The null hypothesis in the “late slope” column is that the coefficient is equal to the coefficient in the early slope column.
Table 4b. Price Changes and P-Q Curve Results for the Merger Group

<table>
<thead>
<tr>
<th>SIC Code</th>
<th>Description</th>
<th>Early avg. rate of price change</th>
<th>Late avg. rate of price change</th>
<th>Early slope</th>
<th>Late Slope</th>
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<tbody>
<tr>
<td>2051</td>
<td>Bread, cake, and related products</td>
<td>-1.0</td>
<td>0.5</td>
<td>.71***</td>
<td>.29****</td>
</tr>
<tr>
<td>2062</td>
<td>Cane sugar refining</td>
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<td>-1.5</td>
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<td>.65</td>
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<td>2079</td>
<td>Edible fats and oils, nec</td>
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<td>.041*</td>
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<td>2085</td>
<td>Distilled and blended liquors</td>
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<td>0.2</td>
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<tr>
<td>2091</td>
<td>Canned and cured fish and seafood</td>
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<td>.022</td>
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<tr>
<td>2095</td>
<td>Roasted coffee</td>
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<td>2.6</td>
<td>-3.0</td>
<td>-1.23</td>
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<td>2121</td>
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<td>2221</td>
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<td>-2.3</td>
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<tr>
<td>2311</td>
<td>Men’s and boys’ suits and coats</td>
<td>-1.7</td>
<td>-9</td>
<td>.64***</td>
<td>.14***</td>
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<tr>
<td>2325</td>
<td>Men’s and boys’ trousers and slacks</td>
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<td>-1.1</td>
<td>.24</td>
<td>.34</td>
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<td>Women’s, misses’, and juniors’ blouses and shirts</td>
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<td>-1.8</td>
<td>-.18*</td>
<td>.24**</td>
</tr>
<tr>
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<td>Women’s and children’s underwear</td>
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<td>-2.1</td>
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<td>.41</td>
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<td>Sanitary food containers</td>
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<td>.024</td>
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<td>2392</td>
<td>Explosives</td>
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<td>-.012</td>
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<td>3144</td>
<td>Women’s footwear, except athletic</td>
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<td>-1.3</td>
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<td>-6</td>
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<td>.034**</td>
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<td>.57</td>
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<td>3255</td>
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<td>.091**</td>
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