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THE PAPER INDUSTRY

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Horizontal Mergers in the Paper Industry
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ABSTRACT

This paper examines mergers and acquisitions in the US paper and paperboard industry. This industry experienced a wave of horizontal mergers during the mid 1980s. We study implications of mergers on consumers, rival firms, and welfare. The analysis is based on a model of investment decisions. We compare the equilibrium investment decisions prior to and after the merger wave. The evidence indicates that the efficiency of the majority of acquiring firms increases following an acquisition. Based on the parameter estimates, we calculate merger welfare effects. We find that total welfare increased by \$583.5 million as a result of the mergers.

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1. INTRODUCTION:

Mergers and acquisitions have long been a public policy concern. In the United States, Section 7 of the Clayton Act prohibits mergers that “substantially decrease competition or tend ... to create a monopoly. ” In recent years the volume of mergers and acquisitions in US industries has increased. Antitrust regulators reviewed a total of 3702 deals in 1997 compared to 1451 in 1991.¹ Mergers are a common phenomenon in industries affecting rival firms and consumers.

This paper studies implications of horizontal mergers in the paper and paperboard industry. A total of 31 horizontal mergers took place during the mid 1980s. We examine the merger effect on consumers, rival firms and welfare. The analysis is based on a model of investment behavior. There are at least two reasons for examining investment decisions: First, mergers alter the capital allocation within an industry, which affects investment decisions.² Second, investment decisions are the main strategic choice variable in the paper industry.³ We have collected a data set containing firm level data that permits a statistical analysis of merger implications.

Although a number of factors may influence the decision to acquire another company, this paper does not focus on the determinants of merger decisions. Instead, it analyzes the implications of mergers. Investment decisions of individual firms prior to and after the merger wave are contrasted to assess changes in costs due to merger. Based on estimates of cost parameters, merger welfare effects are calculated.

Section 3 describes the model. It considers a one-period investment game. The equilibrium decision rule implies that, for a given level of capacity, efficient firms invest more than inefficient firms. Inverting this equilibrium relationship implies that increased investments reflect higher efficiency holding capacity levels constant. We use this equilibrium relationship to infer changes in efficiency following an acquisition. We also describe predicted merger implications. We establish that a merger is profitable even in the absence of merger cost savings, provided the cost of capital is high. Of course, an acquisition may achieve cost savings enhancing the profitability of the

¹ Business Week, p 35, March 23, 1998

² Short run price, or output effects, may mis-measure merger implications, since they do not take into account changes in investment decisions.

³ Paper and paperboard companies operate their plants at 93 percent of capacity on average during the sample period. Due to the high utilization level, production decisions are less important.

acquisition. The welfare effects of mergers depend on the magnitude of cost savings. In the absence of cost savings, mergers reduce total welfare. On the other hand, when mergers do reduce costs, total welfare is increased.

Section 4 gives background information on the paper industry. It also describes the wave of mergers that took place in the mid 1980s. A total of 31 mergers occurred during three years. The wave took place immediately following the 1984 revision of the merger guidelines. Since antitrust authorities adopted a the friendlier position towards mergers which stemmed at least in part from the 1984 revision, we assume that the merger wave was not anticipated when investment decisions were made in the early 1980s.

Section 5 provides descriptive evidence on the effect of mergers between paper companies. The data suggest that there is a dispersion in merger outcomes. About two thirds of acquiring firms lose market shares after the acquisition. On the other hand, about one third of acquiring firms increase their market share. An examination of the investment decision reveals a similar picture: Merged firms are more likely to change their capacity levels than un-merged firms. However, there is a dispersion in investment decisions across merged firms. Some acquiring firms reduce capacity, while others increase theirs.

Section 6 takes the model to the data. The equilibrium investment decisions, before and after this period, are analyzed in order to assess changes in the underlying cost parameters of firms. The estimates indicate cost savings for most firms involved in a merger: The acquiring firm's cost decreases after the merger.

Based on the cost estimates, merger welfare effects are calculated. The data reveal the following: Overall welfare increases by \$583.5 million due to the merger wave. Cost savings lead to welfare gains following an acquisition. The savings in costs result in an increase of producer surplus. Consumer surplus is also increased, but to a lesser extent.

We report the merger implication on firm profit. The main beneficiaries of the merger wave are the firms involved in an acquisition. The combined profit of merged firms increases by \$ 468.3 million. On the other hand, firms not involved in an acquisition incur a loss. The combined profit of firms not involved in an acquisition decreases by \$99.4 million.

The next section discusses the related literature.

2. RELATED LITERATURE

The literature on mergers mainly examines merger implications considering short-run price, or output effects. Davidson and Deneckere (1983) consider price effects in a differentiated products model. Salant, Switzer and Reynolds (1983), Baye, Crocker and Jiandong (1996), Kamien and Zang (1990), Perry and Porter (1985) and Farrell and Shapiro (1990) consider the Cournot model. Salant, Switzer and Reynolds (1983) establish that in the Cournot model with many firms, no profitable mergers need to exist. Farrell and Shapiro (1990) examine welfare effects of mergers and provide sufficient conditions for a profitable merger to increase welfare.

Long run effects of mergers are examined in Stigler (1950), who analyses the profitability of mergers under entry. He assumes entry occurs gradually and the merged firm makes monopoly profit for a short time period. He shows that a merger for monopoly is profitable if the monopoly profit exceeds the future losses. Cheong and Judd (1993), Berry and Pakes (1993) and Gowrisankaran (1995) study dynamic models of mergers using numeric methods. They analyze merger implications when output adjustment is costly.

There is little empirical research on the effects of horizontal mergers. Exceptions are Kim and Singal (1993) and Knapp (1990) who study the effect of airline mergers. Kim and Singal contrast price changes in routes affected by a merger to routes not affected by a merger. They find substantial price increases due to merger. Hall (1988) studies the effects of mergers on research and development for publicly traded US manufacturing firms.

In comparison, the effects of mergers on shareholder wealth has been studied extensively. The evidence shows that shareholders of acquired firms gain, while the shareholders of acquiring firms do not lose. When the wealth effects of acquired and acquiring firms are combined, the joint value of firms involved in successful tender offers increases significantly. Agrawal, Jaffe and Mandelker (1992) and Jarrell, Brickley and Netter (1988) summarize the literature and present evidence on stock performance. Jensen (1986), Jensen (1988), Scherer (1988) examine the motives for corporate mergers and discuss the empirical evidence on mergers.

The paper and paperboard industry has been studied by a number of authors. Recent papers include Ohanian (1994) and Caves and Christensen (1997). Caves and Christensen examine the role of cheap talk in announcing the construction of a new paper plant.

3. INVESTMENT MODEL

In this section, we describe the investment model. Subsection 4.1. derives the equilibrium decision rule. It illustrates how to assess cost changes based on the equilibrium investment equation. Subsection 4.2. examines merger implications. It analyzes the profitability of mergers and examines their welfare implications.

The model considered is one shot. In principle, dynamic aspects can be incorporated by extending the model to a repeated game setting with the capacity level as a state variable. However, a dynamic formulation has two shortcomings: First, the data are available for a short time horizon only. Second, the state space of the dynamic model is rather complex due to the relatively large number of firms. The computation of a dynamic equilibrium is infeasible. For these reasons, we consider a static model.

The model has the following features. The industry consists of n firms producing a homogeneous good. Firm i is endowed with a level of capacity, K_i and decides whether to invest in additional units of capacity, x_i (or to scrap capacity). Capacity depreciates with a constant factor, $\delta \in (0, 1)$. The capacity level of firm i after the investment is, thus, given by $\delta K_i + x_i$. The cost of additional units of capacity, x_i , is denoted by $r(x_i)$. The production costs for firm i are denoted by $C_i(K_i)$ with marginal cost $c_i(K_i)$.⁴

Demand is given by the inverse demand curve $P(Q)$ where Q denotes industry output and P industry price. We assume that firms operate at full capacity⁵ and, thus, total industry production equals the sum of capacities, $Q = \sum K_i$. Firm i receives revenues of $K_i \cdot P(\sum K_j)$ and we assume the marginal revenue slopes down. We assume a common discount factor parameter, $\beta \in (0, 1)$, as a measure of firm's patience with regard to future profits. Payoffs equal discounted future profits minus the cost of investment. This is given by,

$$\frac{\beta}{1 - \beta} [(\delta K_i + x_i)P(\sum_j (\delta K_j + x_j)) - C_i(\delta K_i + x_i)] - r(x_i) \cdot 1_{\{x_i > 0\}} \quad (1)$$

⁴ For simplicity of exposition, the model does not permit future uncertainty. Of course, iid uncertainty in cost or demand can be incorporated without changing the analysis.

⁵ As mentioned previously, this assumption is reasonable for the paper industry. Paper and paperboard companies operate their plants at 93 percent of capacity on average during the sample period.

where $K = (K_1, \dots, K_n)$ is the vector of firm capacity levels, $x = (x_1, \dots, x_n)$ is the vector of investments and $1_{\{x_i > 0\}}$ equals one if the investment of firm i , x_i , is positive.

3.1. INVESTMENT DECISION

First, we characterize the equilibrium investment (scrapping) decision. We assume that an equilibrium exists. The marginal revenue of an additional capacity unit is denoted by MR_i . Proposition 1 gives the equation characterizing the equilibrium investment decision.

Proposition 1. *The equilibrium investment decision, x_i , is characterized by*

$$x_i \cdot \left\{ [MR_i(K, x_i) - c_i(\delta K_i + x_i)] \frac{\beta}{1 - \beta} - \frac{\partial r(x)}{\partial x} \Big|_{x=x_i} \cdot 1_{\{x_i > 0\}} \right\} = 0 \quad (2)$$

Equation (2) in the proposition gives the Kuhn Tucker condition for optimal investment. It states that the future discounted marginal gain of investment equals the marginal cost of investment. Firms with a positive marginal gain purchase additional units of capacity, while firms with a negative gain reduce capacity. Provided that $\frac{\partial r}{\partial x}|_0 \neq 0$, there may also be a subset of firms that does not invest or scrap.

Observe that a dynamic formulation implies an investment equation similar to (2). In particular, for the special case with $\delta = 1$ and $r(x) = r \cdot x$, the equilibrium of the dynamic game coincides with equation (2). The reason is that in the dynamic game investments take place immediately. If nobody delays, then any profitable investment undertaken at some point in the future will yield even more profits if it is undertaken a little earlier.

Equation (2), implicitly, determines the productive efficiency of individual firms. For a given level of capacities, firms that invest more have a lower marginal cost. Our empirical strategy is to identify the unobserved marginal cost parameters of firms based on the equilibrium investment decision. Estimating unobserved marginal cost variables by inverting a structural equation has been used in the literature in a number of places. Recent applications include Bresnahan (1988) for industry studies under the Cournot model and Paarsch (1992) for the auction literature. In contrast to the use of a structural equation in the Cournot and the auction literature, we identify marginal costs based on two firm-specific variables: the equilibrium investment decision and the current capacity level.

Corollary 2 expresses the marginal cost of firm i as an explicit function of capacity levels, investment decisions and the cost of capacity.

Corollary 2. *If $x_i \neq 0$, then the marginal cost of firm i is given by*

$$c_i = \text{MR}_i(K, x, K_i, x_i) - \frac{\partial r(x)}{\partial x} \Big|_{x=x_i} \cdot \frac{1-\beta}{\beta} \cdot \mathbf{1}_{\{x_i > 0\}} \quad (3)$$

If $x_i = 0$, then the marginal cost, c_i , is contained in an interval: $c_i \in [\text{MR}_i(K, x, K_i, x_i) - \frac{\partial r}{\partial x} \Big|_{x_i} \cdot \frac{1-\beta}{\beta} \mathbf{1}_{\{x_i > 0\}}, \text{MR}_i(K, x, K_i, x_i)]$.

The right hand side variables in equation (3) include industry capacity, industry investments, the capacity level and investment choices of firm i , and the cost of additional capacity. Thus, if these data are available, then the marginal production cost can be inferred.

3.2. MERGER ANALYSIS

Next, we describe implications for acquisitions and mergers. A merger combines two (or more) firms into one and takes place prior to the investment stage. The merged firm's capacity equals the sum of the capacities of individual components. After the merger, firms may invest to adjust their capacities to the new industry configuration.

The model is formulated using a rich set of parameters for the empirical analysis. In this section, we restrict the set of parameters to keep the analysis tractable.

Assumption. *The following conditions are satisfied:*

- (i) *Demand is linear: $P(Q) = A - bQ$*
- (ii) *$\frac{\beta}{1-\beta} = \delta = 1$*
- (iii) *Unmerged firms have constant and identical marginal cost, $c_i = c$. The merged firm has constant marginal cost c_m .*
- (iv) *The cost of investment is linear, $r(x) = r \cdot x$*
- (v) *Initial capacities are at Cournot levels, $K_i = \frac{A-c}{b(n+1)}$.*

Assumption (ii) normalizes the discount factor and the rate of depreciation. This has no qualitative effect on the analysis. Assumption (iii) requires that all unmerged firms have constant and identical marginal cost.

The following Remark considers the profitability of mergers in the absence of cost savings. It provides a condition for profitable mergers to exist. All proofs are given in Appendix A.

Remark 3. *Suppose the marginal cost of the merged firm equals the pre-merger level, $c_m = c$. Then, for any n , such that $n + 1 > \frac{A-c}{r}$, a merger is profitable.*

Remark 3 establishes that, even in the absence of cost savings, mergers are profitable with sufficiently many firms, or alternatively, when the cost of investment is high. This finding contrasts with the Cournot model, for which Salant, Schwitzer and Reynolds (1983) show that given constant marginal costs and linear demand, mergers are not profitable (other than merger for monopoly).⁶ The reason for the profitability of mergers is an asymmetry between capacity expansions and reductions in the investment model. Capacity expansions are costly while capacity reductions are not. This asymmetry gives the merged firm an advantage, and, at least, when the cost of additional capacity is high, makes mergers profitable. Of course, cost savings due to mergers may additionally enhance the profitability of mergers.

Next, we consider the implications of a merger. The following remark illustrates that we expect changes after a merger: It states that no changes in investment policies after the merger indicate merger cost savings.

Remark 4. *Suppose the merged firm does not invest after the merger. $x_m = 0$. Then, the marginal cost of the merged firm is below the marginal cost of unmerged firms, $c_m < c$.*

The argument in the proof of Remark 4 is the following: The comparison of the equilibrium investment decision in equation (2) prior to and after the merger reveals that in order to achieve investment levels equal to the pre-merger level, the firms must cut costs substantially. The reason is that the marginal revenues of investment, $MR_i(K, x, K_i, x_i)$, decline after the acquisition of additional capacity. This decline has to be accounted for by a decline in marginal production cost.

In the following, we discuss welfare implications of mergers. We distinguish two cases: where there are cost savings due to merger and where there are no cost savings due to merger. Remark 5 assumes that there are no cost savings due to merger. It establishes that in the absence of merger cost savings, the profitability of a merger requires that output declines. Since in our model firms

⁶ Observe that the model of Salant, Switzer and Reynolds is the limiting case of the conditions in the theorem, as $r \rightarrow 0$. In the limit, with $r = 0$, the condition in the theorem fails to hold and, as Salant, Switzer and Reynolds have shown, mergers are unprofitable (other than merger for monopoly). However, notice that the result by Salant, Switzer and Reynolds is not robust in the following sense: For any $r > 0$, there exist a N , such that for $n > N$ mergers are profitable. With many firms, a profitable merger opportunity exists.

have identical marginal costs, this results in a welfare loss.

Remark 5. *Suppose the marginal cost of the merged firm equals c after the merger. Then the merger reduces welfare.*

On the other hand, under the presence of merger cost savings, a merger may increase welfare. In this case, the cost savings result in an increase of producer surplus. For small effects on consumer surplus this may yield a net increase in total welfare. The following remark states that no changes in investment policies after the merger imply welfare increases.

Remark 6. *Suppose the merged firm does not invest after the merger, $x_m = 0$. Then a merger increases welfare.*

These remarks illustrate the welfare implications of mergers. For expositional purposes, the results are stated using linear demand and constant marginal cost. In the empirical section we wish to consider a more general functional form. Consumer surplus is defined as the difference between the willingness to pay and the actual price paid. Let $Q = \sum K_j$ denote the industry output. For arbitrary demand functions, this can be written as:

$$CS = \int_0^Q P(x)dx - Q \cdot P(Q). \quad (4)$$

We define producer surplus as the difference between the price paid and the production cost. It is given by:

$$PS = \sum_i [K_i P(Q) - C_i(K_i) - r(x_i)1_{\{x_i > 0\}}]. \quad (5)$$

The total welfare effect of mergers and acquisitions is, thus, given by the sum of CS and PS.

4. ACQUISITIONS IN THE PAPER INDUSTRY

This section provides background information on the paper and paperboard industry. It presents the data and provides summary evidence about investment decisions. In addition, we describe the wave of mergers that occurred in the mid 1980s.

We collected data on annual production capacity of individual paper and paperboard producing firms between 1978 and 1992. The data were obtained from the publication “Lockwoods Directory of Paper and Allied Trade.” This publication gives the following information on every

paper plant operating in the US: the location of the plant (town and state); the company operating the plant; the mill status (operating, idle, remodeled); the products produced at the mill and the production capacity by product. In addition, the data are supplemented with price data for individual paper products obtained from the census bureau.

The data divide paper products into nine categories: newsprint, packaging papers, ground-wood printing, coated papers, uncoated papers, other papers (bleached bristol, cotton fiber and thin paper), tissue, linerboard and boxboard. Products within a category are largely homogeneous. An exception are tissue products, where brand names appear important.

Paper machines are specialized, typically producing one category of paper exclusively. According to the data, about 80 percent of capacity is allocated to plants producing only a single paper category. The reason is that it is very costly to reconfigure a paper machine producing one product category so that it can produce another.⁷ Therefore, we expect little spillovers, or externalities, in production between paper categories and assume that individual paper categories constitute independent markets.

We select the US as a geographic market. This market definition may appear narrow for an exporting industry. In 1991, which is at the end of our sample period, about 15 percent of US production are exported and the share of imports is about 12 percent. An exception occurs for the category of newsprint. About 50 percent of newsprint capacity is imported from Canada. We therefore drop newsprint from the analysis. On the other hand the market definition may also appear broad for a product that incurs high transportation costs which are estimated to be 9 percent of the value of shipments⁸ even though between 40 and 70 percent of paper products travel fewer than 500 miles.⁹

(Table 1)

Table 1 provides summary statistics for the paper and paperboard industry over time. The average total number of firms per paper category is given in column eight of Table 1. The number of firms shrinks from about 70 in 1978 to about 60 in 1992. Despite the relatively large number of firms, the paper industry exhibits substantial concentration. The capacity accounted for by

⁷ Georgia-Pacific Corporation, Harvard Business School Case, # 9- 391-174, p.3.

⁸ *Pulp and Paper* 10/91, 50-55.

⁹ Christensen and Caves (1997).

the largest 5 firms has a mean of 56.1 percent across paper categories in 1992. The highest 5-firm concentration is for tissue products, with 75 percent. The lowest 5-firm concentration is in newsprint, with 41 percent.

Total industry capacity increased by about 20 percent between 1978 and 1992. Growth rates, that are on average 0.7 percent before 1987, increase to an average of 2.4 percent after the merger wave, starting in 1987.

Individual firms exhibit substantial variation in their investment strategies. Columns 3 and 4 in Table 1 report investment decisions for two groups of firms: Firms that expand industry capacity and firms that reduce it. Every year about 20 percent of paper companies increase their production capacities. Capacity expansions account for an industry growth rate of on average about 3.7 percent per year.¹⁰ On the other hand, capacity reductions decrease the industry growth rate by about 2.3 percent per year. The difference, or the net annual industry growth rate, is 1.4 percent.

Capacity at existing plants is mostly expanded by improving the speed of the machines. Faster machine speed directly translates into more output. According to Biermann¹¹, the maximum paper machine speed increased by 17 percent between 1981 and 1991 on average across product categories. New plant construction accounts for a small share of capacity growth. Column 5 in Table 1 illustrates that fewer than 15 percent of capacity expansions are achieved through building a new plant (or machine).

Horizontal mergers and acquisitions constitute an important contribution to firm-level growth. Column 6 indicates that, in total, about 40 percent of the capacity expansions at existing firms are achieved through horizontal acquisitions. An examination of ownership changes for individual paper plants indicates the magnitude of merger phenomenon. About 40 percent of the 819 paper and paperboard plants operating in the US between 1978 and 1992 were involved in at least one merger. Dividing the sample into horizontal mergers, in which both acquiring and acquired firm are paper companies, and "unrelated mergers" reveals that more than 2/3 of the plants that are merged are involved in a horizontal merger.

Firms involved in an acquisition tend to be among the large in the industry. According to the

¹⁰ Capacity expansions (or reductions) due to merger are not included in column 3 or 4.

¹¹ Calculated from Table 9.1 on page 210 in C.J. Biermann, "The Essentials of Pulp and Papermaking," 1993, Academic Press.

data, in more than half the occurrences of mergers during the sample period, the acquiring firm is among the top 15 percent of firms in the size distribution. Moreover, the acquired firm is among the top 25 percent of firms in the size distribution.

During the years 85, 86 and 87, the merger activity is substantially higher than during other years. In 1986, the industry publication *Pulp and Paper* called this wave of mergers a "restructuring of the industry." A total of 31 mergers and acquisitions took place between August 1984 and July 1987. This three-year period accounts for about half the total capacity involved in a merger between 1978 and 1992. Appendix B lists the name of the acquiring and acquired firm, the date of the acquisition and the dollar amount. The largest were Jefferson Smurfit Corporations acquisition of Container Corp. for \$1.2 billion, International Papers acquisition of Hammermill for \$1.1 billion and Champion International Corporations acquisitions of St. Regis for \$1.8 billion.

(Table 2)

During this three-year period, there is at least one merger affecting every product category. Table 2 reports the number of acquiring and acquired firms for individual product category. The total number of acquiring firms exceeds 31 in the Table, since some mergers affect more than one product category.

The merger wave among paper companies had a substantial impact on the industry. On average, the number of paper companies per product category shrank from about 65 in 1984 to about 60 in 1988.

We may expect two opposing effects due to horizontal mergers and acquisitions: First, mergers may have anticompetitive effects on price and investment. James River was blocked from acquiring Barlow Rand Ltd. by the Federal Trade Commission in February 1988. The Federal Trade Commission argued that it would reduce competition for certain types of packaging materials.

Second, a mergers may reduce costs. The merger between Kimberly-Clark and Scott Paper provides an example. Kimberly-Clark announced a layoff of 6,000 workers, or ten percent of its work force to achieve savings in restructuring immediately following the acquisition.

Industry publications discuss a number of ways to achieve cost savings following an acquisition: First, savings may be achieved through reorganization of production. Within a paper category a number of different grades can be produced which differ by weight, color and texture. A machine

is more efficient the narrower the range of grades it produces. For example, a grade of uncoated freesheet may cost 20-30 percent less to produce on a machine that is configured especially for that grade than on a machine configured to accommodate a wide variety of grades.¹² In addition, machines operate more efficiently the longer the length of the production runs, since grade changes are costly.

Second, merger allows companies to buy inputs at lower prices. Also, because companies are vertically integrated, supplying inputs such as timber and pulp, combining two companies may yield a more efficient allocation of inputs.

Third, gains are achievable by combining the sales and distribution forces of the companies. A single distribution network may operate more effectively than two distribution networks separately.

The next section focuses on contrasting the decisions of merged and un-merged firms. It provides a description of the data and it studies changes in market shares and in investment behavior following a merger. This analysis may provide evidence for cost reductions stemming from mergers.

5. EFFECTS OF MERGERS

This section provides descriptive analysis of the effects of mergers and acquisitions on annual investment decisions between 1978 and 1992. We examine the change in market share after the merger and document the effect of mergers on investment decisions.

(Table 3)

Table 3 describes the evolution of annual market shares of the merged firms after the merger. Ordinary least square estimates are reported. The first regression considers all categories pooled. Subsequent regressions consider markets for individual paper categories. The explanatory variables are TIME, the time since the occurrence of the merger, and TIME-SQ, which measures the time squared.

Examining the linear and quadratic coefficients in Table 3 reveals that in all but one category the linear coefficient is negative. For all but three categories, the quadratic coefficient is positive. This implies that as TIME increases, the average market share falls initially and then increases. For the first regression, which considers the pooled data, the low occurs after about 5 years with

¹² Georgia-Pacific Corporation, Harvard Business School Case, # 9-391-174, p.3.

90 percent of the initial market share. For individual product categories a similar picture emerges.

Entry in the industry does not explain the falling market shares of merged firms. During the period of study there is very little entry by new firms into the industry.

The decline in market shares may suggest that acquisitions result in only modest cost savings, or none at all. However, the low R-squared in Table 3 suggests variation in merger outcomes. Indeed, a closer examination of individual firms reveals that about 66 percent lose market shares, while 34 percent of firms do gain market shares after the merger. Remark 4 in section 3 states that firms which increase investment after the merger achieve cost savings. Thus, applying Remark 4 suggests that at least one third of acquiring firms achieve cost savings.

Next, we examine the investment decision of individual firms. Table 4 reports a set of qualitative response models considering the investment decision. The first three specifications are probit models. They consider the decision to change capacity, to scrap existing capacity, and to invest in capacity. The fourth specification is an ordered probit and the final specification is a multinomial logit model. We report estimates using pooled data across paper categories. In every year, we consider the set of currently active firms. We do not expect that this selection biases the estimation result since entry and exit is of small magnitude in the paper industry.

(Table 4)

Explanatory variables include MERG-SIZE which measures the capacity of the acquired firm relative to the acquiring firm. MERG-SIZE equals zero if there was no merger. MERG-2-5 is a dummy variable that equals one if the firm acquired another paper company in the years 2 to 5 preceding the merger. The variable PLANTS measures the number of plants and PRODUCTS the number of product categories produced by the firm.

About 24 percent of firms change their capacity every year and in about three out of four instances the capacity is expanded. Table 4 suggests that larger firms are more likely to change capacity and also invest in new capacity. This pattern emerges across all specifications. The linear coefficient of PLANTS is positive and the quadratic coefficient is negative in most specifications. Increasing PLANTS increases the probability of investment at a decreasing rate. On the other hand, the variable PRODUCTS has the opposite effect. Firms that are active in a larger number of categories are less likely to invest or change capacity.

Mergers have significant effects on investment decisions. There are two variables examining the effect of mergers: a variable measuring last year's acquisitions and a variable measuring past acquisitions. MERG-SIZE equals the relative share of the acquired firm to the acquiring firm if a firm is acquired in the preceding period, and is zero otherwise. MERG-2-5 is a dummy variable that equals one if an acquisition occurred in the years 2 to 5 preceding the current period. The effect of MERG-2-5 appears similar to, but smaller in magnitude than, the effect of the variable MERG-SIZE.

The first probit model suggests that the occurrence of a merger increases the probability of a change in current capacity levels. The increase in probability occurs immediately following the merger and persists for the years following the merger.

The second and third probit specification and also the multinomial logit specification suggest that mergers imply a higher probability of scrapping capacity. The probability of investing is also increased, but the coefficient is not significant. This suggests dispersion in investment decisions across acquisitions. Some firms increase capacity after a merger, while others reduce it.

The multinomial logit model has the highest Chi-squared level and fits the data better than the ordered probit model. Again, the variables measuring the occurrence of mergers have positive and significant effects on the decision to scrap capacity. For the investment decision the merger variables also have positive effects, but are not significantly different from zero.

To summarize, the descriptive data analysis suggests the following: First, for two thirds of acquiring firms market shares decline after the merger, while for one third of acquiring firms market shares increase. This suggests that at least one third of acquiring firms achieve cost savings following the acquisition. Second, the investment decision reveals a similar picture: Merged firms are more likely to change their capacity levels than un-merged firms. However, there is a dispersion in investment decisions across merged firms. Some acquiring firms reduce capacity, while others increase theirs. The next section assesses the magnitude of cost savings due to mergers.

6. ESTIMATION RESULTS

This section reports cost and welfare implications of mergers. While the previous section focused on the period between 1978 and 1992, here we focus on the merger wave that took place between August 1984 and July 1987. We contrast investment decisions prior to and after the

merger wave. Section 2.1. compares investment decisions prior to and after the merger wave to infer changes in marginal cost. Section 6.2. reports estimates of the change in consumer and producer surplus due to the merger wave. Section 6.3. remarks on the profitability of mergers.

As described before, in the estimation of the equilibrium investment decision prior to the merger wave, we assume that firms did not take into account the occurrence of future mergers. For example firms assigned a negligible probability that a merger wave would be triggered. This appears reasonable, since the early 1980s firms did not anticipate the change in the position of Antitrust authorities, that would be manifested in the 1984 guidelines.¹³

According to industry publications, it takes between two and three years before capacity becomes usable. We therefore select a three-year window prior to and after the merger wave. We estimate the investment model for both sub-periods.

6.1. COST SYNERGIES

The estimation of marginal cost changes is conducted in two steps: In the first step, the inverse demand equation is estimated. In the second step, the marginal revenue for each firm is calculated and substituted into equation (3) in Corollary 2 to obtain marginal cost parameters.

In the first stage, we adopt the constant elasticity of demand specification:

$$\ln(P_t) = \alpha x_t + \gamma \ln(Q_t) + u_t \quad ,$$

where x denote observed demand shifters, Q denotes total output and u_t follows an AR(1) process,

$$u_t = \rho u_{t-1} + v_t, \quad |\rho| < 1 \quad .$$

The endogenous variables are P and Q , while the exogenous data, z_t , include instruments for the endogenous variable Q . We use gross domestic product as a demand shifter, x_t , and wages of paper industry workers as instruments for Q .

In the second step, a pseudo sample of predicted marginal revenues, $(\hat{M}R_i)_{i=1}^n = (\hat{P}(Q) + \frac{\partial \hat{P}(Q)}{\partial Q} \cdot K_i)_{i=1}^n$, is constructed. The marginal costs, $(\hat{c}_i)_{i=1}^n$, are then directly calculated based on

¹³ Of course, the model can be estimated under the assumption that firms anticipated the merger wave. However, we find this assumption somewhat implausible.

equation (3) in Corollary 2.

$$\hat{c}_i = \hat{M}R_i - \frac{\partial r(x)}{\partial x}|_{x_i} \cdot \frac{1-\beta}{\beta} \cdot \mathbf{1}_{\{x_i > 0\}}$$

As described in Section 3, an identification problem may arise for firms that do not invest, $x_i = 0$. We assume that capacity depreciates at a positive rate, which guarantees identification for our data.¹⁴

The cost estimates depend on the discount factor, β , the depreciation rate, δ , and the cost of additional capacity, $r(x)$. We assume that the discount factor equals 0.95 per year, and vary the specification of the remaining parameters. For the cost of additional capacity, $\frac{1-\beta}{\beta}r(x)$, we assume a function with a linear and quadratic term. A base estimate for the cost of additional capacity is obtained from a sample of reported dollar costs of investment projects in *Pulp and Paper*.

(Figure 1A - 1Q)

Figures 1A to 1Q illustrate the marginal cost estimates per ton of paper produced for individual paper categories. The figures are based on the parameter specification with $\delta = 0.999$ and $\frac{1-\beta}{\beta}r(x) = \frac{1}{100}x^2$. Figures 1A to 1H depict the distribution of cost estimates for acquiring, acquired, and un-merged firms prior to the merger wave. Figures 1I to 1Q depict cost estimates for acquiring and un-merged firms after the merger wave. Each figure reports estimates for an individual paper category. An examination of Figure 1A indicates that the cost distribution of an acquiring firm is stochastically dominated by the cost distribution of un-merged firms. This suggests that, on average, the marginal cost of the acquiring firm is lower than the marginal cost of un-merged firms. An examination of the corresponding figure after the merger wave reveals a similar picture. There the difference in costs appears even stronger. Looking across product categories reveals similar findings.

(Table 5A)

Table 5A reports summary statistics for the difference between the marginal cost estimates for individual groups by paper categories. The difference in the median and mean for the following groups are reported: acquiring and un-merged firms prior to the merger wave, acquired and un-merged firms prior to the merger wave, and acquiring and un-merged firms after the merger wave.

¹⁴ In the limit as the depreciation factor approaches one, this corresponds to selecting the lower endpoint of the interval $[\hat{M}R_i(K, x_i) - \frac{\partial r}{\partial x}|_{x_i} \frac{1-\beta}{\beta} \mathbf{1}_{\{x_i > 0\}}, \hat{M}R_i(K, x_i)]$ in Corollary 2.

The Table considers the specification with $\delta = 0.999$ and $\frac{r(x)}{\beta} = 26.5 \cdot x + \frac{1}{200}x^2$. An examination of the median and mean estimates for the difference between acquiring and un-merged firms prior to the merger wave reveals that all estimates are negative. This suggests that, on average, the acquired firm has a lower marginal cost prior to the merger wave than does the un-merged firm. Similarly, after the merger wave the median acquiring firm has a lower marginal cost estimate than the median un-merged firm for all product categories. The acquired firm also has a lower marginal cost estimate for all but two product categories, groundwood printing and coated papers.

The P-Value reported in parenthesis in Table 5A gives the probability that the data reject the null hypothesis of a negative difference in median (mean) estimate. Observe that for tissue products with only one acquiring firm, the P-Value is not meaningful. However, an examination of the P-Values for other product categories reveals the following: For the difference in mean marginal costs after the merger the P-Value ranges between 0 and 12 percent. For the difference in median marginal costs, the P-Values are higher and range between 0 and 66 percent.

(Table 5B to 5E)

To assess the robustness of estimates to model specifications, we report summary statistics varying the parametric assumptions. Tables 5B to 5E report summary estimates under alternative parametric specifications. A comparison of the tables with Table 5A indicates that summary statistics and P-Values are very similar to summary statistics in Table 5A. This similarity of estimates indicates that the estimates are robust to alternative model specifications.

Contrasting the cost estimates for acquiring firms prior to and after the merger wave reveals that the difference in median (mean) cost estimates increases. This suggests cost savings after the merger. For example, the difference between median cost estimates for Groundwood Printing increases from \$4 to \$8, while the difference between means increases from \$7 to \$13. In all eight product categories, the difference in medians increases after the merger wave for the acquiring firm's marginal cost. The difference in means increases for 7 of 8 product categories.¹⁵

The difference in marginal cost prior to and after the merger wave may also be explained by changes in cost levels. To account for this possibility, we conduct the following exercise. We assign every cost estimate the percentile in the distribution of marginal costs of un-merged firms.

¹⁵ The exception for the mean occurs in the product category boxboard.

We then compare the percentiles between the before and after-merger samples. Figure 2 depicts the distribution of marginal cost estimates. Due to the small number of acquisitions per product category, and since the majority of acquisitions affect only one product category, we report estimates pooled across product categories.

(Figure 2)

Figure 2 suggests that about 90 percent of the acquiring firms achieve cost savings, while about 10 percent are worse off after the merger. Thus, there is some dispersion in merger outcomes. The variation in merger outcomes is in accordance with the earlier finding of the dispersion in investment strategies.

The dispersion in merger outcomes is also reflected in industry reports. An example of a possibly unsuccessful merger constitutes the merger between Champion International Corp. and St. Regis Corp. The merger did not achieve the expected cost synergies and eventually resulted in a downsizing of the merged company.¹⁶

To summarize, acquiring firms are on average firms with lower marginal cost, both before and after the merger wave. For the median firm, the magnitude of the cost advantage of acquiring firms increases after the acquisition. However, there is some dispersion in merger outcomes. About 10 percent of acquiring firms do not achieve cost savings.

6.2. WELFARE EFFECTS

We next take the analysis one step further and quantify welfare effects. The estimated cost parameters of individual firms are used to predict the investment behavior of firms under the industry configuration in which mergers had been forbidden. Based on the predicted "no merger" equilibrium, the changes in consumer and producer surplus due to merger are determined.

The calculation of producer surplus requires firm-specific cost functions. We assume that the technology is characterized by constant marginal cost. Since constant marginal cost implies constant returns to scale, we may interpret this specification as a benchmark.

We project the marginal cost estimates of acquired and acquiring firms to post-merger levels. Since technological changes may affect firms in different ways, we do not base the projection on the

¹⁶ Champion Struggles to make the St. Regis merger work, *Business Week*, page 68, February 25, 1985.

average firm. Instead, we assign every cost estimate a position in the distribution of un-merged firms prior to the merger wave. Then, we infer the projected cost estimate based on the corresponding percentile of the post- merger cost distribution of un-merged firms.

The projection has an error. The magnitude of the projection error can be measured by applying the projection method to the sample of cost estimates for un-merged firms. A comparison between the predicted and the observed cost estimate is used to estimate the variance in the projection. Standard errors of welfare effects are calculated based on the projection error. We assume that the cost of acquiring and acquired firms in the “no merger” scenario is drawn from a normal distribution with mean equal to the predicted mean and variance equal to the variance in the prediction error. We use repeated draws from this distribution to obtain standard errors of welfare estimates.

Welfare effects are calculated using the capacity data, the pseudo-sample of marginal costs and the demand estimates. Specifically, the marginal cost and capacity of the merged firm is replaced with the predicted marginal cost and capacity of the individual components prior to the merger. The equilibrium reaction functions, which are implicitly given in (2), are used to calculate the investment equilibrium in the “no-merger” industry configuration. A comparison between the merger and “no-merger” equilibrium investment decision enables us to calculate changes in consumer and producer surplus based on equations (4) and (5) in section 3.

(Table 6)

Table 6 summarizes the estimates. Estimation results are presented for individual paper categories under alternative parametric assumptions. Five variables are reported for every product category: CONSUMER SURPLUS measures the change in consumer surplus due to the merger, based on equation (4). PRODUCER SURPLUS measures the change in producer surplus based on equation (5). TOTAL WELFARE measures the sum of producer and consumer surplus. The variable GAIN TO MERGED FIRMS measures the profitability of the merger. The variable GAIN TO UN-MERGED FIRMS measures the merger effect on profits of un-merged firms. All the dollar amounts in Table 6 are measured in thousand 1986 dollars.

For example the estimates indicate the following effects for packaging papers: The first element in Table 6 suggests that the mergers increased the annual total welfare by \$61.4 million. The

number in parenthesis gives the standard deviation. The standard deviation is relatively small, which indicates that the total welfare increased significantly. The next four columns report estimates of total welfare under alternative parametric specifications concerning the rate of decay and the cost of additional capacity. The parametric specifications are the same as in Table 5. An examination across specifications reveals that the welfare effect for packaging paper is positive for all specifications. The welfare effect is lowest for the fourth specification which assumes linear costs of investment and highest for the last specification which assumes quadratic costs of investment. Producer surplus increased across all specifications. Moreover, the increase is significant for all specifications except the fourth. In contrast, the effect on the consumer surplus is not significant in all, except for the last specification. There the effect is positive.

Examining across products reveals that total welfare effects are mostly positive. They are significant across all specifications for four of eight categories. These are packaging paper, other paper, tissue and linerboard. For coated papers, the welfare effect is positive but not significant. Welfare effects are in general not significant for the remaining three product categories.

The different model specifications yield similar estimates and do not change the interpretation qualitatively. Specification (2) and (3) yield very similar results as specification (1), which suggests that altering decay and the level of investment costs does not affect the results substantially. Specification (4) yields in general a lower estimate for total welfare than specification (1), with the exception of the product category linerboard. Welfare effects are significant in all product categories for specification (5). The welfare effects are positive for seven of eight categories. The exception is linerboard.

Calculating the sum of welfare effects across product categories reveals that the merger wave increased total welfare in the paper industry by \$583.5 million. Across specifications, this number ranges between \$454 million and \$583 million. The total benefit to consumers amounts to \$213.6 million in specification (1). This number ranges between \$58 million and \$210 million across specifications. The largest winners are producers. The sum of producer surplus increased by \$369.9 million and ranges between \$244 and \$527 across specifications.

6.3. PROFITABILITY OF MERGERS

In the estimation of cost parameters, we did not impose the constraint that mergers are profitable. However, it may be argued that this condition must be satisfied at least for the average acquisition. Instead of imposing this condition as a constraint in the estimation, we determine to what extent it is satisfied by our estimates. This may be interpreted as a test of the adequacy of the investment model.

The profitability of the average merger and acquisition can be calculated based on the model estimates. Table 6 reports the gains to merged firms and the gains to un-merged firms for individual product categories. The merger gains are positive in 6 of eight categories. For four categories they are significant. For two categories, groundwood printing and boxboard the gains are in some specifications negative, but not significantly so. For boxboard this corresponds to the earlier finding of no merger cost savings.

The gains to un-merged firms are mostly not significant. However, for uncoated papers, other papers and tissue they are significant and negative.

Summing across product categories reveals that the merged firms achieved profit increases. The total gain amounts to \$469.3 million. We may interpret this finding as a confirmation of the adequacy of the investment model. On the other hand the merger conferred a negative externality on other firms. Un-merged firms incurred a loss of \$99.4 million.

7. CONCLUSIONS

This study of the merger implications in the paper and paperboard industry focuses on investment decisions rather than changes in short-run price or output. The reason is that short-run price, or output effects, may assess merger implications erroneously, since they do not take into account changes in investment decisions.

We consider a one-shot investment game. We show that profitable merger opportunities exist even in the absence of cost savings. In addition, the profitability of mergers may be enhanced by merger cost savings. The amount of cost savings is reflected in the investment decision. If investment decisions do not change after the merger, then the merger achieves cost savings. Predicted welfare effects depend on the magnitude of merger cost savings. Without cost savings, mergers reduce welfare. On the other hand, if merger cost savings are enabled, then welfare may increase.

The empirical analysis takes the investment model to the data. It assesses merger cost savings and estimates welfare effects. The analysis considers a merger wave that took place during the mid 1980s. The investment model is estimated prior to and after the merger wave.

The empirical analysis suggests the presence of cost savings following the acquisition. However, there is some dispersion in merger outcomes. Although the majority of acquiring firms achieve cost savings, about 10 percent do not.

Based on the estimated parameters, we calculate welfare implications. We find the total welfare increased by \$583.5 million due to merger wave. The primary beneficiaries of the welfare increases are merged firms. Their profit increased in total by \$468.3 million. On the other hand, firms not involved in the merger took a loss. Their profits decreased by \$99.4 million.

APPENDIX A

Proof of Remark 3: We begin with the situation prior to the merger. The payoff function for firm i is $[A - bQ]q - cq$. The first order condition of profit maximization yields, $A - bQ - bq - c = 0$. Summing over all firms yields an expression for total industry production. $Q = \frac{n(A-c)}{b(n+1)}$. Thus, Cournot capacities equal $\frac{A-c}{b(n+1)}$. Substituting equilibrium capacities into the payoff function yields, that Cournot profits equal, $[A - b(\frac{n(A-c)}{b(n+1)})] \cdot \frac{(A-c)}{b(n+1)} - c \frac{(A-c)}{b(n+1)}$, which can be rewritten as $\frac{1}{b} [\frac{A-c}{n+1}]^2$. A merger is profitable if the post merger profit exceeds twice this expression.

Next, we consider the post merger situation. Let m denote the index for the merged firm and i the index for an un-merged firm. The first order condition for optimal investments by an un-merged firm is given by

$$A - c - b[\sum K_j + \sum x_j + K_i + x_i] = r \cdot 1_{\{x_i > 0\}}$$

Substituting Cournot capacity levels yields,

$$A - c - b[\frac{n}{n+1} \frac{(A-c)}{b} + \sum x_j + \frac{A-c}{b(n+1)} + x_i] = r \cdot 1_{\{x_i > 0\}}$$

Canceling terms yields,

$$-b[(n-1)x_i + x_m] = r \cdot 1_{\{x_i > 0\}}$$

An examination of the first order condition yields three distinguishable cases: First, if $x_m < -\frac{r}{b}$, then $x_i = \frac{-bx_m - r}{(n-2)b} > 0$. Second, if $x_m \in [-\frac{r}{b}, 0]$, then $x_i = 0$. Third, if $x_m > 0$, then $x_i < 0$.

Consider next the merged firm m . The first order condition for investment for the merged firm is given by

$$A - c - b[\sum K_j + \sum x_j + K_m + x_m] = r \cdot 1_{\{x_m > 0\}}$$

Substituting Cournot capacity levels yields,

$$A - c - b[\frac{n}{b(n+1)}(A-c) + \sum x_j + 2\frac{A-c}{b(n+1)} + x_m] = r \cdot 1_{\{x_m > 0\}}$$

Rearranging terms yields,

$$-\frac{A-c}{n+1} - b[(n-1)x_i + 2x_m] = r \cdot 1_{\{x_m > 0\}}$$

Suppose that $x_i = 0$. Then the first order condition for firm m yields, $x_m = -\frac{1}{2b} \cdot \frac{A-c}{n+1}$. Observe that these investment decisions constitute an equilibrium provided the condition stated in the remark is satisfied. To see this, notice that the first order condition for firm i implies that x_i is indeed zero, provided that $x_m > -\frac{r}{b}$. This condition, can be rewritten as, $\frac{A-c}{n+1} < r$ which is the condition stated in the remark.

Finally, we substitute equilibrium investment levels into payoffs to assess the profitability of the merger: The profit for firm m is given by, $[A - c - b\frac{2n-1}{2b(n+1)}(A - c)] \cdot \frac{3}{2b} \frac{A-c}{n+1}$. Simplifying this expression yields, $\frac{1}{b}(\frac{A-c}{n+1})^2 \cdot \frac{9}{4}$. The merger gains are given by the difference between the post merger equilibrium profit and the pre merger profit. This yields, $\frac{1}{b}(\frac{A-c}{n+1})^2 \cdot \frac{1}{4}$, which is indeed positive.

QED

Proof of Remark 4: Consider the equilibrium investment condition for the merged firm after the merger. Let c_m denote the marginal cost of the merged firm. From Proposition 1 it is given by,

$$A - c_m - b[\sum K_j + \sum x_j + K_m + x_m] = r \cdot 1_{\{x_m > 0\}}$$

By assumption, there is no investment, $x_i = 0$ for all i , and capacities equal Cournot levels. Rewriting the equation yields,

$$A - c_m - b[\frac{n}{b(n+1)}(A - c) + 2\frac{A - c}{b(n+1)}] \in [0, r]$$

This can be rewritten as:

$$A - c_m - \frac{n+2}{n+1}(A - c) \in [0, r]$$

The lower bound gives the inequality $\frac{A-c_m}{A-c} \geq \frac{n+2}{n+1}$. The inequality implies that the marginal cost after the merger is below the level prior to the merger, $c_m < c$.

QED

Proof of Remark 5: Observe that production costs are unaffected by merger, since all firms have the same marginal cost. Thus, it is enough to establish that consumer surplus declines.

Suppose to the contrary, that is, that capacity increases after the merger, $\sum x_j > 0$. Now, the first order condition for firm i implies that $x_i \leq 0$. Consider next the first order condition for firm m . It implies that $x_m \leq 0$. However, $\sum x_j = (n - 2)x_i + x_m$, which yields a contradiction. Thus, capacity declines after the merger.

QED

Proof of Remark 6: Observe that consumer surplus is unaffected by merger, since aggregate output does not change. Remark 4 states that the marginal cost of the merged firm declines. Therefore, producer surplus increases, yielding an increase in total welfare.

QED

APPENDIX B

Table A: Timing and Price of Acquisitions between 8/1/84 and 7/17/87

Announce- ment Date*	Price	Description of Acquisition
8/1/84	\$1.8 bil	Champion International Corp. acquires St. Regis Corp.
8/8/84	N/A	Little Rapids Corp. acquires Potsdam Paper Corp.
9/11/84	N/A	Simpkins Industries Inc. acquires Deerfield Speciality Papers
11/5/84	N/A	International Paper acquires of Durham Mills Inc.
84	\$382 mil	USGA Acoustical Products Co acquires Masonite Corp.
84	N/A	Caraustar Industries acquires Mobil Corp.
84	N/A	Simpson Paper acquires Harding Jones Paper Corp.
3/6/85	\$260 mil	Federal Paper Board Company acquires Continental Forest
4/29/85	N/A	Hammermill Paper Business acquires Nicolet Paper Co (owned by Philip Morris Industrial Inc.)
5/1/85	\$214 mil	Chesapeake Paper Products Co acquires 2 units of Philip Morris Industrial (Tissue Mill Inc. and Plainwell Paper Co)
7/1/85	\$75 mil	Simpson paper acquires a division of Champion International Corp
8/12/85	\$40 mil	USG Acoustical Prod. Co acquires Conwed Corp.
9/30/85	\$442 mill	Stone Container acquires a division of Champion International (division sold after merger with St Regis Corp.)
12/6/85	\$150 mil	Jefferson Smurfit Corp. acquires a division of Publisher Paper Co (owned by Times Mirror)
12/17/85	\$800 mil	James River acquires Crown Zellerbach
12/21/85	N/A	Federal Paper Board Company acquires division of Nabisco Inc.
85	N/A	Packaging Corp. of America acquires Diamond Int. Corp.
1/3/86	N/A	James River Corp. acquires a division of Preco Corp.
2/4/86	\$228 mil	Temple Inland acquires a division of Owens Illinois Inc.
7/27/86	\$1.2 bil	Jefferson Smurfit Corp. acquires Container Corp. (owned by Mobil Corp.)
8/12/86	\$1.1 bil	International Paper acquires Hammermill
8/21/86	N/A	Stone Container acquires a division of Newark Group
12/31/86	N/A	Stone Container acquires Jackson Ville Kraft Paper Co
12/23/86	N/A	Georgia Pacific acquires Superwood Corp.
86	N/A	Boise Cascade Corp. acquires SCM Corp.
86	N/A	Jefferson Smurfit Corp. acquires a division Union Camp Corp.
1/28/87	\$442 mil	Stone Container acquires Southwest Forest
2/2/87	\$24 mil	Pope & Talbot acquires a division of Potlatch Corp.
2/3/87	N/A	Jim Walter Corp. acquires Owens Corning Fiberglass Corp.
3/26/87	N/A	James River acquires Dennison Mfg. Co
7/17/87	\$1.15 bil	Great Northern Nekoosa acquires Owens Illinois

*: The date is the announcement date of the merger. We report only the announcement year when the exact announcement date is not known.

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Table 1: Summary Statistics of the Paper Industry

Year	Industry Growth Rate	Growth Rate contribution by Firms* that expand capacity	Growth Rate contribution by Firms* that reduce capacity	Growth Rate contribution by building a New Plant	Growth achieved at Firms by Horizontal Merger	Avg. # of Firms per Product Category
78	-	-	-	-	-	70.6
79	1.32	2.91	-1.59	1.10	0.79	70.4
80	-0.09	3.24	-3.33	0.26	2.25	69.5
81	2.30	4.58	-2.28	0.89	0.67	67.6
82	1.56	3.97	-2.41	1.14	1.46	66.6
83	0.64	3.67	-3.03	0.09	2.12	65.6
84	-1.47	3.45	-4.92	0.29	1.72	64.7
85	0.99	2.76	-1.77	0.38	5.83	63.6
86	0.19	3.61	-3.42	0.34	7.43	62.3
87	3.14	4.09	-0.95	0.50	5.83	61.1
88	1.96	4.56	-2.60	0.00	1.84	60.2
89	1.76	4.47	-2.71	0.92	2.15	58.7
90	1.21	2.64	-1.43	0.34	5.13	56.6
91	3.39	4.45	-1.06	0.35	1.78	59.8
92	2.82	3.58	-0.76	0.69	1.69	60.4

* excluding capacity acquired by an acquisition or merger.

Table2: Number of Acquiring and Acquired Firms

Product Category	Pack aging Papers	Ground- wood Printing	Coated Papers	Un- coated Papers	Other Papers	Tissue	Box board	Liner board
Number of Acquired Firms	11	3	8	10	2	2	7	11
Number of Acquiring Firms	10	2	7	9	2	1	7	10

Table 3: Change in Market Share after a Merger

Dependent Variable:	Market Share of Merged Firm in Percent of Market Share at the Time of the Merger								
	Paper Category								
	Pooled	Pack aging Papers	Ground- wood Printing	Coated Papers	Un- coated Papers	Other Papers	Tissue	Box board	Liner board
Observations	1112	158	30	156	219	30	74	149	193
R-Squared	0.04	0.42	0.08	0.12	0.2	0.32	0.22	0.28	0.08
TIME	-3.66 (5.9)	-12.4 (6.3)	-2.25 (0.6)	-6.38 (5.2)	-6.2 (8.1)	-8.88 (1.1)	2.95 (1.4)	-1.54 (1.7)	-3.67 (3.8)
TIME-SQ	0.35 (3.0)	2.3 (9.1)	-0.12 (0.2)	0.55 (3.4)	0.5 (4.9)	-1.43 (0.5)	-1.1 (3.1)	0.55 (4.6)	0.24 (1.8)

T-statistics of variables are displayed in parenthesis.

Table 4: INVESTMENT DECISION*

Estimation Method:	Probit			Ordered Probit	Multinomial Logit	
Dependent Var:	CHANGE i<>0	SCRAP i<0	INVEST i>0	INVEST i in {-1,0,1}	SCRAP	INVEST
Occurrences in Percent:	24	5.9	18.1			
Observations:	9352	9352	9352	9352	9352	
Degrees of Freedom:	9323	9323	9323	9323	9294	
Chi-squared:	710.9	325.8	394.8	127.7	828.7	
Variable						
MERG-SIZE	0.7589 (3.5)	0.8017 (2.9)	0.3982 (0.4)	-0.1031 (0.1)	1.9112 (1.9)	1.0243 (1.0)
MERG-2-5	0.6004 (2.4)	0.7027 (2.2)	0.3044 (1.2)	-0.0552 (0.2)	1.7027 (2.7)	0.7922 (1.7)
PLANTS	0.2354 (1.8)	0.0065 (0.1)	0.3608 (2.6)	0.3489 (2.9)	0.1557 (0.5)	0.5289 (2.2)
PLANTS-SQ	-0.1078 (1.5)	0.0615 (0.7)	-0.2392 (3.2)	-0.273 (4.2)	0.0135 (0.1)	-0.312 (2.3)
PRODUCTS	-0.0936 (3.8)	-0.0679 (1.9)	-0.0415 (1.6)	0.0097 (0.5)	-0.16 (2.1)	-0.122 (2.6)
PRODUCTS-SQ	0.0205 (8.8)	0.0169 (5.3)	0.012 (5.0)	0.0005 (0.2)	0.0413 (6.2)	0.0289 (6.6)

*: All variables are in logarithms. Absolute values of t-statistics are displayed in parenthesis. Each regression includes a set of year specific dummies and a set of product dummies.

Figure 1A: Packaging Paper, Before

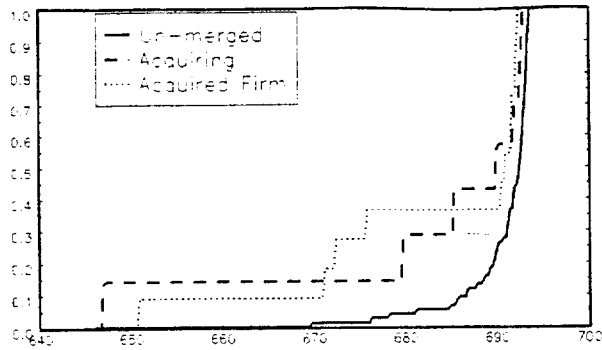


Figure 1I: Packaging Paper, After

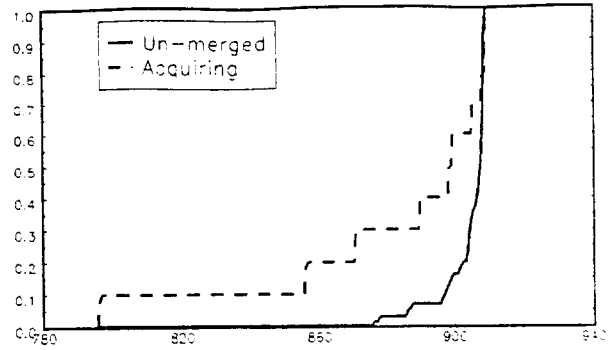


Figure 1B: Groundwood Printing, Before

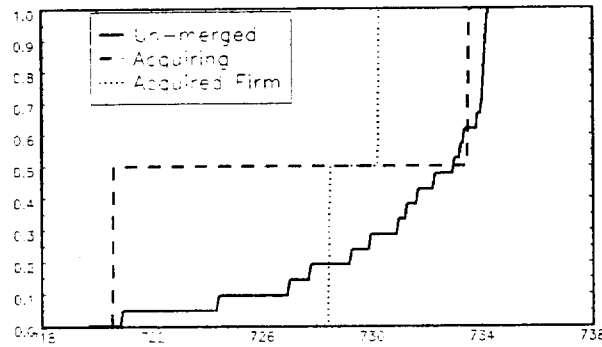


Figure 1J: Groundwood Printing, After

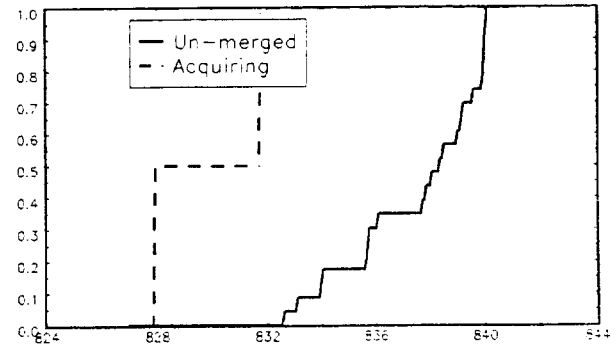


Figure 1C: Coated Papers, Before

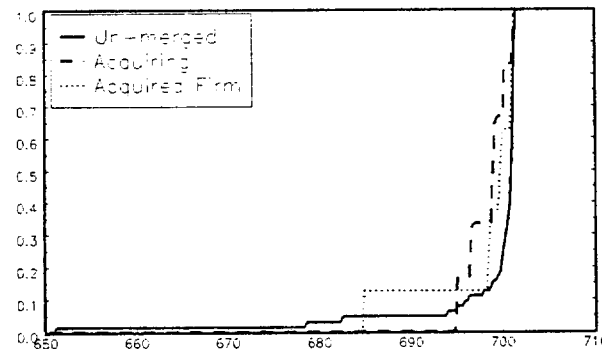


Figure 1K: Coated Papers, After

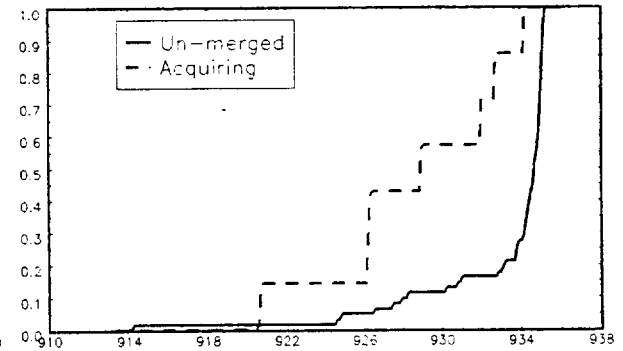


Figure 1D: UnCoated Papers, Before

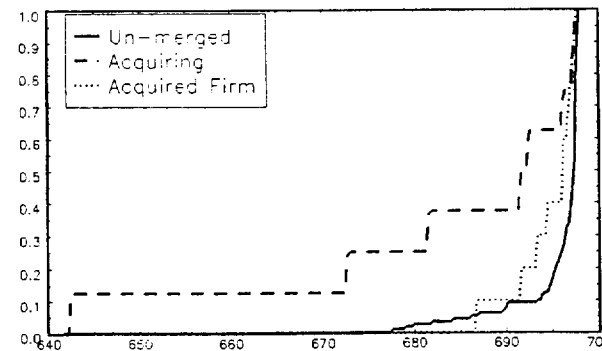


Figure 1L: UnCoated Papers, After

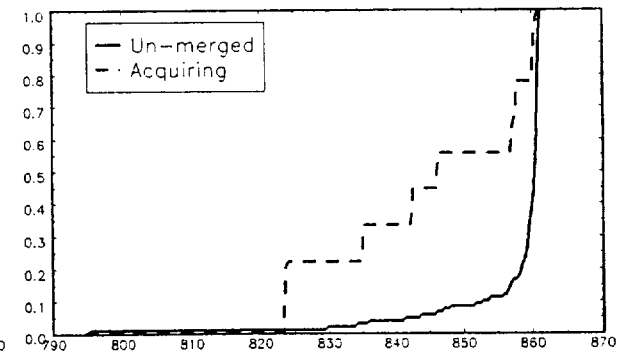


Figure 1E: Other Papers, Before

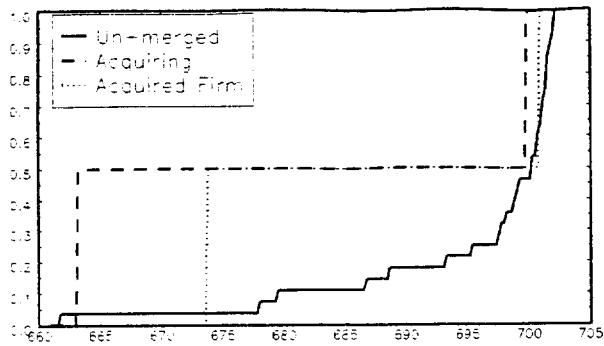


Figure 1M: Other Papers, After

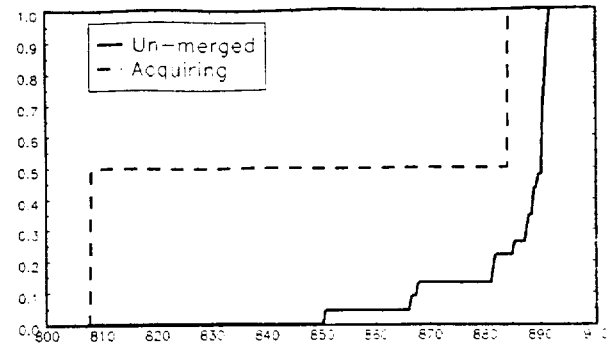


Figure 1F: Tissue Papers, Before

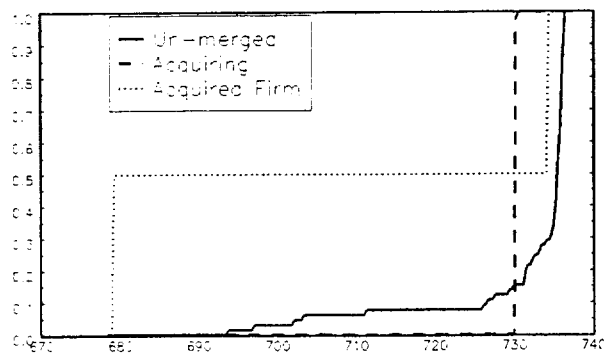


Figure 1N: Tissue Papers, After

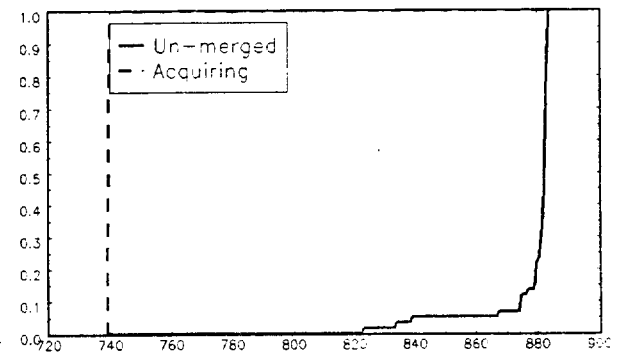


Figure 1G: Boxboard, Before

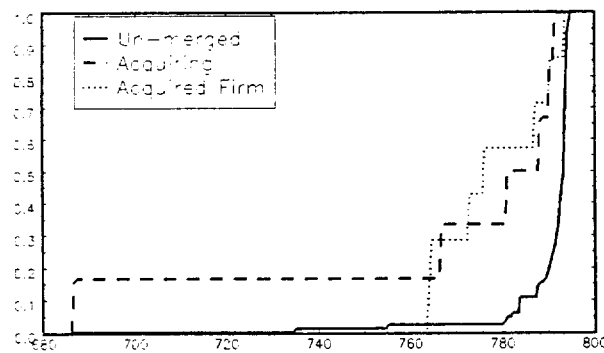


Figure 1O: Boxboard, After

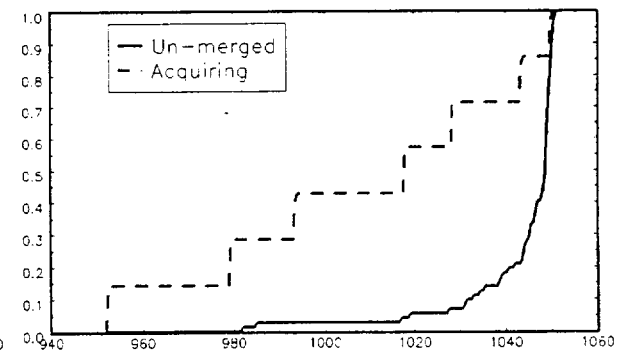


Figure 1H: Linerboard, Before

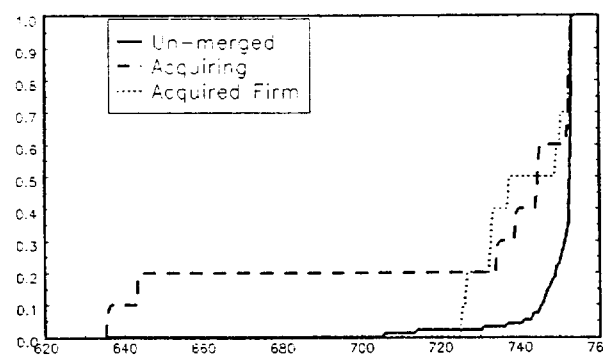


Figure 1P: Linerboard, After

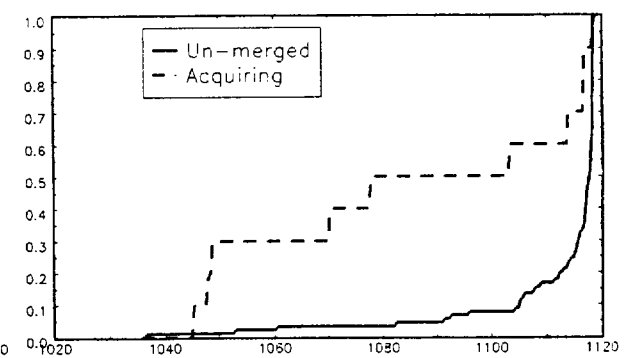


Table5A: Differences in Cost Estimates*: Decay = 0.999, Linear = 26.50, Quadratic= 0.005.

Product Category	Pack aging Papers	Ground- wood Printing	Coated Papers	Un- coated Papers	Other Papers	Tissue	Box board	Liner board
Difference in Cost Estimate between								
Acquiring and Unmerged Firm, Prior								
Median	-0.93	-4.39	-1.44	-0.69	-19.26	-5.71	-9.06	-4.72
P-Value	(0.17)	(0.05)	(0.12)	(0.16)	(0.04)	-	(0.00)	(0.55)
Mean	-8.65	-6.97	-1.77	-8.09	-19.40	-8.09	-28.25	-13.20
P-Value	(0.13)	(0.06)	(0.33)	(0.13)	(0.15)	-	(0.04)	(0.08)
Acquired and Unmerged Firm, Prior								
Median	-1.07	8.59	-0.75	-0.62	-13.31	-29.13	-3.36	-2.98
P-Value	(0.01)	(0.75)	(0.16)	(0.28)	(0.54)	(0.00)	(0.44)	(0.26)
Mean	-9.85	6.00	0.62	-0.37	-13.45	-31.51	-9.55	-9.65
P-Value	(0.01)	(0.68)	(0.55)	(0.45)	(0.17)	(0.13)	(0.10)	(0.00)
Acquiring and Unmerged Firm, After								
Median	-8.99	-8.01	-5.96	-10.52	-43.21	-143.04	-20.75	-26.88
P-Value	(0.29)	(0.00)	(0.27)	(0.16)	(0.00)	-	(0.34)	(0.66)
Mean	-16.11	-12.87	-6.88	-12.82	-44.14	-143.87	-25.73	-21.09
P-Value	(0.06)	(0.00)	(0.08)	(0.02)	(0.12)	-	(0.03)	(0.04)

Table 5B: Differences in Cost Estimates*: Decay = 0.95, Linear = 26.50, Quadratic= 0.005.

Product Category	Pack aging Papers	Ground- wood Printing	Coated Papers	Un- coated Papers	Other Papers	Tissue	Box board	Liner board
Difference in Cost Estimate between								
Acquiring and Unmerged Firm, Prior								
Median	-2.85	-3.62	-1.43	-3.10	-19.04	-5.71	-9.08	-8.46
P-Value	(0.02)	(0.17)	(0.12)	(0.06)	(0.04)	-	(0.00)	(0.53)
Mean	-11.76	-3.24	-0.90	-11.28	-18.45	-7.67	-28.07	-17.22
P-Value	(0.03)	(0.22)	(0.41)	(0.03)	(0.16)	-	(0.05)	(0.04)
Acquired and Unmerged Firm, Prior								
Median	-1.97	-3.84	-1.28	-0.61	-13.09	-29.22	-3.36	-9.95
P-Value	(0.00)	(0.00)	(0.15)	(0.28)	(0.62)	(0.00)	(0.44)	(0.01)
Mean	-11.59	-3.46	-1.92	0.09	-12.51	-31.17	-9.28	-12.25
P-Value	(0.00)	(0.01)	(0.32)	(0.51)	(0.18)	(0.13)	(0.11)	(0.00)
Acquiring and Unmerged Firm, After								
Median	-9.00	-8.32	-6.03	-10.49	-43.35	-144.27	-30.96	-28.50
P-Value	(0.29)	(0.00)	(0.27)	(0.16)	(0.00)	-	(0.27)	(0.66)
Mean	-15.57	-13.17	-6.51	-12.42	-43.17	-145.08	-36.92	-23.30
P-Value	(0.07)	(0.00)	(0.10)	(0.02)	(0.13)	-	(0.00)	(0.04)

Table 5C: Differences in Cost Estimates*: Decay = 0.999, Linear = 36.50, Quadratic= 0.007.

Product Category	Pack aging Papers	Ground- wood Printing	Coated Papers	Un- coated Papers	Other Papers	Tissue	Box board	Liner board
Difference in Cost Estimate between								
Acquiring and Unmerged Firm, Prior								
Median	-0.93	-5.25	-1.44	-0.69	-19.26	-5.73	-9.06	-4.72
P-Value	(0.17)	(0.05)	(0.12)	(0.16)	(0.04)	-	(0.00)	(0.55)
Mean	-8.80	-9.65	-1.76	-7.86	-21.18	-10.39	-30.03	-16.12
P-Value	(0.15)	(0.04)	(0.38)	(0.18)	(0.13)	-	(0.04)	(0.09)
Acquired and Unmerged Firm, Prior								
Median	-1.07	13.59	-0.76	-0.62	-13.31	-29.15	-3.36	-3.01
P-Value	(0.01)	(0.75)	(0.16)	(0.28)	(0.54)	(0.00)	(0.44)	(0.26)
Mean	-10.52	9.18	1.27	-0.06	-15.24	-33.81	-8.51	-10.33
P-Value	(0.01)	(0.70)	(0.57)	(0.49)	(0.14)	(0.11)	(0.17)	(0.01)
Acquiring and Unmerged Firm, After								
Median	-8.99	-8.24	-5.98	-3.64	-43.54	-143.11	-20.75	-27.05
P-Value	(0.29)	(0.00)	(0.27)	(0.16)	(0.00)	-	(0.61)	(0.66)
Mean	-16.19	-15.27	-7.69	-12.77	-46.65	-145.62	-22.72	-20.57
P-Value	(0.09)	(0.00)	(0.12)	(0.04)	(0.11)	-	(0.06)	(0.07)

Table 5D: Differences in Cost Estimates*: Decay = 0.999, Linear = 53.00, Quadratic= 0.

Product Category	Pack aging Papers	Ground- wood Printing	Coated Papers	Un- coated Papers	Other Papers	Tissue	Box board	Liner board
Difference in Cost Estimate between								
Acquiring and Unmerged Firm, Prior								
Median	-0.93	-2.66	-1.44	-0.69	-19.26	-5.73	-9.05	-4.70
P-Value	(0.17)	(0.05)	(0.12)	(0.16)	(0.04)	(0.00)	(0.00)	(0.55)
Mean	-9.05	-10.46	-2.77	-4.80	-24.13	-14.22	-32.98	-4.86
P-Value	(0.19)	(0.01)	(0.37)	(0.31)	(0.10)	-(1.00)	(0.02)	(0.29)
Acquired and Unmerged Firm, Prior								
Median	-1.06	21.84	-0.73	-0.63	-13.31	-29.14	-3.36	-2.91
P-Value	(0.01)	(0.75)	(0.16)	(0.28)	(0.54)	(0.00)	(0.45)	(0.26)
Mean	-11.62	14.04	2.23	0.44	-18.18	-37.63	-6.65	-10.43
P-Value	(0.02)	(0.71)	(0.59)	(0.53)	(0.10)	(0.09)	(0.29)	(0.03)
Acquiring and Unmerged Firm, After								
Median	-5.50	-7.53	-5.92	-3.53	-42.54	-142.91	-20.75	-26.53
P-Value	(0.33)	(0.00)	(0.27)	(0.41)	(0.00)	(0.00)	(0.61)	(0.66)
Mean	-12.56	-18.17	-9.11	-12.92	-49.24	-148.25	-16.98	-15.93
P-Value	(0.15)	(0.00)	(0.15)	(0.08)	(0.09)	-(1.00)	(0.14)	(0.14)

Table 5E: Differences in Cost Estimates*: Decay = 0.999, Linear = 0, Quadratic= 0.010

Product Category	Ground- wood Printing	Coated Papers	Un- coated Papers	Other Papers	Tissue	Pack aging Papers	Box board	Liner board
Difference in Cost Estimate between								
Acquiring and Unmerged Firm, Prior								
Median	-5.92	-2.00	-5.43	-18.80	-5.44	-2.62	-8.95	-8.24
P-Value	(0.20)	(0.01)	(0.06)	(0.07)	-	(0.11)	(0.00)	(0.44)
Mean	-4.25	-0.55	-11.96	-14.66	-1.96	-8.25	-23.52	-25.01
P-Value	(0.26)	(0.34)	(0.04)	(0.21)	-	(0.09)	(0.08)	(0.04)
Acquired and Unmerged Firm, Prior								
Median	-3.62	-1.26	-1.16	-12.86	-28.86	-1.73	-17.24	-9.69
P-Value	(0.00)	(0.18)	(0.26)	(0.68)	(0.00)	(0.02)	(0.03)	(0.04)
Mean	-1.95	-0.96	-1.17	-8.72	-25.38	-8.08	-12.49	-9.10
P-Value	(0.05)	(0.32)	(0.15)	(0.26)	(0.18)	(0.03)	(0.00)	(0.01)
Acquiring and Unmerged Firm, After								
Median	-8.60	-5.77	-14.16	-44.17	-143.06	-8.75	-30.78	-27.18
P-Value	(0.00)	(0.00)	(0.01)	(0.00)	-	(0.29)	(0.27)	(0.25)
Mean	-7.80	-4.63	-12.67	-39.38	-139.55	-20.47	-34.64	-27.06
P-Value	(0.00)	(0.01)	(0.01)	(0.15)	-	(0.04)	(0.01)	(0.00)

Figure 2:

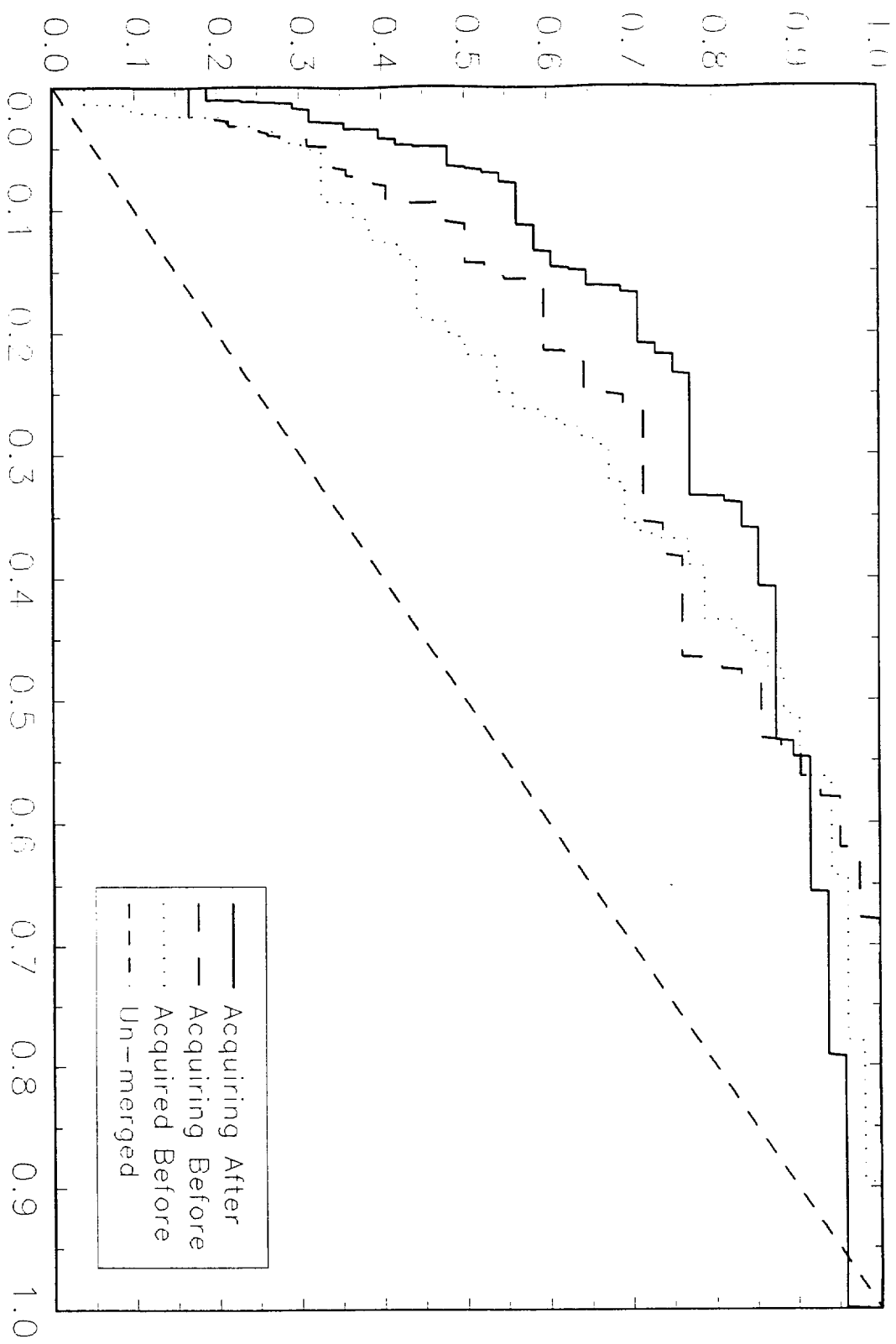


Table 6: WELFARE EFFECTS

Parameters:					
Decay	0.999	0.950	0.999	0.999	0.999
Linear	26.50	26.50	36.50	53.00	-
Quadratic	0.005	0.005	0.007	-	0.010
Product:					
1. PACKAGING PAPER:					
Total Welfare	61,440 (14,635)	53,515 (12,051)	66,530 (15,463)	2,786 (23,740)	153,976 (1,885)
Consumer Surplus	9,499 (6,174)	-1,974 (6,060)	12,711 (10,625)	-16,360 (21,947)	16,537 (919)
Producer Surplus	51,940 (9,145)	55,489 (6,816)	53,819 (9,243)	19,146 (12,665)	137,439 (1,156)
Gain to Merged Firms	57,090 (12,135)	54,834 (8,994)	59,767 (11,440)	12,469 (14,850)	145,128 (1,493)
Gain to Un-merged Firms	-5,149 (3,494)	655 (2,697)	-5,948 (5,162)	6,678 (9,781)	-7,689 (458)
2. GROUNDWOOD PRINTING:					
Total Welfare	1,736 (12,187)	-8,024 (12,429)	-195 (17,204)	-5,191 (25,016)	8,936 (1,016)
Consumer Surplus	3,132 (6,380)	-5,000 (9,174)	357 (10,801)	-6,186 (19,334)	2,731 (670)
Producer Surplus	-1,395 (6,393)	-3,024 (4,419)	-552 (7,625)	995 (8,017)	6,205 (598)
Gain to Merged Firms	419 (9,207)	-5,190 (7,790)	-29 (12,062)	-1,649 (15,478)	8,154 (924)
Gain to Un-merged Firms	-1,815 (3,213)	2,166 (4,211)	-523 (5,293)	2,644 (9,192)	-1,949 (563)
3. COATED PAPERS:					
Total Welfare	9,617 (11,036)	6,932 (8,271)	8,129 (13,509)	2,960 (29,308)	6,970 (1,651)
Consumer Surplus	10,604 (11,241)	5,486 (9,353)	2,067 (13,087)	-9,582 (23,639)	5,362 (1,570)
Producer Surplus	-987 (3,950)	1,445 (3,064)	6,062 (4,706)	12,543 (11,255)	1,608 (1,203)
Gain to Merged Firms	5,708 (7,321)	4,948 (5,140)	7,574 (8,769)	7,603 (19,476)	6,512 (1,611)
Gain to Un-merged Firms	-6,695 (7,118)	-3,503 (5,900)	-1,512 (7,916)	4,939 (12,872)	-4,903 (1,518)
4. UNCOATED PAPERS:					
Total Welfare	16,826 (21,463)	15,187 (20,916)	6,078 (28,420)	-4,760 (59,514)	27,877 (4,674)
Consumer Surplus	21,277 (10,197)	17,167 (8,793)	19,960 (30,289)	-9,464 (50,235)	23,555 (2,348)
Producer Surplus	-4,451 (13,863)	-1,980 (13,695)	-13,882 (13,307)	4,704 (21,616)	4,321 (3,235)
Gain to Merged Firms	9,747	9,930	-703	371	21,224

	(18,991)	(18,702)	(19,682)	(40,571)	(4,273)
Gain to Un-merged Firms	-14,198	-11,910	-13,180	4,333	-16,903
	(7,234)	(6,269)	(20,030)	(29,608)	(1,809)

5. OTHER PAPERS:

Total Welfare	31,166	30,507	30,396	25,590	36,311
	(4,094)	(4,100)	(6,209)	(9,016)	(894)
Consumer Surplus	4,888	4,347	7,953	8,405	6,319
	(1,713)	(1,610)	(4,486)	(6,213)	(632)
Producer Surplus	26,278	26,160	22,444	17,185	29,992
	(2,479)	(2,683)	(2,945)	(3,533)	(328)
Gain to Merged Firms	28,832	28,651	26,765	21,470	34,280
	(3,439)	(3,581)	(4,633)	(6,404)	(752)
Gain to Un-merged Firms	-2,554	-2,490	-4,322	-4,285	-4,288
	(1,036)	(1,050)	(2,715)	(3,499)	(485)

6. TISSUE:

Total Welfare	298,692	301,234	294,882	293,335	295,869
	(14,676)	(14,595)	(21,106)	(25,415)	(3,338)
Consumer Surplus	96,089	96,097	96,269	91,971	93,258
	(7,950)	(8,209)	(10,542)	(12,404)	(1,714)
Producer Surplus	202,604	205,137	198,613	201,365	202,611
	(6,815)	(6,423)	(10,614)	(13,196)	(1,624)
Gain to Merged Firms	242,905	245,941	234,938	230,820	250,956
	(11,952)	(11,619)	(16,422)	(19,950)	(3,056)
Gain to Un-merged Firms	-40,301	-40,804	-36,326	-29,456	-48,345
	(5,240)	(5,238)	(5,894)	(6,907)	(1,432)

7. BOXBOARD:

Total Welfare	412	72,568	-17,910	-38,689	60,377
	(16,381)	(13,263)	(18,191)	(18,204)	(10,913)
Consumer Surplus	-22,098	12,865	-18,346	-17,315	-27,686
	(8,594)	(7,484)	(8,466)	(6,736)	(6,669)
Producer Surplus	22,510	59,702	436	-21,374	88,063
	(8,412)	(6,931)	(10,240)	(11,908)	(5,908)
Gain to Merged Firms	11,832	65,724	-8,566	-31,594	74,950
	(12,233)	(9,652)	(14,051)	(15,507)	(7,889)
Gain to Un-merged Firms	10,679	-6,022	9,002	10,220	13,113
	(4,235)	(3,466)	(4,134)	(3,900)	(3,056)

8. LINERBOARD:

Total Welfare	163,587	108,186	84,374	178,452	-121,580
	(82,962)	(91,518)	(117,588)	(91,258)	(37,630)
Consumer Surplus	90,203	-31,157	69,329	168,745	-178,631
	(64,079)	(72,043)	(72,225)	(72,517)	(31,272)
Producer Surplus	73,384	139,344	15,045	9,707	57,050
	(52,942)	(66,982)	(65,256)	(55,270)	(30,739)
Gain to Merged Firms	112,771	128,791	45,789	98,758	-26,638
	(60,261)	(68,989)	(84,430)	(67,712)	(30,158)
Gain to Un-merged Firms	-39,386	10,553	-30,744	-89,051	83,688
	(28,788)	(27,798)	(31,328)	(39,047)	(13,768)