CASE STUDIES OF THE PRICE EFFECTS OF HORIZONTAL MERGERS

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EXECUTIVE SUMMARY

This report presents three case studies examining the effects of horizontal mergers on product prices. As a collection of case studies, the research is not intended to offer general conclusions about the efficacy of antitrust enforcement, but rather to offer some insight into certain issues that can influence the effectiveness of horizontal merger policy. The first case is one in which the Federal Trade Commission unsuccessfully challenged a merger that it alleged would likely lessen competition. The two other cases involve horizontal mergers that were not challenged by antitrust authorities, but involved circumstances that might raise competitive concerns.

To measure the effect of a merger on market price, one must control for changes in price that might have occurred even if the merger had not taken place. We attempt to control for these changes through a regression analysis that includes the demand and cost factors affecting the price of each product. By holding constant the effects of these factors on price, this approach can provide an estimate of the impact of a merger on the price of the product.

The first case that we examine, which is in many respects the most complex of the three, concerns Weyerhaeuser's purchase of Menasha Corporation's North Bend, Oregon corrugating medium mill. Corrugating medium is a paperboard product used to produce the fluted inner layer of corrugated board, which in turn is used in the manufacture of corrugated boxes. This acquisition was one component of Weyerhaeuser's purchase of Menasha's entire west coast paperboard and container operations. Although the merger was challenged by the Federal Trade Commission on antitrust grounds, the court permitted the merger to be consummated subject to a "hold-separate" order that allowed Weyerhaeuser to own, but not control, the North Bend mill during the four-year period in which the case was in administrative adjudication. Along with insulating Weyerhaeuser from the management of the North Bend mill, the hold-separate order also prevented Weyerhaeuser from receiving any preference in the distribution of the mill's output. After an administrative trial, the Commission dismissed the complaint

and the hold-separate order was lifted.

Our results indicate that allowing Weyerhaeuser to control and operate the North Bend mill unfettered resulted in a very small and statistically insignificant increase in the price of corrugating medium. However, during the period in which Weyerhaeuser owned but could not control the mill under the hold-separate order, corrugating medium prices rose by a statistically significant 17 percent. Prices fell back to approximate pre-merger levels after the case was dismissed and the hold-separate order removed. These results suggest that 1) the hold-separate order may have failed to deter any price increasing effects of the merger, and 2) the hold-separate order may have prevented significant vertical efficiencies by disallowing any preference to Weyerhaeuser in the distribution of the North Bend mill's output.

Although the hold-separate order prevented Weyerhaeuser from directly influencing production and pricing decisions of the North Bend mill, it did not prevent Weyerhaeuser from purchasing the mill and, accordingly, receiving the profits from the mill's operation. To the extent that the managers of the North Bend mill believed it possible that Weyerhaeuser would ultimately own the mill free of the order's restrictions, they may not have acted fully independently of what they perceived to be Weyerhaeuser's interest. As a result, the hold-separate order may not have prevented a lessening of competition in the market for corrugating medium.

On the other hand, virtually the only use for corrugating medium is, ultimately, to produce corrugated boxes. Both Weyerhaeuser and Menasha were vertically integrated in the production of boxes in the west coast market, as were eight of the nine additional firms that produced corrugating medium in this market. Moreover, the acquisition itself involved not only the purchase of a corrugating medium mill, but also the purchase of a box plant. Given the relationship between medium and boxes, an important force motivating the purchase may have been the realization of production efficiencies through further vertical integration. In addition, the hold-separate order may have disturbed the ongoing vertical relationship between the North Bend

corrugating medium mill and the former Menasha box plant.

The vertical effects of the hold-separate order can be studied directly by measuring the impact of the merger on corrugated box prices. We find that allowing Weyerhaeuser to purchase the North Bend corrugating medium mill under the hold-separate order had an insignificant effect on corrugated box prices, but that the removal of the hold-separate order with the dismissal of the antitrust complaint led to a statistically significant 5.7 percent decline in box prices.

Thus, Weyerhaeuser's acquisition of the North Bend mill under the hold-separate order may have fostered anticompetitive effects by creating an incentive for the management of the mill to pursue the best interests of Weyerhaeuser. On the other hand, by preventing Weyerhaeuser from receiving preferential distribution of the North Bend mill's output, the hold-separate order may have prevented the realization of the vertical efficiencies that eventually (once the order was removed) returned the price of medium to pre-merger levels and lowered the price of corrugated boxes.[1]

The second study examines the effects of the merger of the Hawaiian cement operations of Kaiser Cement Corp. and Lone Star Industries into a single firm, Lone Star Hawaii. This merger is interesting because Kaiser and Lone Star were the only firms that produced cement in Hawaii. Since imports generally did not have a significant presence in the Hawaiian cement market over the twenty-year period preceding the merger, one might view this acquisition as an anticompetitive merger to monopoly that would result in higher Hawaiian cement prices. Nevertheless, imports, particularly from the Far East, were accessible, and constituted a significant

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[1] Our result suggests that maintaining the acquired firm as a viable entity under independent management is not identical to the pre-merger status quo and should not be treated as such. A hold-separate order may result in higher product prices and lower output, and should be used judiciously. We do not mean to suggest, however, that a hold-separate order is necessarily improper. By facilitating divestiture, a hold-separate order can be an important tool in antitrust enforcement, and, in many cases, it may represent the most practical arrangement prior to settlement of an antitrust case.

fraction of Hawaiian cement sales in the two years immediately preceding the acquisition. Moreover, cement sales in Hawaii had declined substantially in the years preceding the acquisition, and the two cement plants carried substantial excess capacity.

The study finds no persuasive evidence that the creation of Lone Star Hawaii increased the price of cement in Hawaii. In fact, once Japanese demand and supply factors (that implicitly control for imports) are included in the regression model, we find a large and statistically significant decline in the price of cement in Hawaii following the merger. This result suggests that the merger created real efficiencies. Moreover, following the merger, imports remained at or above the relatively high levels achieved during the years immediately before the merger. These results suggest that when imports are easily accessible, they may have an important impact on price following a merger.

The third study examines the purchase by SCM Corp. of Gulf & Western's titanium dioxide manufacturing facilities in Ashtabula, Ohio. Titanium dioxide (TiO_2) is a pigment used to provide whiteness, opacity, and brightness to paint, paper, plastics, and other materials. This acquisition is interesting for a number of reasons. On the one hand, the TiO_2 industry is highly concentrated, and has a history of antitrust litigation. On the other hand, the acquisition facilitated a transfer of technology that may have created substantial technical efficiencies at the former Gulf & Western plant.

The results of this study indicate that following SCM's purchase of Gulf & Western's TiO_2 facilities, domestic TiO_2 prices rose by 28% above what would be expected given the changes in demand and cost factors during this period. That the purchase of a plant with less than 5% of an industry's output would result in such a large price increase is somewhat surprising even in a highly concentrated industry. Yet, this price increase cannot be explained by increases in input prices or demand factors that are controlled for in our price equation. Nor can the price increase be explained by positing that the merger merely coincided with an unexpected capacity "crunch" that may have occurred in 1988 and late 1987 (which

we also control for).[2] Nor can the price increase be explained by other domestic mergers.[3] Our results also suggest that efficiencies, such as those that may have been created through the transfer of technology facilitated by this acquisition, will not necessarily prevent post-merger price increases when mergers take place in highly concentrated industries. Consequently, we conclude that the evidence is consistent with the merger lessening competition in the domestic TiO_2 market.[4]

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[2] It may be the case that firms anticipated the capacity constraint before it became binding so that prices reflected this constraint sometime before the end of 1987. If this is the case, we may overstate the effects of the merger. Nevertheless, to the extent that the capacity "crunch" was anticipated well before the end of 1987, it would not be properly considered exogenous. Firms will expand capacity if they anticipate a future need.

[3] Since SCM's purchase of the Gulf & Western Ashtabula TiO_2 plant, no other domestic producers of TiO_2 have merged with one another. Slightly less than a year after SCM purchased the Ashtabula plant, SCM acquired the TiO_2 assets of Laporte Industries PLC, a British manufacturer of TiO_2 with plants in England and Australia. In 1985, Kemira Oy, a Finnish producer of TiO_2, purchased American Cyanamid's TiO_2 production facilities (after NL Industries dropped its proposed acquisition of these assets). Both LaPorte and Kemira Oy were very small fringe suppliers of TiO_2 in the U.S. prior to these acquisitions, and the effects of these acquisitions on domestic concentration were negligible. Thus, it is difficult to believe that the SCM/Laporte and the Kemira Oy/American Cyanamid acquisitions could have contributed to such a large increase in domestic TiO_2 prices.

[4] A merger resulting in lower costs and higher prices need not reduce social welfare. If demand is sufficiently inelastic, the welfare gain from a small decrease in cost could offset the welfare loss even from a large increase in prices. See Williamson (1968). Measuring the effects on social welfare of the three mergers that we study is, however, beyond the scope of this report.

Case Studies of the Price Effects of Horizontal Mergers

I. Introduction

In recent years economists have seen a resurgence of empirical research in industrial organization. This body of economic literature, termed the "new empirical industrial organization" or NEIO in Bresnahan (1989), has largely focused on empirical measures of market power in individual industries based on time series data.[1] The NEIO is primarily a response to a number of criticisms of the earlier cross-sectional research based on the structure-conduct-performance paradigm.

Despite this new focus on empirical measures of market power, little research has been devoted to the study of the price effects of individual horizontal mergers.[2] Given the theoretical links between increases in concentration that follow from horizontal mergers and increases in market power and the large amounts of government and private resources devoted to antitrust enforcement and litigation, the scarcity of research in this area is somewhat surprising.[3] Two notable

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[1] Recent surveys of this literature include Bresnahan (1989) and Geroski (1988). The Journal of Law & Economics XXXII (2) (Pt. 2) [October 1989] is entirely devoted to empirical approaches to market power.

[2] A large number of studies have examined the relationship between concentration and profits or margins across industries. (See Schmalensee (1989) and Salinger (1990)). However, concentration can vary across industries (or across time in a given industry) for reasons unrelated to mergers and acquisitions. Further, even to the extent that such studies might provide a meaningful relationship between concentration and profitability, they can not incorporate the idiosyncracies of the specific industry and the specific firms affected by a specific merger. That differences in concentration across different industries (or across time in a given industry) might be associated with differences in profits or margins does not imply that the changes in concentration in a given industry resulting from a given merger will affect profits or margins of firms in that industry in any particular manner.

[3] A number of additional studies have used an ex ante analysis to determine if a hypothetical merger in a particular industry could raise prices, rather than whether or not an actual merger did indeed raise prices. Baker and Bresnahan (1985), for example, estimate the elasticity of the "residual demand curve" facing a firm, where this curve measures the relationship between the firm's price and quantity after taking into account the supply responses of rivals. Although this

exceptions are Barton and Sherman (1984), which examined the effects of two mergers in the microfilm industry on price and profits, and Werden, Joskow, and Johnson (1989), which examined the effects of two airline mergers on price and the provision of services.[4]

This report presents three case studies examining the effects of horizontal mergers on market prices. As a collection of case studies, the research is not intended to offer general conclusions about the efficacy of antitrust enforcement, but rather to offer some insight into certain issues that can influence the effectiveness of horizontal merger policy. We selected these cases largely because their circumstances raised questions of potential anticompetitive effects.[5] In order to use the effect of the mergers on price as a measure of their effect on competition, we chose cases that involved essentially homogeneous products so that the issue of competition in dimensions other than price would be minimized. The first case is one in which the Federal Trade Commission unsuccessfully challenged a merger that it alleged would likely lessen competition. The two other cases involve horizontal mergers that were not challenged by antitrust authorities, but involved situations that might raise competitive concerns.

The first study examines Weyerhaeuser Company's 1981 purchase of Menasha Corporation's corrugating medium mill in North Bend, Oregon. This case is of interest because

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method is suitable for measuring the potential for a price increase following a merger, it does not take into account how efficiency gains from a merger might alter the response of rivals. The Baker and Bresnahan approach also requires detailed firm-specific data that are generally not available. Thus, rather than studying the potential anticompetitive effects of realized acquisitions based on pre-merger analysis, our approach is to study directly the actual effects of the acquisitions on market price.

[4] Borenstein (1990) also examined the effects on prices and services of the same two airline mergers that Werden, Joskow, and Johnson studied. However, unlike Werden et al., Borenstein does not formally model the process generating equilibrium prices, but instead, examines average prices at hubs relative to industry average prices during periods before and after the mergers.

[5] Data availability also affected case selection.

the FTC complaint alleged that the acquisition would likely lessen competition in the market for corrugating medium in the region west of the Rocky Mountains. One obvious issue of interest is, did the acquisition actually lead to higher prices, as predicted by the Commission's complaint? A second issue that we wish to examine is the effect of a hold-separate order that allowed Weyerhaeuser to own the North Bend mill during the four-year period that the case was in administrative adjudication.

The second study examines the price effects of the 1985 merger of the Hawaiian cement operations of Kaiser Cement Corporation and Lone Star Industries. At the time of the merger, Kaiser Cement and Lone Star were the only firms producing cement in Hawaii. Thus, if the state of Hawaii were a relevant cement market for antitrust purposes, this merger would have been a merger to monopoly. Although inland cement markets tend to be relatively localized on account of the high costs of transporting cement over land, Hawaii is fortuitously surrounded by the Pacific ocean and accessible to imports from countries such as Japan that export cement to ports along the west coast of the U.S. This case, therefore, allows us to examine issues of geographic market definition and the role of imports in restraining the price effects of potentially anticompetitive mergers.

The third study measures the effect on price from SCM Corporation's purchase of Gulf & Western's titanium dioxide plant in Ashtabula, Ohio in October 1983. The titanium dioxide (TiO_2) industry is highly concentrated and has had an interesting history of antitrust investigations in recent years. Most notable among these was a 1978 complaint issued by the FTC against Du Pont, then and now the largest producer of TiO_2. In the complaint, the Commission charged that Du Pont attempted to monopolize the production of TiO_2 through strategic capacity expansion.[6] No attempt was made by federal antitrust authorities to block the SCM/Gulf & Western

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[6] E.I. Du Pont de Nemours & Co., 96 FTC 653 (1980) (dismissing complaint). See Holt and Scheffman (1989) for an interesting discussion of this case as well as general discussion of theories of strategic business behavior and their difficult application to antitrust enforcement.

acquisition; yet, little over a year later, the FTC did successfully block another proposed acquisition of one TiO_2 manufacturer by another.[7]

Section II of this report discusses the general methods we used to measure the effects of the mergers on price. Sections III through V present the three case studies, and Section VI summarizes and concludes the paper.

[7] Of course, following the SCM/Gulf & Western acquisition, the industry was more concentrated. The point here is not that blocking the second merger was inconsistent with not blocking the SCM acquisition. The facts of the case may have been very different and anticompetitive effects may have appeared more likely. The point here is simply that the SCM/Gulf & Western acquisition took place in an industry with a history of government concern with respect to the level of competition.

II. Methods

The purpose of this study is to measure the effect of horizontal mergers on market prices. To do so, we use a reduced-form equation mapping exogenous demand and supply variables to price.

In perfectly competitive and monopolistic markets, the determination of price is straightforward; however, most industries are neither perfectly competitive nor monopolistic. Models that examine the determination of price in such oligopolistic markets often feature substantial theoretical complexity. Firms in these markets may recognize that alternative sources of supply exist, but also realize that not all customers may move elsewhere in response to a price increase. The number of customers that ultimately switch producers in response to a single firm's price increase depends largely on the reactions of that firm's rivals. A large body of theoretical research describes the diverse forms of potential rival behavior. The highly stylized models used in this research yield a wide range of equilibrium prices and outputs that depend on their specific assumptions.[8] In many of these models, an increase in concentration will lead to higher prices in the absence of efficiency gains. However, when a horizontal merger does create real efficiencies, the impact on price from the subsequent increase in concentration is ambiguous. In many cases in which, holding all other factors constant, greater concentration leads to higher prices, market price can fall and industry output increase when those other factors are not constant, such as when a merger results in lower costs. Thus, the issue of whether or not an actual merger can affect price is entirely an empirical question.[9]

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[8] A general discussion of these models is contained in Tirole (1988) [particularly, Chapter 5].

[9] As noted by Williamson (1968), a merger that creates efficiencies may increase social welfare even if it results in higher prices. Our purpose here is not to determine whether or not the mergers enhanced social welfare, but rather to examine strictly the effects of the mergers on market price. If price falls following a merger, we can unambiguously conclude that social welfare increased. If price rises following a merger, the social welfare implications are ambiguous; however, we can generally conclude that the process by which firms within the industry interact

To develop our reduced-form price equation, we begin by assuming a log-linear market demand function

$$Q = \alpha P^{-\varepsilon} D^{\beta} e^{\mu}, \tag{II.1}$$

where Q is the quantity demanded in a given time period, P is the price of the product during that time period, D is a vector $(d_1,d_2,...,d_n)$ of n exogenous factors affecting demand, e is the natural exponential constant, μ is a log-normal random disturbance, and α, ε, and β are parameters.[10]

Next, we assume a homogeneous industry-wide production function. Such a production function implies that industry costs are of the form

$$TC = f(Q)c(\pi), \tag{II.2}$$

where TC is the total cost to the industry of producing an industry-wide output Q, and π is a vector $(\pi_1,\pi_2,...,\pi_s)$ of s input prices. The function $c(\cdot)$ is a linear logarithmic cost function that provides a local approximation to a continuous arbitrary differentiable function such that

$$\ell nc = c_0 + \sum_{i=1}^{s} c_i \ell n \pi_i . \tag{II.3}$$

Homogeneity of the production function implies a constant elasticity of total cost with respect to output, η, so that $f(\cdot)$ takes the form $f(Q) = kQ^{\eta}$.[11] The value of the constant k influences both the level of total industry cost and the steepness of the marginal cost curve. Thus, k is a measure of industry efficiency. η is a characteristic of the underlying

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to determine market price changed in a way that can be described as anticompetitive. A possible exception to this general rule would be the case of a merger in a declining industry where the pre-merger price might be below long-run average cost.

[10] Throughout the discussion of methods, time subscripts are suppressed to simplify the notation.

[11] The inverse of η is the degree of homogeneity of the underlying production function. See Chambers (1988), chapter 2.

technology. From this relationship, we can derive a marginal cost function (MC) that can be related to the demand curve:

$$\eta = \frac{\delta TC}{\delta Q}\frac{Q}{TC}, \text{ which implies that}$$

$$MC = \eta AC,$$

$$= \eta k Q^{\eta-1} c(\pi). \qquad \text{(II.4)}$$

We combine the industry demand and cost equations assuming that the firms in an industry seek to maximize profits given certain constraints on their ability to cooperate. These constraints may be imposed by the legal system (e.g., laws against price-fixing conspiracies) or arise from the incentives created by the technologies or institutions characterizing the industry. In the limiting case of only one producer, price and quantity will be set where marginal revenue equals marginal cost, implying that

$$P = [\varepsilon/(\varepsilon-1)]MC,$$

where ε is the price elasticity of demand. Given the constraints on the ability of firms to cooperate, we hypothesize that a collection of firms will set price at some point less than the monopoly level, but possibly above the perfectly competitive level (P = MC). Thus, we hypothesize that

$$P = \gamma[\varepsilon/(\varepsilon-1)]MC,$$

where γ reflects the constraints that act to prevent the firms in an industry from jointly maximizing profits. For a monopolist or a perfect cartel, γ would equal 1; for a perfectly competitive industry, γ equals $[(\varepsilon-1)/\varepsilon]$. To simplify the notation, we can collapse $\gamma[\varepsilon/(\varepsilon-1)]$ into a single parameter, m, resulting in

$$P = mMC, \qquad \text{(II.5)}$$

where m measures the mark-up of market price over a measure of marginal cost for the industry. Substituting equation (II.4) into equation (II.5), taking the logs of both sides of the equation and adding a random error term, v, gives

us

$$\ell nP = \ell nm + \ell nk + \ell n\eta + (\eta-1)\ell nQ + \ell nc(\pi) + \nu. \qquad \text{(II.6)}$$

Substituting equations (II.1) and (II.3) into equation (II.6) results in the following reduced-form price equation:

$$\ell nP = \phi_0 + \sum_{i=1}^{n} \phi_i \ell nd_i + \sum_{i=1}^{s} \omega_i \ell n\pi_i + \tau, \qquad \text{(II.7)}$$

where $\phi_0 = [\ell nm + \ell nk + \ell n\eta + c_0 + (\eta-1)\ell n\alpha](1 + (\eta-1)\varepsilon)^{-1}$

$\phi_i = [(\eta-1)\beta_i](1 + (\eta-1)\varepsilon)^{-1}$

$\omega_i = c_i(1 + (\eta-1)\varepsilon)^{-1}$

and $\tau = [(\eta-1)\mu + \nu](1 + (\eta-1)\varepsilon)^{-1}$.

Each of the coefficients in equation II.7 is a function of one or more parameters that may be altered by a merger. Accordingly, to measure the effects of a merger on market price we estimate the equation

$$\ell nP = \phi_0 + \phi_0^*DM + \sum_{i=1}^{n} \phi_i \ell nd_i + \sum_{i=1}^{n} \phi_i^* DM\, \ell nd_i + \sum_{i=1}^{s} \omega_i \ell n\pi_i +$$

$$\sum_{i=1}^{s} \omega_i^* DM\, \ell n\pi_i + \tau, \qquad \text{(II.8)}$$

where DM is a dummy variable (or, in certain cases, a vector of dummy variables) equal to zero before a merger (or merger related event) and equal to one thereafter. ϕ_i^*, ω_i^* measure the changes in the coefficients on the exogenous variables as a result of the merger or merger related event. Using this model, the effect of the merger on price is the difference quotient,

$$\Delta\ell nP/\Delta DM = \phi_0^* + \sum_{i=1}^{n} \phi_i^* \ell nd_i + \sum_{i=1}^{s} \omega_i^* \ell n\pi_i,$$

which we evaluate at the average levels of the exogenous

variables during the period following the merger (i.e., the period in which DM equals one).

Our method of measuring the price effects of horizontal mergers differs considerably from those of Barton and Sherman (1984) and Werden, Joskow, and Johnson (1989). Barton and Sherman's method resulted from a unique situation. They examined the price effects of two mergers by the Xidex Corporation that eliminated a major rival in each of two main product lines, diazo and vesicular microfilm. Although the two products are not perfect substitutes, the factors influencing demand are largely the same. Moreover, the two types of microfilm are produced in very similar processes with the same ingredients.[12] The two mergers took place three years apart, and consequently, Barton and Sherman could control for changing demand and cost conditions (as we do with our reduced-form price equation) and study the effects of the two mergers by simply examining the ratio of the vesicular and diazo prices before and after each of the mergers.

Werden, Joskow, and Johnson (1989) examined the effects of two 1986 airline mergers, TWA/Ozark and Northwest/Republic. They estimated a reduced-form equation in which average revenue per passenger (yield) is a function of demand, cost, and concentration characteristics. They use data from 867 city pairs (routes) in 1985 (the pre-merger period) and 948 city pairs in 1987 (the post-merger period). Using cross-sectional analysis, they estimate the reduced-form yield equation for city pairs not affected by the mergers for both the pre- and post-merger years, and then use these estimated coefficients to predict the yields (pre- and post-merger) for the city pairs affected by the mergers.

Our method estimates the reduced-form price equation for each industry using time-series data. We forsake using concentration as an explanatory variable, trying to isolate explicitly the effects of individual events (i.e., the mergers)

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[12] Although the production processes are very similar, supply-side substitution is hampered by patents and trade secrets surrounding vesicular coating formulations. See Barton and Sherman (1984), footnote 5.

that alter market structure. We adopt this approach for examining changes in industry pricing behavior over time, since, over long periods of time, changes in concentration may result from technological innovations as well as mergers, and we wish to focus solely on the effects of mergers (or other forms of acquisitions) on price.

III. Weyerhaeuser's 1981 Acquisition of Menasha Corp.'s Corrugating Medium Mill at North Bend, Oregon

A. Background

Corrugating medium is a paperboard product used to produce the fluted inner layer of corrugated board, which in turn is used in the manufacture of corrugated boxes. Corrugated board consists of two sheets of linerboard on either side of the fluted corrugating medium. The corrugating medium provides the corrugated board with stiffness, rigidity, and crush strength, whereas the linerboard provides the corrugated board with burst and tear strength.

In September of 1980, the Weyerhaeuser Co. agreed to purchase the west coast paperboard and container operations of Menasha Corporation.[13] These assets included (1) a corrugating medium plant in North Bend, Oregon; (2) a 710 acre unimproved mill site in North Bend, Oregon; (3) a corrugated box plant in Anaheim, California; and (4) three waste paper plants, two in Portland and one in Eugene, Oregon.[14]

On December 12, 1980 the Federal Trade Commission filed suit in U.S. District Court seeking a preliminary injunction (PI) blocking the Weyerhaeuser/Menasha acquisition. The Commission argued that Weyerhaeuser's purchase of the North Bend corrugating medium mill would likely lessen competition in the production of corrugating medium in the eleven-state region west of the Rocky Mountains. Within this geographic market, Menasha was the fourth largest producer with a pre-merger market share of 11.26%, and Weyerhaeuser was fifth largest with a pre-merger market share of 9.38%. The post-merger level of concentration in the west coast market, as measured by the Herfindahl-Hirschman index (HHI), would be 1166, and the change in concentration resulting from the merger would be 211. The acquisition would leave Weyerhaeuser the largest producer in

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[13] See The Wall Street Journal, September 12, 1980, p. 4.

[14] Weyerhaeuser Co., 106 F.T.C. at 174.

the west coast market with a market share of 20.64%.[15]

On February 9, 1981 the FTC issued an administrative complaint charging that Weyerhaeuser's planned acquisition of Menasha's North Bend medium mill violated Section 7 of the Clayton Act and Section 5 of the FTC Act. The complaint alleged that the acquisition would (1) "eliminate Menasha as a competitive entity ... in the West Coast market; (2) eliminate substantial actual competition .. in the West Coast market; (3) significantly increase already high levels of concentration in the West Coast market...; [and] (4) ... affect the availability of corrugating medium in the West Coast market."

On March 25, 1981 the District Court denied the FTC's request for a PI to block the merger and allowed Weyerhaeuser to purchase Menasha's west coast assets.[16] However, the Court attached the condition that the North Bend mill be operated under the terms specified by the Court in a hold-separate order. A hold-separate order is a form of preliminary relief that permits a challenged transaction to go forward, but requires the acquiring company to preserve the acquired company (or assets) as a separate and independent entity during the course of antitrust proceedings. The purpose of such an order is to maintain the acquired unit (in this case, the North Bend mill) as a viable competitor so that eventual divestiture would be a "feasible remedy" should the government succeed in proving the acquisition anticompetitive in a full hearing on the merits of the case (in this case, a hearing before the Federal Trade Commission). Thus, the Court required Weyerhaeuser to insulate itself from the management, supply, production, sales, and pricing decisions of the mill. Further, Weyerhaeuser's box plants

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[15] These market share and concentration numbers are those adopted by the Federal Trade Commission in its final Opinion (see Weyerhaeuser Co., 106 F.T.C. at 279). These numbers are somewhat higher than those adopted by the administrative law judge (ALJ) in his Initial Decision (see Weyerhaeuser Co., 106 F.T.C. at 220-221). The ALJ included in his market share numbers capacity from east coast plants. The Commission, in its Opinion, specifically rejected the method by which the ALJ calculated market shares.

[16] FTC v. Weyerhaeuser Co., 1981-1 Trade Cas. (CCH) ¶ 63,974 (D.D.C.), aff'd. 665 F.2d 1072 (D.C. Cir. 1981).

could not receive preferential distribution of the mill's output.[17]

The administrative hearing on the merits lasted from January 17, 1983 to May 16, 1983, and the administrative law judge (ALJ) who heard the case issued his initial decision on October 11, 1983. The ALJ concluded that complaint counsel had failed to prove that Weyerhaeuser's acquisition of the North Bend mill would likely lessen competition or tend to create monopoly, and ordered the complaint dismissed. Complaint counsel appealed the initial decision to the Commission, and on September 26, 1985 the Commission dismissed the complaint.[18]

The Weyerhaeuser/Menasha acquisition raises a number of issues that are important to effective antitrust policy and, therefore, worth careful examination. First, and obviously, the government's allegation that the Weyerhaeuser/Menasha acquisition would tend to lessen competition and lead to high corrugating medium prices in the west coast market can be examined and tested directly. Further, this case allows us to examine the impact on prices of the hold-separate order.

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[17] In addition to these provisions, the hold-separate order also stipulated that Weyerhaeuser could not reduce the output of the North Bend mill; however, this particular provision was subsequently modified by the court. According to Dennis Johnson, the lead FTC attorney during the administrative proceedings, on at least two separate occasions, Weyerhaeuser successfully applied to the district court for permission to reduce output at the North Bend mill. Unfortunately, the orders approving these applications were not published. For the complete text of the hold-separate order, see Federal Trade Commission v. Weyerhaeuser in Court Decisions: Federal Trade Commission, XVI, January 1,1982 to December 31, 1982, pp. 7-11.

[18] Weyerhaeuser Co., 106 F.T.C. 265 - 290. Although the Commission agreed with the ALJ's ultimate decision to dismiss the complaint, the Commission agreed with complaint counsel that the ALJ had based his decision, in part, on erroneous analysis. Specifically, the Commission rejected the ALJ's conclusion that the relevant geographic market was national in scope. Further, although the ALJ concluded that the acquisition would not harm competition even if the relevant geographic market was the west coast, the Commission disagreed with certain portions of the ALJ's analysis that led to this conclusion, particularly his market share and concentration numbers (see footnote 15). Nevertheless, the Commission dismissed the complaint.

There are a number of interesting issues raised by hold-separate orders in general and the Weyerhaeuser/Menasha hold-separate order in particular. As discussed above, a hold-separate order is designed to preserve the acquired asset or firm, the North Bend mill in this case, as an independently managed entity that could be sold to a third party if the acquisition is later found to be anticompetitive. Thus, the hold-separate order is designed with the intent of allowing a return to the pre-acquisition status quo. To this end, a hold-separate order contains very specific provisions governing the post-acquisition relationship between the acquired and acquiring entities. These provisions are designed to prevent the management of the acquiring firm from controlling the production and pricing decisions of the acquired entity or from allowing the acquired entity to deteriorate in such a way as to no longer be viable as an independent firm.

These provisions notwithstanding, a key aspect of a hold-separate order is that it allows the acquisition to take place. Weyerhaeuser, in this case, was able to take ownership of the North Bend mill during the period in which the administrative complaint was being adjudicated. One critical issue is, if an acquisition is in fact anticompetitive, can the restrictions imposed by a hold-separate order effectively prevent a lessening of competition in the industry? An important consideration in this regard is the incentives of the management of the acquired assets. Suppose for example that the hold-separate order governing Weyerhaeuser's purchase of the North Bend mill did effectively prevent Weyerhaeuser's management from directly influencing the output and pricing decisions of the North Bend mill's management. The managers of the North Bend mill, although independent of direct Weyerhaeuser influence, were still employees of Weyerhaeuser, and Weyerhaeuser received the profits of the North Bend mill. If the managers of the North Bend mill perceived a positive probability that Weyerhaeuser would win the pending antitrust case and gain full control of the North Bend mill, then they may have believed that their best interest required setting prices or production policies in ways that they believed would be in the best interest of Weyerhaeuser. Thus, even though Weyerhaeuser could not directly control the North Bend mill, its ownership of the mill under the hold-separate

order may have created incentives for those who did control the North Bend mill to act to maximize Weyerhaeuser's profits. To the extent that this sort of incentive problem proves significant under similar hold-separate orders, it may limit the effectiveness of hold-separate orders as means of preventing anticompetitive harm while cases are being litigated.

A second aspect of the hold-separate order that raises concerns specific to this particular case is the clause that prevented the North Bend mill from giving Weyerhaeuser any preference in the supply of medium. Although the complaint addressed primarily the horizontal effects of the North Bend mill's acquisition, a very important facet of Weyerhaeuser's acquisition of Menasha's west coast assets was the vertical features of the acquisition. Virtually the only use for corrugating medium is, ultimately, to produce corrugated boxes. Both Weyerhaeuser and Menasha were vertically integrated in the production of boxes in the west coast market, as were eight of the nine additional firms that produced corrugating medium in this market. Moreover, the acquisition itself involved not only the purchase of a corrugating medium mill, but also the purchase of a box plant.[19]

The Commission's complaint alleges, among other things, that the acquisition would affect the availability of corrugating medium, suggesting the possibility that independent corrugated box producers (i.e., box producers that did not also produce medium) would be harmed by the foreclosure of Menasha's output from the corrugating medium market. According to one FTC attorney, the hold-separate order was consistent with the goals of the case. In an article in The Wall Street Journal, this attorney explained that "the ruling frustrated Weyerhaeuser's 'whole intention, which was to integrate the North Bend mill into their own corrugated container production operations.'"[20]

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[19] The purchase of the box plant, however, was not challenged as anticompetitive.

[20] The Wall Street Journal, March 27, 1981, p. 34.

Given the relationship between medium and boxes, an important force motivating the purchase may have been the realization of production efficiencies through further vertical integration.[21] Thus, the hold-separate order, by preventing Weyerhaeuser from integrating the North Bend mill into its corrugated container operations, may have prevented the realization of vertical efficiencies. In addition, the hold-separate order may have increased costs at the former Menasha box plant (a Weyerhaeuser box plant after the acquisition) by disturbing the vertical relationship that had existed when both the box plant and the medium mill were owned and operated by Menasha.

Even absent vertical efficiencies, the hold-separate order, by preventing further vertical integration by Weyerhaeuser, may have had the effect of preventing price decreases in corrugating medium that would result from vertical integration. In a recent study of the linerboard market, Salinger (1991) shows that vertical integration makes it harder for linerboard manufacturers to maintain a collusive agreement and provides incentives for integrated linerboard producers to disrupt a collusive agreement by lowering linerboard prices to independent box producers. Although Salinger examines vertical integration of linerboard and box production, the analysis could be applied equally well to vertical integration of corrugating medium and box production. Salinger's empirical results suggest that in this industry horizontal integration leads to price increases and vertical integration leads to price decreases.

Thus, the hold-separate order may have had a rather ironic effect. By failing to eliminate incentives for the North Bend mill's management to act in Weyerhaeuser's interest, the order may have allowed any anticompetitive effects of the acquisition to be realized. At the same time, by preventing

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[21] See Fisher and Sciacca (1984) for a detailed review of the potential efficiencies created by vertical integration. Vertical efficiencies could be realized both in the production of boxes and in the production of medium. The latter efficiencies arise from the significant costs imposed by down-time at a corrugating medium plant. By allowing for better coordination between medium production, linerboard production, and box production, vertical integration can lessen the amount of down-time at each stage of production, and, consequently, lower costs at each stage.

Weyerhaeuser from receiving any observable preference in the distribution of the mill's output, the order may have eliminated potential price reductions resulting from further vertical integration.[22]

B. Data

Table III.1 lists and describes the data we used to estimate the west coast corrugating medium price equation. We estimated the reduced-form price equation using 52 quarterly observations beginning the first quarter of 1976 and ending the fourth quarter of 1988. The dependent variable is the average of the Bureau of Labor Statistic's corrugating medium price indices for the west coast states.[23] Two dummy variables were used in each of the equations. The first, DUM81, equals 1 during the entire post-acquisition period from the second quarter of 1981 through the fourth quarter of 1988, and zero otherwise. The second, DUM85, equals 1 from the third quarter of 1985 through the fourth

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[22] Though these two propositions may appear inconsistent, they are not. To offer Weyerhaeuser a significant preference in the output of the mill would have required that the North Bend's management foreclose that output to other customers by canceling or failing to renew contracts with those other customers. Such overt action would be difficult to conceal, and the customers losing access to the mill's output might have strong incentives to report these actions to the Court. On the other hand, the mill's management could unilaterally set prices or output at levels it believed to be in the interest of Weyerhaeuser, without direct involvement of Weyerhaeuser's management and, therefore, without technically violating the hold-separate order.

[23] A number of studies published in the 1960's and early 1970's were critical of the price statistics gathered by the Bureau of Labor Statistics (BLS). These studies suggested that the BLS prices were based on list prices rather than transaction prices, and thus did not reflect the actual prices at which goods were sold. [See Carlton and Perloff (1990), p. 705, for a discussion of these studies.] The BLS changed its methods of collecting prices in response to these criticisms. According to the BLS Handbook of Methods 1988, the BLS prices that we use are based on "transaction prices, including all discounts, premiums, rebates, allowances, etc., rather than fictitious list or book prices." (p. 126) Monthly prices are based on transactions prices for a particular day of a given month. The quarterly prices that we use are the end-of-quarter monthly prices. Obviously, once we average across the west coast states our prices will not strictly represent the prices of any given transaction; nevertheless, the prices are not merely average list prices and should, at least on average, tend to vary with changing market conditions as we would expect from transaction prices.

quarter of 1988, the period in which Weyerhaeuser had complete control over the North Bend corrugating medium plant.

The demand for corrugating medium is derived from the demand for corrugated boxes. Corrugated boxes are used to ship such diverse products as canned and bottled goods, agricultural products, clothing, appliances, toys, drugs, books, and furniture (to name just a few). Thus, the demand for corrugated boxes tends to rise and fall with the general level of economic activity and income; accordingly, we used average real personal income for the states in the west coast market to measure demand. Cost variables that we used were a west coast wage index for SIC 26 (paper and allied products), a corporate discount rate, and price indices for industrial power (average for the west coast states), wood chips, and sodium hydroxide, the latter two being important ingredients in the process that produces the pulp for the medium.

Figure III.1 plots the inflation-adjusted prices of corrugating medium in the west coast region for the period studied. As indicated in the figure, the west coast medium prices appear to be fairly stable in the years immediately following the acquisition, but rise sharply in the years following dismissal of the FTC complaint in mid-1985. We examine in the next section whether the price path illustrated in Figure III.1 is the result of the combined effects of the hold-separate agreement and the dismissal of the antitrust complaint or is fully explained by the factors influencing the demand and supply of corrugating medium.

Table III.1

Variable Descriptions For Price Equations[1]

Variable	
PCMW	Dependent variable: average real price index of corrugated medium, western United States[2]
PBOXW	Dependent variable: average real price index of corrugated boxes, western United States[2]
C	Constant
LPOWER	Log of real industrial power price index, average for west coast states[2]
LW26	Log of real wage index, SIC 26, western U.S.[3]
LNAOH	Log of real sodium hydroxide price index[2]
LCHIPC	Log of real price of wood chips, California[4]
LCHIPW	Log of real price of wood chips, Washington State[4]
LDISC	Log of real discount rate[5]
LPYW	Log of real personal income, average for west coast states[3]
Q1	First quarter seasonal dummy variable
Q2	Second quarter seasonal dummy variable
Q3	Third quarter seasonal dummy variable
DUM81	Post-acquisition dummy variable (= 1 for 1981.Q2 - 1988.Q4)
DUM85	Post-litigation dummy variable (= 1 for 1985.Q3 - 1988.Q4)

[1]All nominal values were deflated using the Bureau of Labor Statistics' Producer Price Index
[2]Source: Bureau of Labor Statistics
[3]Source: Department of Commerce
[4]Source: Production, Prices, Employment, and Trade in Northwest Forest Industries, U.S. Forest Service, U.S. Department of Agriculture. The Washington and California woodchip prices are export prices.
[5]The discount rate is 1 plus the real interest rate, where the real interest rate is calculated as end-of-quarter Moody's AAA Corporate Bond rate minus the annualized quarterly inflation rate.
[6]Source: Timber Marts, Inc.

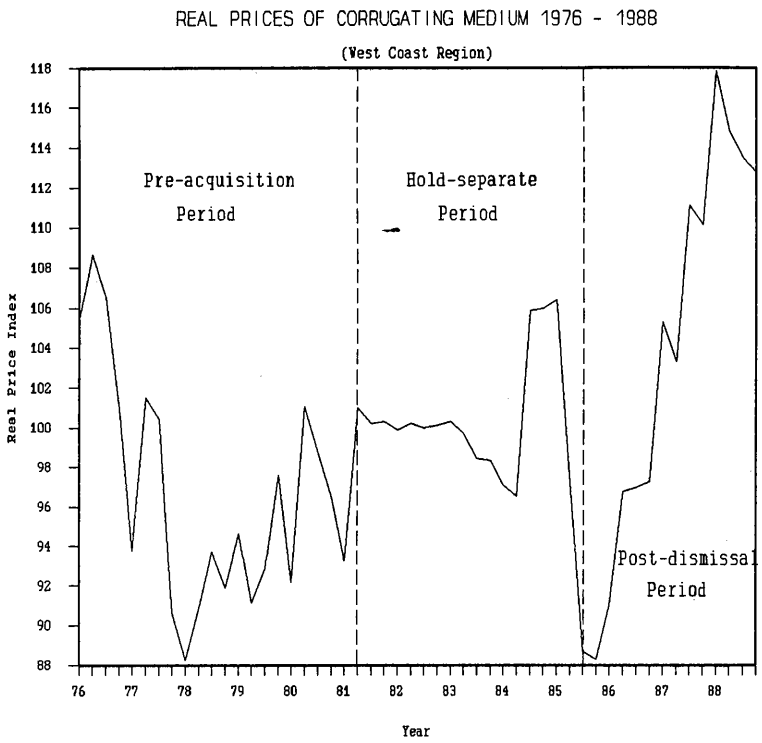
REAL PRICES OF CORRUGATING MEDIUM 1976 - 1988
(West Coast Region)
Real Price Index
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
Pre-acquisition
Period
Hold-separate
Period
Post-dismissal
Period
76
77
78
79
80
81
82
83
84
85
86
87
88
Year

Figure III.1

C. Results

Column 2 in Table III.2 reports the results for the reduced-form price equation for corrugating medium. The coefficients for the exogenous variables that do not interact with one of the two dummy variables measure how changes in the demand and cost variables translated into changes in price in the period before the merger occurred. We would expect the signs of these variables to be positive since increases in costs and demand should result in higher medium prices. Two of the coefficients, LPOWER and LCHIPW, have the wrong sign; however, only LPOWER is statistically significant at the .1 level. LW26, LNAOH, LCHIPC, LDISC, and LPYW have the expected positive sign and are all significant at less than the .05 level.[24]

$\Delta\ell nP/\Delta DUM81$ measures the effect on medium prices of allowing the merger to be consummated and imposing the hold-separate order. The estimated coefficients reported in Table III.2 indicate that

$$\Delta\ell nP/\Delta DUM81 = 0.154 - 0.046*LPOWER + 0.726*LW26 + 0.193*LNAOH - 0.153*LCHIPC + 0.524*LCHIPW + 0.126*LDISC + 0.988*LPYW,$$

which, as reported in Table III.3, equals 0.1576 when evaluated at the average levels of the exogenous variables over the post-merger period and is statistically significant at the .05 level (its t-statistic is 2.55). $\Delta\ell nP/\Delta DUM81$ indicates that corrugating medium prices rose by approximately 17%

[24] The relevant geographic market played an important role in the case. Complaint counsel argued that it was the eleven-state region west of the Rocky Mountains. The Commission, in its opinion, agreed with complaint counsel on this issue. Weyerhaeuser and the ALJ agreed that the relevant geographic market consisted of the entire nation. Consequently, we estimated a second specification of the price equation that included an industrial power index for the east coast, a price index for wood chips sold in the east, and real GNP in addition to the west coast variables. These additional variables, however, did not appear to have much explanatory power. The χ^2 statistic for the test of the joint significance of these variables is 12.73 with 9 degrees of freedom, which is not statistically significant.

Table III.2

Reduced-Form Price Equations

(t-statistics in parentheses)

Variable	Corrugating Medium	Corrugated Bo
C	1.1306** (2.3820)	1.3999** (7.0130)
LPOWER	-0.1281* (-1.7425)	-0.0979 (-1.0352)
LW26	0.1395** (2.5544)	-0.0810 (-1.0727)
LNAOH	0.1910** (2.3963)	0.0783* (1.9422)
LCHIPC	0.1020** (2.3361)	0.0514** (2.5860)
LCHIPW	-0.0832 (-1.3575)	-0.0273 (-0.9586)
LDISC	0.3703** (2.3563)	0.4647** (3.2650)
LPYW	0.3775** (4.3039)	0.4997** (6.9688)
LPOWER*DUM81	-0.0462 (-0.2423)	0.1071 (1.2830)
LW26*DUM81	0.7261 (1.3968)	-0.2827 (-1.1910)
LNAOH*DUM81	0.1929 (1.4058)	0.1144* (1.9127)
LCHIPC*DUM81	-0.1531 (-1.1925)	0.0722 (1.2337)
LCHIPW*DUM81	0.5242** (2.3506)	0.1168 (1.0733)
LDISC*DUM81	0.1261 (0.2463)	-0.1506 (-0.6234)
LPYW*DUM81	0.9877* (2.0193)	1.2426** (5.6454)

Table III.2 - Continued

Reduced-Form Price Equations

Variable	Corrugating Medium	Corrugated Boxes
LPOWER*DUM85	-0.0465 (-0.2023)	-0.01383 (-0.1341)
LW26*DUM85	1.2822 (0.9561)	1.0346 (1.6712)
LNAOH*DUM85	0.5561 (1.3318)	0.2447 (1.2429)
LCHIPC*DUM85	-0.0189 (-0.0816)	-0.0536 (-0.4822)
LCHIPW*DUM85	-0.2351 (-0.7160)	-0.2337 (-1.3929)
LDISC*DUM85	-1.1020** (-2.1222)	-0.5893** (-2.4414)
LPYW*DUM85	0.8859 (1.6235)	-0.3579 (-1.4351)
DUM81	0.1544 (0.0933)	-2.5124** (-3.2709)
DUM85	1.1953 (0.3405)	2.6274 (1.6171)
Q1	0.0092 (0.4275)	0.0004 (0.0034)
Q2	0.0210 (1.4146)	0.2269** (3.3446)
Q3	0.0330** (2.2620)	0.02031** (2.2092)
R^2	0.9522	0.9919
Adjusted R^2	0.9025	0.9834
F-statistic (26,25)	19.0781**	117.5370**

*Significant at 0.10 level
**Significant at 0.05 level

†Each specification is estimated using the Beach and MacKinnon (1978) adjustment for first-order autocorrelation.

Table III.3

Price Effects of the Imposition

and Removal of the Hold-Separate Order

(t-statistics in parentheses)

Difference Quotient	Corrugating Medium	Corru
$\Delta \ln P/\Delta DUM81$	0.1576**	-0.0
	(2.5528)	(-1.1
$\Delta \ln P/\Delta DUM85$	-0.1391**	-0.0
	(-2.8341)	(-2.6
$(\Delta \ln P/\Delta DUM81)+(\Delta \ln P/\Delta DUM85)$	0.0185	-0.1
	(0.2929)	(-2.5

*Significant at 0.10 level
**Significant at 0.05 level

Difference Quotients Evaluated at

Average Values of the Exogenous Variables

Variable	1981:Q2 - 1988:Q4	1985:Q3 -
LPOWER	0.0225	0.0
LW26	-1.9826	-1.9
LNAOH	-0.4083	-0.5
LCHIPC	-0.2953	-0.3
LCHIPW	-0.2565	-0.2
LDISC	0.0927	0.0
LPYW	1.6200	1.6

after consummation of the merger under the hold-separate order.[25]

$\Delta\ell nP/\Delta DUM85$ measures the effect on medium prices of the dismissal of the antitrust case against Weyerhaeuser and the subsequent removal of the hold-separate order. This difference quotient is

$$\Delta\ell nP/\Delta DUM85 = 1.195 - 0.047*LPOWER + 1.282*LW26 + 0.556*LNAOH - 0.019*LCHIPC - 0.235*LCHIPW - 1.102*LDISC + 0.886*LPYW,$$

which equals -0.1391 when evaluated at the average values of the exogenous variables from the period beginning after the dismissal of the case (1985:Q3 - 1988:Q4). $\Delta\ell nP/\Delta DUM85$ is statistically significant at less than the .05 level (its t-statistic equals -2.83), and indicates that removal of the hold-separate order resulted in a 13% decline in medium prices.

The sum of $\Delta\ell nP/\Delta DUM81$ and $\Delta\ell nP/\Delta DUM85$ measures the full impact on medium prices of an unfettered acquisition. As indicated in Table III.3 this sum equals 0.0185, with a statistically insignificant t-statistic of 0.29. Thus, the results reported in Tables III.2 and III.3 indicate that over the entire period following Weyerhaeuser's 1981 acquisition of the North Bend mill, corrugating medium prices did not change by a statistically significant amount.[26] Removal of the hold-

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[25] Since the change in the dummy variable is discrete and not continuous, the difference quotient, $\Delta\ell nP/\Delta DUM81$, is not a percentage change in price (which we would have if DUM81 were a continuous variable and we were, therefore, calculating a derivative). The percentage change in price equals 100*[exp(d) - 1], where d is the value of $\Delta\ell nP/\Delta DUM81$. See Halvorsen and Palmquist (1980).

[26] To insure the appropriateness of the difference quotients and our model specification, we calculated three likelihood ratio statistics. The first tests the null hypothesis that DUM81 and the DUM81 interaction terms are jointly equal to zero (while allowing DUM85 and the DUM85 interaction terms to be unrestricted). The second tests the null hypothesis that DUM85 and the DUM85 interaction terms are jointly equal to zero (while allowing DUM81 and the DUM81 interaction terms to be unrestricted). The third tests the null hypothesis that DUM81, DUM85, and their respective interaction terms are all jointly equal to zero. The values of -2

separate order, however, resulted in a price decline of approximately 13 percent. This result is consistent with the proposition discussed above that the hold-separate order may have been a poor remedy. By allowing Weyerhaeuser to acquire the North Bend mill, the hold-separate order may have allowed any potential anticompetitive effects of the acquisition to be realized by creating a strong incentive for the management of the mill to pursue the best interests of Weyerhaeuser. On the other hand, by preventing Weyerhaeuser from receiving preferential distribution of the North Bend mill's output, the hold-separate order may have prevented the realization of vertical efficiencies that ultimately lowered the cost of corrugating medium after the order was removed. The hold-separate may have also interfered with the vertical relationship between the North Bend medium mill and the former Menasha box plant that was purchased by Weyerhaeuser along with the corrugating medium plant. These results are also consistent with Salinger's analysis (Salinger (1991)) indicating that vertical integration may make horizontal collusion more difficult and lead to lower prices.[27]

The values of $\Delta\ell nP/\Delta DUM81$ and $\Delta\ell nP/\Delta DUM85$ and their respective levels of significance depend on the values of the exogenous variables that are used to evaluate them. We believe that using the post-merger average values of the exogenous variables is reasonable and appropriate. Nevertheless, the use of these values for this purpose is admittedly arbitrary. To examine the robustness of our results we calculated $\Delta\ell nP/\Delta DUM81$ and $\Delta\ell nP/\Delta DUM85$ using the actual values of the exogenous variables for each of the 31

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times the likelihood ratios for each of these tests are 36.86, 46.06, and 96.21, which are asymptotically distributed as χ^2 with 8, 8, and 16 degrees of freedom respectively. Each is statistically significant at well under the .05 level.

[27] As a test of model specification, as well as an additional test of the appropriate geographic market [see footnote 24] we estimated our model using east coast medium prices and exogenous variables. This regression indicated no statistically significant effects on east coast medium prices coincident with the imposition and removal of the hold-separate order. This regression indicated values of $\Delta\ell nP/\Delta DUM81$ of 0.0302 (t-statistic = 0.2273) and $\Delta\ell nP/\Delta DUM85$ of -0.0524 (t-statistic = -0.3723).

post-merger quarters. These difference quotients and their respective t-statistics are reported in Table III.4.[28]

As indicated in Table III.4, 28 of the 31 values of $\Delta\ell nP/\Delta DUM81$ are positive, and the three negative values are small and statistically insignificant. Of the 28 positive values of $\Delta\ell nP/\Delta DUM81$, 16 are statistically significant at less than the .05 level and three are statistically significant at less than the .10 level. Further, 22 of the difference quotients exceed 0.10 in magnitude. With respect to $\Delta\ell nP/\Delta DUM85$, 29 of the 31 values are negative, and the two positive values of $\Delta\ell nP/\Delta DUM85$ are also very small and statistically insignificant. Of the 29 negative values of $\Delta\ell nP/\Delta DUM85$, 20 are statistically significant at less than the .05 level, and 2 are statistically significant at less than the .10 level. Twenty-three of the values of $\Delta\ell nP/\Delta DUM85$ exceed .10 in absolute value, and 16 exceed .20. Since DUM85 is set to zero for periods prior to 1985:Q3, evaluating $\Delta\ell nP/\Delta DUM85$ using the values of the exogenous variables from quarters preceding 1985:Q3 may not be all that meaningful. Examining $\Delta\ell nP/\Delta DUM85$ over the 14-quarter period (1985:Q3 - 1988:Q4) in which DUM85 equals 1 indicates that all 14 values of $\Delta\ell nP/\Delta DUM85$ are negative. Eleven values of $\Delta\ell nP/\Delta DUM85$ are statistically significant at less than the .05 level, 2 are significant at less than the .10 level, and all magnitudes exceed .10 in absolute value.

Overall, the values of the difference quotients reported in Table III.4 lend substantial support to the conclusions that we draw based on the use of the post-merger average values of the exogenous variables. They strongly suggest that allowing Weyerhaeuser to purchase Menasha's North Bend corrugating medium plant under the hold-separate order resulted in an increase in corrugating medium prices, and that the

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[28] The rows at the bottom of Table III.4 are intended to summarize the distribution of values of both the difference quotients and their degree of statistical significance (as measured by the t-statistics). Thus, in the row designated Maximum are the maximum values of each difference quotient in a given column and the maximum values of the t-statistics in a given column. Similarly, in the row with average values, the values of the t-statistics are the averages of the t-statistics over the 31 quarters, not the t-statistics indicating the degree of significance of the average value of a corresponding difference quotient.

Table III.4

Effects on Corrugating Medium Prices of the Imposition

and Removal of the Hold-Separate Order

Evaluated at Values of the Exogenous Variables For Each Post-Merger Quarter

	Quarter	ΔlnP/ΔDUM81	t-stat	ΔlnP/ΔDUM85	t-stat	Sum	t-stat
1.	1981:Q2	0.1108	1.4972	-0.0203	-0.4320	0.0905	1.1691
2.	1981:Q3	0.0864	0.6234	-0.0697	-0.3935	0.0167	0.3237
3.	1981:Q4	0.0751	0.5214	0.0027	0.1207	0.0778	0.6814
4.	1982:Q1	0.0093	0.0396	-0.1041	-1.4975	-0.0947	-1.5537
5.	1982:Q2	-0.0080	-0.1879	-0.0453	-1.4181	-0.0533	-1.2122
6.	1982:Q3	0.1587	1.7391	-0.0387	-0.7669	0.1200	0.4773
7.	1982:Q4	-0.0456	-0.1265	-0.0542	-1.2369	-0.0998	-1.7937
8.	1983:Q1	0.0822	0.9231	0.0393	0.4704	0.1215	1.5964
9.	1983:Q2	0.0643	0.6448	-0.1232	-3.5724	-0.0589	-1.3370
10.	1983:Q3	0.1348	1.8641	-0.2034	-2.6078	-0.0685	-0.7836
11.	1983:Q4	0.0913	0.8550	-0.2660	-3.2105	-0.1747	-2.3070
12.	1984:Q1	0.1010	1.0074	-0.3255	-3.3459	-0.2245	-3.5414
13.	1984:Q2	-0.0159	-0.4710	-0.2071	-3.6062	-0.2230	-3.0921
14.	1984:Q3	0.1153	1.3683	-0.3445	-5.4796	-0.2293	-2.7303
15.	1984:Q4	0.1663	2.7590	-0.2596	-3.1033	-0.0933	-1.5497
16.	1985:Q1	0.1824	2.9150	-0.2424	-4.6923	-0.0600	-1.2829
17.	1985:Q2	0.1660	2.0014	-0.3097	-4.6120	-0.1437	-1.4813
18.	1985:Q3	0.1669	2.4286	-0.2416	-5.9661	-0.0748	-1.9273
19.	1985:Q4	0.2248	3.3424	-0.2189	-3.2833	0.0059	0.1190
20.	1986:Q1	0.2980	3.6831	-0.2269	-4.1121	0.0710	0.8186
21.	1986:Q2	0.2849	3.5712	-0.2578	-3.1296	0.0271	0.4517
22.	1986:Q3	0.2049	3.6858	-0.2440	-2.2408	-0.0392	-0.5285
23.	1986:Q4	0.2925	3.1510	-0.1383	-1.7741	0.1542	1.6869
24.	1987:Q1	0.3627	3.5210	-0.1993	-1.9912	0.1634	1.4860
25.	1987:Q2	0.3164	2.9831	-0.2385	-2.8551	0.0779	0.9755
26.	1987:Q3	0.2049	3.3271	-0.1463	-1.6016	0.0585	1.3407
27.	1987:Q4	0.1824	3.2147	-0.1922	-2.4109	-0.0098	-0.2963
28.	1988:Q1	0.1978	2.8034	-0.1522	-2.0692	0.0456	0.6982
29.	1988:Q2	0.2077	2.4830	-0.2053	-2.7977	0.0024	0.2482
30.	1988:Q3	0.2122	2.5873	-0.1815	-2.2085	0.0307	0.4391
31.	1988:Q4	0.2297	2.4195	-0.2336	-3.3083	-0.0039	-0.1286
	Maximum	0.3627	3.6858	0.0393	0.4704	0.1634	1.6869
	Minimum	-0.0456	-0.4710	-0.3445	-5.9661	-0.2293	-3.5414
	Average	0.1568	1.9734	-0.1757	-2.5527	-0.0190	-0.4204
	85:Q3 - 88:Q4	0.2418	3.0858	-0.2055	-2.8392	0.0364	0.3845

suspension of the hold-separate order upon dismissal of the antitrust complaint resulted in a significant decrease in medium prices of comparable magnitude.

We can examine the vertical effects of the merger and the hold-separate order more directly by studying their effects on corrugated box prices. Figure III.2 plots the real price of corrugated boxes over the period 1976 through 1988. The figure shows no discernible effects from the acquisition, but, again, we must account for shifting supply and demand factors in order to distinguish their effects from those of the acquisition and hold-separate order.

The two major inputs in the production of corrugated boxes are corrugating medium and linerboard. Linerboard is produced with essentially the same ingredients as corrugating medium. The only significant difference is corrugating medium is produced primarily with hardwood pulp and linerboard is produced primarily with softwood pulp.[29] Since the demand for medium is derived from the demand for boxes, the demand-side factors are identical. Thus, we estimated a reduced-form price equation for corrugated boxes sold in the west coast region using the same exogenous variables that were used to estimate the price equation for corrugating medium.

Column 3 in Table III.2 reports the results from the estimation of the price equation for corrugated boxes. As was the case with the medium price equation, the coefficients on LPOWER and LCHIPW are negative, which is not what one would expect. In addition, the coefficient on LW26 is also negative. All of the negative coefficients in this regression are, however, statistically insignificant. The coefficients on LNAOH, LCHIPC, LDISC, and LPYW are positive, and all but LNAOH are significant at the .05 level. LNAOH is significant at the .10 level.

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[29] Although the inputs are essentially the same, the processes used to produce corrugating medium and linerboard are significantly different so that supply-side substitution is difficult.

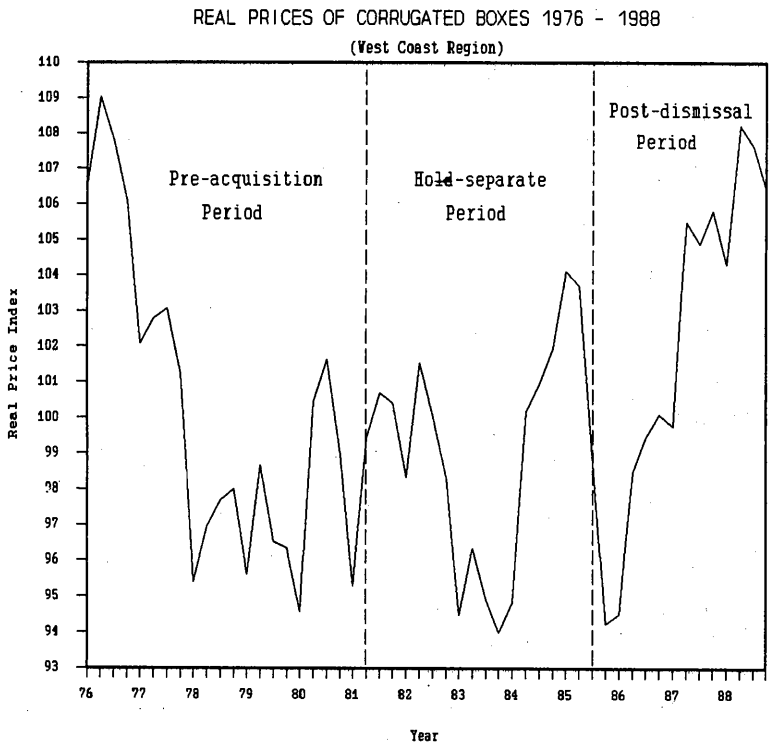
REAL PRICES OF CORRUGATED BOXES 1976 - 1988
(West Coast Region)
Real Price Index
110
109
108
107
106
105
104
103
102
101
100
99
98
97
96
95
94
93
Pre-acquisition Period
Hold-separate Period
Post-dismissal Period
76
77
78
79
80
81
82
83
84
85
86
87
88
Year

Figure III.2

The effect on the price of corrugated boxes of Weyerhaeuser's purchase of the North Bend corrugating medium plant under the hold separate-order is

$$\Delta\ell nP/\Delta DUM81 = -2.512 + 0.107*LPOWER - 0.283*LW26 + 0.114*LNAOH + 0.072*LCHIPC + 0.117*LCHIPW - 0.151*LDISC + 1.243*LPYW.$$

As indicated in Table III.3, the value of this difference quotient is -0.0485 when evaluated at the average levels of the exogenous variables over the post-merger period and, it is not statistically significant (its t-statistic is -1.16). Thus, box prices do not appear to have been affected by Weyerhaeuser's purchase of the North Bend corrugating medium mill and the imposition of the hold-separate order.

The change in the price of boxes as a result of the dismissal of the antitrust complaint against Weyerhaeuser is

$$\Delta\ell nP/\Delta DUM85 = 2.627 - 0.014*LPOWER + 1.035*LW26 + 0.245*LNAOH - 0.054*LCHIPC - 0.234*LCHIPW - 0.589*LDISC - 0.358*LPYW.$$

As indicated in Table III.3, the value of $\Delta\ell nP/\Delta DUM85$ is -0.0589 when evaluated at the average levels of the exogenous variables over the period following dismissal of the case. This difference quotient is statistically significant at less than the .05 level (its t-statistic is -2.68), indicating that removal of the hold-separate order was followed by a 5.7% decline in the price of corrugated boxes sold in the west coast market. The sum of $\Delta\ell nP/\Delta DUM81$ and $\Delta\ell nP/\Delta DUM85$ is -0.107, which is statistically significant at the .05 level (its t-statistic is -2.57).[30]

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[30] As we did with the corrugation medium regression, we calculated three likelihood ratio statistics to examine the joint significance of DUM81, DUM85, and their respective interaction terms. [See footnote 26.] The values of -2 times the three likelihood ratio statistics are 36.72, 57.59, and 56.34, which are asymptotically

Thus, it appears from these results that Weyerhaeuser's purchase of Menasha's west coast assets resulted in a decrease in corrugated box prices in the 11 state region west of the Rockies of over 10%. Moreover, these results also support the conclusion that the hold-separate order may have prevented significant vertical efficiencies or may have prevented the breakdown of upstream collusive agreements by frustrating Weyerhaeuser's attempt to further vertically integrate.

Table III.5 provides the values of $\Delta\ell nP/\Delta DUM81$ and $\Delta\ell nP/\Delta DUM85$ for the corrugated box price equations when evaluated at the values of the exogenous variables for each of the 31 post-merger quarters. The values of $\Delta\ell nP/\Delta DUM81$ are varied and somewhat difficult to interpret. Whereas $\Delta\ell nP/\Delta DUM81$ evaluated at the average post-merger values of the exogenous variables is negative but statistically insignificant, we see that prior to 1984:Q1 the values of $\Delta\ell nP/\Delta DUM81$ when evaluated at the actual levels of the exogenous variables for each quarter are negative and significant at less than the .05 level. The values of $\Delta\ell nP/\Delta DUM81$ evaluated at levels of the exogenous variables during the eight quarter period 1987:Q1 through 1988:Q4 are all positive. One is significant at the .05 level, and another is significant at the .10 level. Thus, from Table III.5 it is not particularly clear whether $\Delta\ell nP/\Delta DUM81$ is negative, positive, or essentially zero.

That $\Delta\ell nP/\Delta DUM81$ with respect to the corrugated box price equation may be negative does not necessarily contradict our earlier result indicating that the purchase of the North Bend mill under the hold-separate order raised medium prices. One should recall that Weyerhaeuser's purchase of Menasha's west coast operations involved not only the purchase of the North Bend corrugating medium mill, but also the purchase of a box plant and other assets. The purchase of the box plant may have had an efficient, procompetitive impact in what may have been an already competitive corrugated box market (see footnote 19). In this case, corrugated box producers that were not vertically integrated into the production of medium

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distributed as χ^2 with 8, 8, and 16 degrees of freedom respectively. As before, these statistics are statistically significant at less than the .05 level.

Table III.5

Effects on Corrugated Box Prices of the Imposition

and Removal of the Hold-Separate Order

Evaluated at Values of the Exogenous Variables For Each Post-Merger Quarter

	Quarter	ΔlnP/ΔDUM81	t-stat	ΔlnP/ΔDUM85	t-stat	Sum	t-stat
1.	1981:Q2	-0.1166	-2.7386	-0.1064	-2.3006	-0.2230	-4.1363
2.	1981:Q3	-0.1479	-3.1494	-0.0765	-1.4039	-0.2244	-2.7562
3.	1981:Q4	-0.1258	-2.5848	-0.0589	-1.1445	-0.1847	-2.2070
4.	1982:Q1	-0.0907	-2.1061	0.0045	0.1481	-0.0862	-1.3531
5.	1982:Q2	-0.1301	-2.9856	-0.0112	-0.1391	-0.1413	-1.5111
6.	1982:Q3	-0.1060	-2.8690	0.0205	0.5008	-0.0855	-1.3652
7.	1982:Q4	-0.1103	-2.8069	-0.0092	-0.1212	-0.1195	-1.3784
8.	1983:Q1	-0.1080	-2.6707	-0.0294	-0.6812	-0.1374	-2.2277
9.	1983:Q2	-0.1105	-2.9165	-0.0196	-0.6329	-0.1301	-2.5924
10.	1983:Q3	-0.1260	-2.9990	-0.0192	-0.6264	-0.1452	-2.6598
11.	1983:Q4	-0.1073	-2.6936	-0.0283	-1.3048	-0.1356	-2.9083
12.	1984:Q1	-0.0763	-2.3794	-0.0865	-1.9219	-0.1627	-2.9033
13.	1984:Q2	-0.0780	-1.8147	-0.1044	-2.3339	-0.1824	-2.8016
14.	1984:Q3	-0.0292	-0.8912	-0.1277	-4.5360	-0.1570	-3.6016
15.	1984:Q4	-0.0368	-1.1394	-0.1161	-6.8393	-0.1529	-4.1723
16.	1985:Q1	-0.0086	-0.1899	-0.1098	-8.3355	-0.1185	-2.4015
17.	1985:Q2	-0.1485	-1.9310	-0.0952	-4.5096	-0.2438	-2.9301
18.	1985:Q3	-0.1506	-2.0298	-0.0809	-5.4482	-0.2315	-2.9485
19.	1985:Q4	-0.1308	-1.7121	-0.0504	-3.2852	-0.1812	-2.2594
20.	1986:Q1	-0.0798	-0.5931	-0.1508	-5.9766	-0.2306	-1.6683
21.	1986:Q2	-0.0512	-0.9703	-0.1058	-6.0468	-0.1570	-2.6934
22.	1986:Q3	-0.0354	-0.6698	-0.0905	-4.9630	-0.1259	-2.0936
23.	1986:Q4	-0.0126	-0.3337	-0.0763	-3.4719	-0.0889	-1.6351
24.	1987:Q1	0.0219	0.5967	-0.0896	-2.8199	-0.0677	-1.0502
25.	1987:Q2	0.0352	0.7971	-0.1050	-2.4197	-0.0697	-1.6727
26.	1987:Q3	0.0069	0.1790	-0.0883	-1.9309	-0.0813	-1.9484
27.	1987:Q4	0.0589	1.3351	-0.1047	-3.0292	-0.0459	-0.6018
28.	1988:Q1	0.0916	1.5823	-0.1396	-2.5547	-0.0479	-0.9274
29.	1988:Q2	0.1097	1.6758	-0.0967	-1.9014	0.0130	0.1400
30.	1988:Q3	0.1560	2.0781	-0.2467	-2.9831	-0.0907	-1.9005
31.	1988:Q4	0.1279	1.7179	-0.1764	-1.9224	-0.0485	-1.2490
	Maximum	0.1560	2.0781	0.0205	0.5008	0.0130	0.1400
	Minimum	-0.1506	-3.1494	-0.2467	-8.3355	-0.2438	-4.1723
	Average	-0.0487	-1.1359	-0.0831	-2.7398	-0.1317	-2.1424
	85:Q3 - 88:Q4	0.0106	0.2609	-0.1144	-3.4824	-0.1038	-1.6077

would have been forced to absorb the higher corrugated medium prices rather than pass those higher costs on to consumers. Thus, Weyerhaeuser's purchase of Menasha's west coast assets may have increased competition in the corrugated box market even if competition in the corrugating medium market diminished.

Since the hold-separate order affected just Weyerhaeuser's purchase and control of the North Bend corrugating medium plant, the effect on box prices of removing the hold separate order (i.e., $\Delta \ell nP/\Delta DUM85$) would arise entirely from the vertical relationship between medium and boxes, and could not be attributed to Weyerhaeuser's purchase of the box plant. Of the 31 values of $\Delta \ell nP/\Delta DUM85$ reported in Table III.5, all but two are negative, and the two positive values have very low t-statistics. Of the 29 negative values of $\Delta \ell nP/\Delta DUM85$ reported in Table III.5, 17 are statistically significant at less than the .05 level, and 4 are significant at less than the .10 level. The 14 values of $\Delta \ell nP/\Delta DUM85$ evaluated at the values of the exogenous variables from the period 1985:Q3 - 1988:Q4 (i.e., the actual period following removal of the hold-separate order) are all negative. Eleven of these are statistically significant at the .05 level, and the remaining 3 are significant at the .10 level.

The values of $\Delta \ell nP/\Delta DUM85$ reported in Table III.5 strongly support the conclusion that removal of the hold-separate order increased competition in the corrugated box market. The evidence suggests that by frustrating Weyerhaeuser's intention to "integrate the North Bend mill into their own corrugated container production operations" (see footnote 20), the hold-separate order prevented the realization of vertical efficiencies and/or the breakdown of possible collusive behavior within the medium market (as suggested by Salinger).

IV. The 1985 Merger of the Hawaiian Cement Operations of Kaiser Cement Corporation and Lone Star Industries into Lone Star Hawaii

A. Background

Cement is a highly standardized product produced in large capital intensive plants by chemically combining limestone, clay, and silica. It is used primarily as an input in the production of concrete, one of modern society's major building materials. Because cement is relatively costly to ship over land, it tends to be sold in relatively small regional markets. Nevertheless, the transportation of cement over water is relatively cheap, so buyers in areas accessible to ocean shipping (such as Hawaii) can often choose to purchase cement from foreign suppliers, which tends to attenuate any market power of the local cement firms.

On May 7, 1985, Lone Star Industries (LSI), Adelaide Brighton Cement Holdings Ltd., and Angeston Inc. created a partnership, Lone Star Hawaii, which proceeded to acquire all of the Hawaiian cement and related assets of LSI and Kaiser Cement Corporation (Kaiser).[31] The merger of the Hawaiian cement operations of LSI and Kaiser reduced the number of firms producing cement in Hawaii from two to one. Even though the merger resulted in a monopoly in the Hawaiian cement industry, it was not challenged by federal antitrust authorities.

Although the merger resulted in a single cement producer in Hawaii, arguments can be made that the merger might be innocuous or even beneficial. Economies of scale in the production of cement can be large, and in the years preceding the merger, the demand for cement in Hawaii declined precipitously. In the two years immediately preceding the acquisition, capacity utilization by the two Hawaiian cement plants was approximately half of the average level of capacity utilization by cement plants for the

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[31] Wall Street Journal, May 8, 1985, p. 2.

country as a whole.[32] Such low levels of capacity utilizatio may have caused substantial increases in average cost Consequently, cost savings from this merger may hav restrained any tendency toward higher prices resulting fro the combination of competitors. Furthermore, the ability t import cement at prices competitive with the domestic produc could constrain any attempt by Lone Star Hawaii to exercis monopoly power. Thus, whether this merger woul significantly increase or decrease Hawaiian cement price depends on the extent of efficiencies created through th consolidation of Hawaiian cement production and th responsiveness of imports to changes in the prices charged b Lone Star Hawaii.

B. Methods

Limitations on the availability of data require that we estimate the reduced-form price equation with annual data that end with the 1987 observation. Unfortunately, we do not have the degrees of freedom to allow all of the coefficients on our exogenous right-hand-side variables to change. We, therefore, measure the effect of the merger on Hawaiian cement prices by measuring shifts in the constant term, ϕ_0, in equation II.7 and restrict the coefficients ϕ_i and ω_i to be unaffected by the merger. This restriction implies the following assumptions: 1) the merger does not affect the demand function (i.e. ε and β from equation II.1 do not change), and 2)η and the c_i's from the cost function are unaffected by merger.

The first of these two restrictions is fairly weak. We would not generally expect a merger to directly affect the demand schedule by somehow altering tastes or other factors that determine the parameters in the demand equation. The second assumption is somewhat stronger. It requires that technical change created by the merger (i.e., efficiencies) take

[32] In 1983, capacity utilization by the two cement plant in Hawaii was 37.5%. The average level of capacity utilization of cement plants for the entire country was 64.6%. In 1984, capacity utilization for the Hawaiian plants was 32.3%; for the country as a whole, capacity utilization by cement plants averaged 71.8%. Source: U.S. Department of the Interior, Bureau of Mines, Mineral Industry Surveys: Cement in 1984.

very specific forms. That the merger would not affect η implies that technical change is "Hicks neutral." That is, the marginal rates of technical substitution of inputs are the same both before and after the merger. That the merger would not affect the c_i's (the elasticities of cost with respect to input prices) implies that technical change created by the merger is cost-neutral. That is, for any given input price vector, the optimal ratios of inputs are unaffected by the merger. Together, Hicks neutrality and cost neutrality imply that efficiencies created by the merger relabel the isoquant map, but do not change the shape of the isoquants, and preserve the marginal rate of technical substitution along any ray from the origin in input space. Although these implications appear particularly strong, basically they imply that the underlying technology of cement production was not affected by the merger, which is not an entirely unreasonable assumption.

In order to gain more precision in our estimates of the cement price function, we use a second-order approximation of the industry cost function. Thus, we replace equation II.3 with a twice differentiable function such that

$$\ell nc = c_0 + \sum_{i=1}^{s} c_i \ell n\pi_i + \sum_{j=1}^{s}\sum_{k=1}^{s} c_{jk} \ell n\pi_j \ell n\pi_k. \qquad \text{(II.3a)}$$

Replacing equation II.3 with equation II.3a results in a reduced-form price equation

$$\ell nP = \phi_0 + \phi_0^{*}DM + \sum_{i=1}^{n} \phi_i \ell nd_i + \sum_{i=1}^{s} \omega_i \ell n\pi_i + \sum_{j=1}^{s}\sum_{k=1}^{s} \omega_{jk} \ell n\pi_j \ell n\pi_k + \tau \qquad \text{(II.8a)}$$

C. Including Imports in the Model

Before describing the exogenous variables used in our reduced-form model, we need to present a method of accounting for the presence of imports. We start by defining the industry as the firms producing cement in Hawaii. The industry demand is a function of, among other things, the

substitutes for cement produced by Hawaiian firms. Among these substitutes are imports of cement from other locales, particularly Japan. By treating these imports as a substitute good, one can develop a demand model for cement produced in Hawaii.

This type of model is called a residual demand curve, and we use it to derive the reduced-form price equation.[33] The residual demand function facing cement firms located in Hawaii is

$$QH = d(PH, PJ, YH), \qquad (IV.1)$$

where QH is the quantity of cement demanded from Hawaiian producers, PH is the price of cement sold in Hawaii, PJ is the price (in American currency) of cement sold in Japan, the major market from which cement is exported to Hawaii, and YH is a set of exogenous variables that determine the demand for cement in Hawaii.

The next step is to derive a reduced-form price equation for Japanese cement:

$$PJ = r(YJ, XJ) \qquad (IV.2)$$

where YJ is set of exogenous variables that determine the demand for cement in Japan, and XJ is a set of exogenous variables that determine the supply of cement in Japan. When this equation is substituted into equation IV.1, we have the residual demand curve:

$$QH = d(PH, YH, YJ, XJ). \qquad (IV.1a)$$

This equation, when substituted into the reduced-form price equation II.8a, gives us the following general form:

$$PH = r(D, YH, YJ, XJ, XH) \qquad (IV.3)$$

where D is a set of dummy variables for the years after the

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[33] See Scheffman and Spiller (1987) and Baker and Bresnahan (1985) for discussions of residual demand curves.

Lone Star Hawaii merger, and XH are the exogenous variables in the cost function for Hawaiian cement.

D. Data

Table IV.1 lists and describes the variables that we use to estimate the reduced-form price equation for Hawaiian cement. The sample consists of yearly data from 1961 to 1987. The construction of the two cement plants in Hawaii began in 1959, but they were not ready for full production until 1961. Data for many of the Hawaiian variables described below were not available for the years after 1987.

The variables can be divided into four groups. The first, the vector D above, are the dummy variables D85 and D8687 that measure the change in price resulting from the 1985 LSI/Kaiser merger. As noted in the introduction, the Lone Star Hawaii merger took place in mid-1985. Since only annual price information is available, we cannot determine whether any change in the average 1985 price reflected price changes that occurred before or after the acquisition. Consequently, we use two dummy variables in the estimation of the reduced-form price equation. D85 is set equal to 1 for 1985 and 0 for all other years, and D8687 is set equal to 1 for the unambiguous post-acquisition years, 1986 and 1987, and 0 for all other years.

The second group of variables are the exogenous demand variables for the Hawaiian cement market, YA and H. YA is an index of construction activity in Hawaii, and H is an index of state and local government spending on highways in Hawaii.

The third group of variables are the exogenous supply variables for the Hawaiian cement industry, W, F, and I. W is the average constant dollar wage rate for manufacturing in Hawaii; F is a constant dollar index of fuel costs in Hawaii, and I is the real prime rate of interest in the United States which reflects the borrowing costs of the Hawaiian cement firms.

The fourth group of variables represent demand and supply conditions in the cement markets exporting to Hawaii.

Japan was the largest (and for much of the period, the sole) exporter of cement to Hawaii.[34] Thus, variables affecting the Japanese cement industry are used to explain the levels of imports of cement into Hawaii. JYA is an index of constant yen construction material spending for the nation of Japan; it is a proxy for Japanese construction activity. JH is an index of constant yen spending on roads in Japan. JW is an index of constant yen wage rates for the industries manufacturing ceramic, stone, and clay products in Japan. JI is the prime rate of interest for Japan, and reflects the borrowing costs of the Japanese cement firms.[35]

Figure IV.1 plots the average price-per-ton of Hawaiian cement in constant 1982 dollars over the period 1960 through 1988.[36] As indicated, cement prices in Hawaii reached record levels in the two years immediately preceding

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[34] See Minerals Yearbook, issues 1960-1987.

[35] Two variables that might seem to be likely candidates for inclusion in the Japanese data set have been left out. The first is fuel, a major input into the production of cement; however, a fuel price series for Hawaii is already included in the model. Since oil, the major fuel used in the cement industries of both Hawaii and Japan, is traded in a world market, only one fuel price series is needed. On the surface, it would seem that this argument could be applied to the interest rate, but the control of capital by the Japanese government may lead to deviations between Japanese and American interest rates. Thus, it is not clear that the Hawaiian and Japanese cement firms faced the same capital market constraints.

The second candidate for inclusion is the yen/dollar exchange rate. This is left out of the equation because both the Japanese and Hawaiian variables have been adjusted for inflation. Holding productivity changes and other real influences on exchange rates constant, changes in exchange rates over time should reflect the differences between the rates of inflation in Japan and the U.S. Since we include such variables as the real Japanese wage and interest rates in the equation, and since these variables should be highly correlated with other real variables affecting exchange rates, inclusion of the yen/dollar exchange rate would be redundant. When the exchange rate is included in the equations its coefficient is very small and not significantly different from zero in all specifications.

[36] The source of the raw (unadjusted) price data for Hawaiian cement is the U.S. Department of the Interior, Bureau of Mines publication Minerals Yearbook, issues 1960-1987. This source gives the total consumption of cement (in tons) in Hawaii and the total dollar sales of cement in Hawaii for each year. The average price is computed by dividing consumption into total sales. The cement prices are adjusted for inflation with the GNP price deflator (1982 base) found in the U.S. Council of Economic Advisors, 1989 Economic Report of the President.

Table IV.1

Variable Descriptions For Hawaiian Cement Price Equations[1]

Variable	
LCEMENT	Log of average constant dollar price-per-ton of cement sold in Hawaii*
C	Constant
LYA	Log of index of construction activity in Hawaii**
LH	Log of index of constant dollar state and local government spending on highways in Hawaii***
LW	Log of average constant dollar wage rate for manufacturing in Hawaii**
LF	Log of constant dollar fuel cost index**
LI	Log of real prime rate of interest for the U.S.‡
LJYA	Log of index of constant yen spending on construction material by the nation of Japan†
LJH	Log of index of constant yen spending on roads in Japan†
LJW	Log of index of constant yen wage rates for industries manufacturing ceramic, stone, and clay products in Japan†
LJI	Log of real prime rate of interest in Japan†

[1] All nominal values were deflated using the GNP price deflator (1982 base).

*Source: Minerals Yearbook, U.S. Department of the Interior, Bureau of Mines. Cement prices were adjusted for inflation with the GNP price deflator (1982 base) found in the 1989 Economic Report of the President.

**Source: Schmitt (1977), State of Hawaii (1982, 1986). Unpublished 1987 figures were provided to us by the State of Hawaii.

***Source: Government Finances 1959-1987, U.S. Department of Commerce, Bureau of the Census.

‡Source: 1989 Economic Report of the President, Council of Economic Advisors.

†Source: Japan Statistical Yearbook, 1959-1990.

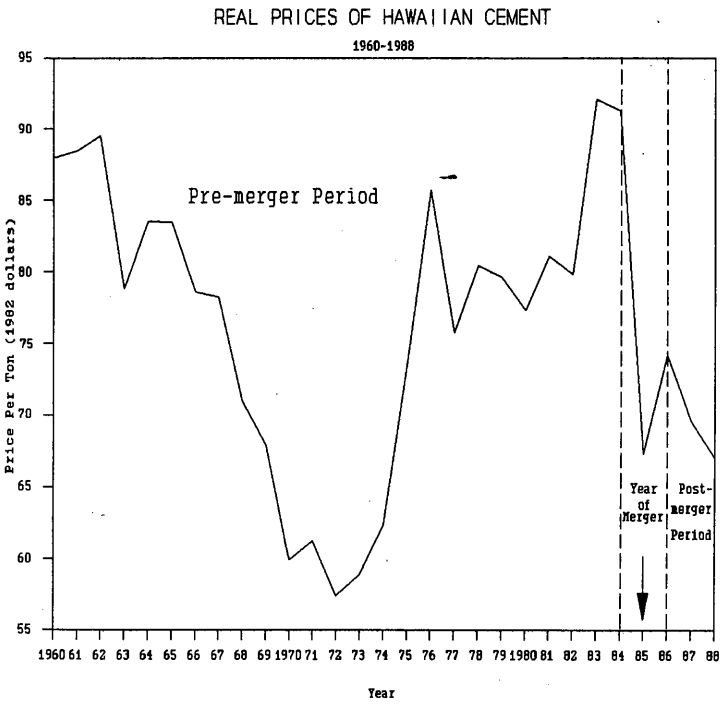
REAL PRICES OF HAWAIIAN CEMENT
1960-1988
Price Per Ton (1982 dollars)
95
90
85
80
75
70
65
60
55
Pre-merger Period
Year of Merger
Post-merger Period
1960 61 62 63 64 65 66 67 68 69 1970 71 72 73 74 75 76 77 78 79 1980 81 82 83 84 85 86 87 88
Year

Figure IV.1

Table IV.2

Hawaiian Cement Imports

Year	Quantity Imported (1000 ton units)	% of Total Hawaiian Consumption
1962	0.4	0.2%
1963	0.2	0.1
1964	0.1	0.1
1965	0.4	0.1
1966	0.6	0.2
1967	0.6	0.2
1968	0.4	0.1
1969	72.0	15.6
1970	45.5	10.3
1971	15.6	4.0
1972	1.0	0.2
1973	1.0	0.2
1974	16.0	3.2
1975	28.0	5.8
1976	6.0	1.8
1977	0.0	0.0
1978	0.0	0.0
1979	0.0	0.0
1980	23.0	6.0
1981	0.0	0.0
1982	0.0	0.0
1983	37.0	14.6
1984	24.0	11.4
1985	52.0	19.5
1986	95.0	24.9
1987	48.0	12.9

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1962-1987.

the merger and fell precipitously in 1985, the year of the merger. Since 1985, Hawaiian cement prices have remained well below their immediate pre-merger levels.

Table IV.2 lists imports of cement into Hawaii and imports as a percentage of total Hawaiian consumption (imports plus domestic Hawaiian production) since 1962.[37] Except for 1969 and 1970, imports of cement into Hawaii during the 21-year period between 1962 and 1982 were at most six percent of total consumption, and less than one percent in fourteen of these years. Imports increased substantially after 1982, and have remained at heightened levels in the years following the merger.

The price data depicted in Figure IV.1 suggest that the consolidation of cement production in Hawaii could have benefitted society by lowering costs and prices. Moreover, the growth of cement imports into Hawaii supports the theory that imports could prevent Lone Star Hawaii from exercising monopoly power. Nevertheless, the raw data alone cannot reveal what prices or levels of imports would have prevailed had the LSI/Kaiser merger not taken place. Perhaps prices would have fallen to lower levels in 1986 and 1987 had two competing firms remained in the market. This is the question that we examine by means of the reduced-form price equation.

E. Results

Table IV.3 reports the results for two specifications of the price equation. Specification IV.1 is a naive model that uses only the Hawaiian demand and cost variables, and excludes the Japanese variables. Specification IV.2 is derived from the equations (II.8) and (IV.3). This specification is based on a residual demand model and includes the Japanese variables.

The coefficient for D85 in Specification IV.1 indicates that the price of Hawaiian cement for 1985 was nearly 16 percent lower than that predicted by the levels of the supply

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[37] No data on imports into Hawaii are available before 1962.

and demand variables.[38] This decrease in price is significant at the 0.05 level. In contrast, the coefficient for D8687 indicates that the average 1986-1987 price of Hawaiian cement is 0.1 percent higher than that predicted from the supply and demand variables; however, this coefficient is not even close to being statistically significant. This suggests that the price fell temporarily in 1985, but then returned to pre-merger levels in 1986 and 1987. Thus, Specification IV.1 indicates that the merger did not induce a change in price different from what one might expect given the normal year-to-year price fluctuations present in the data.[39]

The coefficients for D85 and D8687 in Specification IV.2 strongly suggest that the merger brought significant permanent decreases in price. Both D85 and D8687 are negative and statistically significant, suggesting that the price of Hawaiian cement declined by approximately 23% during the post-merger period.[40] These results are consistent with a sustained, procompetitive effect from the merger. Moreover, including the Japanese variables appears to be appropriate since the χ^2 statistic testing the joint significance of the coefficients on the Japanese variables is 27.02 with 4 degrees of freedom, which is statistically significant at less than the .05 level.

Table IV.4 reports the derivatives of the cement price equation with respect to the cost variables. The derivative with respect to the wage is positive and significant at the .05

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[38] As noted in the last section, the percentage change in price equals 100*[exp(c)-1], where c is the coefficient on the dummy variable.

[39] When 1985 was included in the post-acquisition period in Specification IV.1, the coefficient on the dummy variable indicated a decline in price of 8.5%; however, this decline was not statistically significant (the t-statistic was -1.4502). Since the Kaiser plant had been closed in March of 1985 and had not been reopened by the time the merger took place, cement prices over three-quarters of 1985 reflect the operation of just one firm in the market. Thus, including 1985 in the pre-acquisition period does not appear to be sensible.

[40] When 1985 was included in the post-merger period in Specification V.2, the coefficient on the dummy variable indicated a decline in price of over 24%. In this case, the coefficient on the dummy variable was statistically significant (t-statistic = -4.3016).

level in Specification IV.1, and positive and significant at the .10 level in Specification IV.2; however, in Specification IV.2 this derivative is greater than 1. The derivatives with respect to the cost of fuel are positive and significant at the .05 level in both specifications; however, in Specification IV.1 this derivative is greater that 2, which is substantially larger than one would expect. In Specification IV.1, the derivative on the interest rate is negative, but statistically insignificant. In Specification IV.2, this derivative has the expected positive sign, but is also insignificant.

The results for the other variables are mixed. The coefficient on LYA has the wrong sign (i.e., negative) and significant in Specification IV.1. With the introduction of the Japanese variables in Specification IV.2, the sign on LYA reverses, but it is statistically insignificant. LH has the expected positive sign in both specifications, but it is insignificant in Specification IV.2. Two of the four Japanese variables in Specification IV.2, LJYA and LJW, are statistically significant, but have counter-intuitive negative signs. LJH and LJI have the expected positive sign; however, of these two variables, only LJI is statistically significant. It must be realized, however, that the reduced form coefficients, particularly those of the Japanese variables, are fairly complex combinations of various structural coefficients, and in some circumstances these combinations can cause the regression coefficients to take on counter-intuitive signs.

Although the creation of Lone Star Hawaii restricted cement production in Hawaii to a single firm, we find no persuasive evidence that this merger significantly increased the price of the product. To the contrary, Specification IV.2 indicates a significant price decline averaging 23 percent in the period after the merger. Since Specification IV.2 includes Japanese variables that, at least in part, control for the presence of imports, the merger appears to have created substantial efficiencies.[41] Further, this result supports the

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[41] It may be the case that with only two cement producers in the entire state, the pre-merger price of cement in Hawaii may have been the monopoly price. If there was essentially perfect collusion before the merger, it would not be correct to characterize this as a merger from duopoly to monopoly, since the pre-merger price

view that in markets in which imports are easily accessible, imports may have an important impact on price following a merger even if they have not played an important role for an extended period prior to the merger.

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may have been the monopoly price. If this were the case, the merger could not further reduce the existing level of competition and could (and apparently did) create real efficiencies.

Table IV.3

Dependent Variable: Log of Average Price-Per-Ton of Cement Sold in Hawaii (1982 Prices)†

(t-statistics in parentheses)

Variable	Specification IV.1	Specification IV.2
C	-396.6000* (-2.1334)	-458.1500** (-2.6421)
LYA	-0.1458** (-2.1612)	0.0328 (0.3305)
LH	0.3336** (3.2664)	0.1874 (1.0612)
LW	96.1660 1.6473	141.4500** (2.5726)
LF	80.7960** (2.3536)	63.6410* (2.2319)
LI	-96.6110 (-0.7337)	24.6520 (0.2338)
LW^2	-4.5583 (-1.1299)	-8.1239 (-2.1308)*
LF^2	-2.3804 (-0.8507)	0.7916 (0.3422)
LR^2	1.9863 (0.0466)	-15.8670 (-0.2306)
LW*LF	-12.6040 (-2.3479)**	-15.2460 (-2.983)**
LW*LI	41.2860 (1.8190)*	6.3421 (0.3019)
LF*LI	-21.2950 (-0.9432)	-11.9590 (-0.5622)

Table IV.3 -- Continued

Dependent Variable: Log of Average Price-Per-Ton of Cement Sold in Hawaii (1982 Prices)

(t-statistics in parentheses)

Variable	Specification IV.1	Specification IV.2
LJYA	----	-0.6412** (-3.9182)
LJH	----	0.1297 (0.9494)
LJW	----	-0.3514* (-2.1017)
LJI	----	1.2489** (2.7870)
D85	-0.1735** (-2.7497)	-0.2818** (-4.1223)
D8687	-0.0011 (-0.0194)	-0.2603** (-2.9513)
R^2	0.9966	0.9996
Adjusted R^2	0.9933	0.9990
F-statistic (13,13)	284.7560**	-----
F-statistic (17,9)	-----	1552.0500**

*Significant at 0.10 level
**Significant at 0.05 level

†Each specification is estimated using the Beach and MacKinnon (1978) adjustment for first-order autocorrelation.

Table IV.4

Derivatives of the Cement Price Equation with Respect to the Cost Variables

Evaluated at Average Values over the 1962 - 1987 Period

(t-statistics in parentheses)

Derivative	Specification IV.1	Specification IV.2
$\partial \ell nP/\partial LW$	0.8682**	1.1133*
	(2.7418)	(1.8695)
$\partial \ell nP/\partial LF$	2.0374**	0.9161**
	(4.6814)	(2.3822)
$\partial \ell nP/\partial LI$	-2.0292	0.1804
	(-1.0546)	(1.1188)

*Significant at 0.10 level
**Significant at 0.05 level

Average Values of Cost Variables 1962 - 1987

LW	4.5443
LF	4.3747
LI	0.0307

V. SCM's 1983 Acquisition of Gulf & Western's Titanium Dioxide Assets

A. Background

Titanium dioxide (TiO_2) is a pigment used to provide whiteness, opacity, and brightness to paint, paper, plastics, and other materials. Approximately 50 percent of TiO_2 sales are used in the manufacture of paints and other coatings, 25% are used in the manufacture of paper, and 15% in the manufacture of plastics.[42]

On July 15, 1983 SCM Corp. announced that it had signed an agreement to acquire the assets of Gulf & Western's titanium dioxide manufacturing facility in Ashtabula, Ohio. At this time, five firms produced TiO_2 in the U.S. SCM was the second largest domestic TiO_2 producer, owning approximately 16% of domestic capacity, and Gulf & Western was the fourth largest domestic manufacturer with approximately 9% of domestic capacity. Other domestic TiO_2 producers were Du Pont, the largest producer with 57% of domestic capacity, American Cyanamid, with 12%, and Kerr McGee with 6%.

During the twenty years preceding this announcement, the titanium dioxide industry had experienced considerable technological change. In the late 1950's and early 1960's large quantities of titanium-rich rutile ore were discovered in eastern Australia. The change in relative prices of rutile and the lower-quality ilmenite ore led to a technological transformation in the industry from a sulfur-based technology that used ilmenite ore to a chlorine-based technology that used

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[42] The source for industry statistics and individual firm capacities contained in this section is the Department of the Interior, Bureau of Mines, Minerals Yearbook. Data on imports came from various articles in the Chemical Market Reporter as well as the Minerals Yearbook. Much of the discussion of the technological transformation in the industry is taken from E.I.Du Pont De Nemours & Company, 96 F.T.C. 650 (1980) and the Minerals Yearbook.

rutile ore.[43]

Although unexpected shortages of rutile ore developed in the early 1970's, environmental regulations enacted at this time kept the cost of sulfate-process plants very high relative to the cost of chloride-process plants. The older sulfate process produces three and one-half tons of waste for every ton of TiO_2 produced. This waste is a solution of iron sulfate and sulfuric acid that is highly toxic. The typical chloride process in use during the early 1970's produced just one-half ton of waste for every ton of TiO_2 produced, and this waste, dry ferric chloride, is much easier and less costly to dispose of than the acidic waste produced by the sulfate process.[44]

As a result of the relatively low price of rutile during the 1960's and the environmental regulations enacted in the early 1970's, the manufacture of TiO_2 gradually converted from the sulfate technology to the chloride technology. All plants built in the United States since 1960 have used the chloride technology. In 1960, eight of ten plants producing TiO_2 used the sulfate process; by 1989 only two of ten plants used the sulfate process. The percentage of TiO_2 produced with the sulfate process fell from approximately 75% in 1960 to 57% in 1970, 24% in 1980, and just 14% in 1989.

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[43] In the 1940's Du Pont developed a chloride process that used the lower-quality ilmenite ore. This particular process had little competitive significance within the industry until the early 1970's when cost of rutile ore rose significantly and newly enacted environmental regulations greatly increased the cost of using the sulfate process. During the early 1970's, Du Pont obtained a significant competitive advantage from its ilmenite-chloride process that resulted in a significant growth in its market share. See footnote 6 and the related discussion in the text.

[44] Two TiO_2 producers, American Cyanamid and SCM, developed, in 1975 and 1978 respectively, methods of converting the sulfate wastes to gypsum (hydrous calcium sulfate) and iron oxides. Although these processes reduce the cost of disposing of the sulfate wastes, sales of the gypsum recover less than 25% of the cost of the treatment [see Minerals Yearbook 1977 for further discussion]. American Cyanamid sold its TiO_2 plant to the Finnish firm Kemira Oy in 1985. Kemira and SCM are the only two sulfate-process producers of TiO_2 still in business in the United States. NL Industries and Gulf & Western, the only other firms producing TiO_2 by the sulfate process in 1978, did not (or, could not) develop cost-effective methods for disposing of the sulfate wastes and withdrew from the industry. NL closed its St. Louis, Mo. plant in 1979 and its Sayreville, N. J. plant in 1982. Gulf & Western closed its Gloucester City, N. J. plant in 1983.

Chloride capacity steadily replaced sulfate capacity as older sulfate plants were retired. Although there were individual years where total capacity fell due to the closing of one or more sulfate plants, newer, lower-cost chloride capacity tended to quickly replace shut-down sulfate capacity. In 1960, total domestic TiO_2 capacity was 643,000 tons per year. By 1970, total domestic TiO_2 capacity had grown to 840,000 tons per year. By 1980, total domestic capacity was at 1,027,000 tons, and by 1989 total domestic capacity was at 1,060,000 tons per year.

Gulf & Western's Ashtabula plant was one of the first chloride process rutile plants built in the U.S. The plant, originally owned by the Cabot Corporation, opened in 1964 and was purchased by Gulf & Western in 1975. Gulf & Western owned a second TiO_2 plant located in Gloucester City, N.J. The Gloucester City plant was an old, high-cost sulfate-process plant that was not included in the acquisition of the Ashtabula plant by SCM. Gulf & Western closed the Gloucester City plant in November of 1983. Recalculating pre-merger market shares after removing the Gloucester City capacity from the market gives SCM just over 17% of total domestic capacity, and Gulf & Western just under 5% of total capacity. Du Pont has 59% of total domestic capacity, American Cyanamid has 12.5% of domestic capacity, and Kerr-McGee has 6.5%

In 1982, the year before the acquisition, imports of TiO_2 equalled approximately 19% of domestic sales. Slightly less than half of the imports were sold by NL Industries, which had recently closed its sulfate-process TiO_2 plant in Sayreville, N.J. and no longer produced TiO_2 in the U.S. NL Industry's sales in the U.S. represented 8.7% of total domestic sales. The rest of the imports were sold by a number of foreign firms, most of which had market shares of less than one percent.

SCM completed the acquisition of Gulf & Western's Ashtabula plant in November of 1983 at a cost of approximately $48,000,000. As a result, the number of domestic manufacturers declined from five to four, and the number of firms with domestic sales greater than four percent declined from six to five. Despite the relatively small number

of firms manufacturing TiO_2 in the U.S. and the high market concentration in domestic sales of TiO_2, the merger was not challenged by federal antitrust authorities.[45] Yet, little more than a year later the FTC successfully blocked the acquisition of American Cyanamid's TiO_2 production facilities by NL Industries.[46]

Although published accounts did not discuss specific reasons why federal antitrust authorities may have decided not to challenge the SCM/Gulf & Western acquisition, a number of trade publications and newspapers did contain reports indicating that the acquisition might lead to cost reductions through scale and technical economies. According to these reports, SCM planned to spend $15 to $20 million upgrading the facility.[47] SCM's 1985 Annual Report indicates that the firm ultimately spent $25 million installing a proprietary low-cost, chlorine-based manufacturing process at the plant. This technology replaced a higher-cost process that had been used at the plant since it opened in 1964.[48] SCM completed the installation of its process at the former

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[45] The policy of the FTC is to neither confirm nor deny the existence of confidential investigations such as those conducted under the pre-merger notification regulations established by the Hart-Scott-Rodino Antitrust Improvements Act. Nevertheless, a number of trade publications did carry stories in which an SCM spokesman stated that this acquisition had been investigated by the FTC, and that the FTC had decided not to pursue an antitrust complaint. See, for example, American Metal Marketing, October 25, 1983, p. 20.

[46] See The Wall Street Journal, "NL Drops Plan to Buy Cyanamid Operations," February 1, 1985, p. 6. The parties abandoned the proposed acquisition after the FTC authorized its staff to seek a preliminary injunction in federal court to prevent its consummation. Such actions by the FTC are publicly announced.

[47] See, for example, Modern Plastics, "SCM Buys TiO_2 Unit," September 1983, p. 20. Further discussion of SCM's plans for the Gulf & Western TiO_2 plant can be found in SCM's 1983 and 1984 Annual Report.

[48] The technology originally installed at the Gulf & Western plant in Ashtabula was a "chlorine fuming" process developed by the Cabot Corporation, the plant's original owner, and licensed to Gulf & Western when it purchased the plant in 1975. Industry consultants inform us that this process ultimately proved to be much less efficient than subsequent chlorine-based technologies developed by rival firms. The SCM process is based, in part, on technology licensed from Du Pont, the industry leader, and on technology developed "in house" by SCM.

Gulf & Western plant approximately one year after the acquisition.

The efficiencies created by such a transfer of superior technology are certainly desirable and procompetitive in and of themselves. Nonetheless, an important issue of interest is whether such efficiencies could offset any reduction in competition resulting from the increase in market concentration created by the merger.[49]

B. Data and Methods

We estimate the reduced-form price equation, equation II.8 from Section II, using 62 quarterly observations beginning with the first quarter of 1974 and ending with the second quarter of 1989. Table V.1 lists and briefly describes the demand and cost variables. All nominal prices and price indices have been deflated using the BLS Producer Price Index. The dependent variable is the Bureau of Labor Statistics' (BLS) domestic price index for titanium pigment (i.e., TiO_2).[50]

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[49] One could argue that part of any reduction in industry competition coincident with SCM's purchase of the Ashtabula plant could be a result of the closing of Gulf & Western's Gloucester City plant. We tend to discount the importance of the Gloucester City plant. It was an old and very high cost sulfate-process plant. Having sold the Ashtabula plant, Gulf & Western could not have been a viable competitor based solely on the Gloucester City plant. Moreover, within a year of the shut-down of the Gloucester City plant, nearly half of its lost capacity had been replaced through new lower-cost chloride capacity. Within two years, nearly all of the lost Gloucester City capacity was offset by increases in lower-cost chloride capacity by other industry participants. We believe that, with respect to the competitive effects of the closing of the Gloucester plant, it is more useful to view the closing of this plant as part of the ongoing, procompetitive conversion within the industry of high-cost sulfate capacity to lower-cost chloride capacity, rather than strictly a loss of industry capacity.

[50] As previously discussed in footnote 23, the BLS Handbook of Methods 1988 describes these prices as based on "transaction prices, including all discounts, premiums, rebates, allowances, etc., rather than fictitious list or book prices." (p. 126) Monthly prices are based on transactions prices for a particular day of a given month. The quarterly prices that we use are the end-of-quarter monthly price.

Table V.1

Variable Descriptions***

Variable	
LTIO2	Dependent variable: Log of deflated TiO_2 price index**
C	Constant
LPAINT	Log of paint production index (SIC 2851)*
LPLASTIC	Log of plastic production index (SIC 2821)*
LPAPER	Log of paper production index (SIC 2600)*
LW281	Log of real wages index (SIC 281 - Inorganic Chemicals)**
LCHL	Log of real chlorine price index**
LPOWER	Log of real industrial power price index**
LSULF	Log of real sulfur price index**
LDISC	Log of real discount rate[1]
LRXA	Log of real exchange rate - Australia (A$/US$)*
LRXG	Log of real exchange rate - Germany (M/US$)*
LRXC	Log of real exchange rate - Canada (C$/US$)*
Q1	First quarter seasonal dummy variable
Q2	Second quarter seasonal dummy variable
Q3	Third quarter seasonal dummy variable
DUM84	Post-merger dummy variable (= 1 for 1984.Q1-1989.Q2)

*Source: Federal Reserve Board of Governors

**Source: Bureau of Labor Statistics

***All nominal values were deflated using the Bureau of Labor Statistics' Producer Price Index

[1]The discount rate is 1 plus the real interest rate, where the real interest rate is calculated as end-of-quarter Moody's AAA Corporate Bond rate minus the annualized quarterly inflation rate.

As discussed above, TiO_2 is manufactured by two different technologies: a sulfate process and a chloride process; therefore, both sulfur and chlorine prices are used as supply-side variables. Other supply-side variables are a wage index for inorganic chemical workers, an industrial power price index, a corporate discount rate, and real currency exchange rates for Australia, Germany, and Canada. Australia is the major source of titanium ore; consequently, fluctuations in the value of its currency directly affect the cost of producing TiO_2. Canada and Germany are important sources of U.S. TiO_2 imports. Consequently, fluctuations in these countries' currencies may influence the supply of TiO_2 sold in the U.S.[51]

The demand-side variables in the reduced-form equation consist of industrial production indices for paint (SIC 2851), pulp and paper products (SIC 2600), and plastics and resins (SIC 2821), the primary sources of TiO_2 demand. Although paper and plastic production represent significant sources of TiO_2 demand, expenditures on TiO_2 represent small percentages of the total material costs of producing these products.

According to the 1982 Census of Manufactures, expenditures on TiO_2 represented just 0.7% of total materials cost in the production of pulp and paper products, and expenditures on all inorganic pigments (which include TiO_2) represented just 0.4% of total materials cost in the production of plastics and resins. Since expenditures on TiO_2 constitute such a small percentage of the total cost of producing paper and plastic products, we would expect changes in the price of TiO_2 to have minimal effects on the levels of production of these products.

Expenditures on TiO_2, however, were approximately

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[51] On account of a limited number of degrees of freedom, we could not use the "residual demand" approach to imports that we use in Section IV. Nonetheless, the real variables that would determine the demand for TiO_2 in Canada and Germany should be the same real variables that would be determining changes in the real exchange rates for these countries' currencies. Thus, in Section IV, the inclusion of the real Japanese variables determining the Japanese demand for cement eliminated any explanatory effects from the real yen/dollar exchange rate (see footnote 35).

8% of total materials cost in the production of paint. To avoid possible simultaneity bias, we replaced the log of the paint production index, LPAINT, in our reduced-form price equation with fitted values from the regression of the logs of real GNP, the industrial power price index, the discount rate, a constant term, and three quarterly dummy variables on LPAINT. The R^2 statistic from this regression is .9724 and the Adjusted R^2 statistic is .9704. The F statistic is F(6,54) = 329.62.[52]

The technological change that occurred during the 1974-1989 period that we examine would be expected to alter the parameters of the industry's total cost function, equation II.2, and, consequently, the coefficients in the reduced-form price equation. To account for the effects of the change in technology, we added to the price equation the interaction of each of the exogenous variables with a time trend.[53]

Figure V.1 plots real quarterly TiO_2 prices from the first quarter of 1974 through the second quarter of 1989. Prices do appear to trend upward after the merger occurred in late 1983; however, these price increases could result from increases in costs, demand, or both, and be unrelated to the merger. Using the reduced-form price equation, we will be able to separate independent cost and demand influences on price from the effects of the merger.

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[52] The regression was adjusted for first-order autocorrelation. The results from the regression (with t-statistics in parenthesis) are

LPAINT = -1.57 + 0.72*LGNP - 0.44*LPOWER - 0.02*LDISC + 0.34*Q1 + 0.49*Q2
(-0.71) (2.65) (-1.76) (-0.11) (20.1) (24.9)
+ 0.35*Q3.
(19.3)

The fitted values of LPAINT are referred to in the text as LPAINT‡.

[53] The appropriateness of the time interaction terms is borne out by the results of the regressions discussed in more detail below. For Specification V.1, the χ^2 statistic testing the joint significance of the time interaction terms is 63.92 with 11 degrees of freedom. For Specification V.2, the χ^2 statistic testing the joint significance of the time interaction terms is 72.37 with 11 degrees of freedom. Both χ^2 statistics are significant at well under the .05 level.

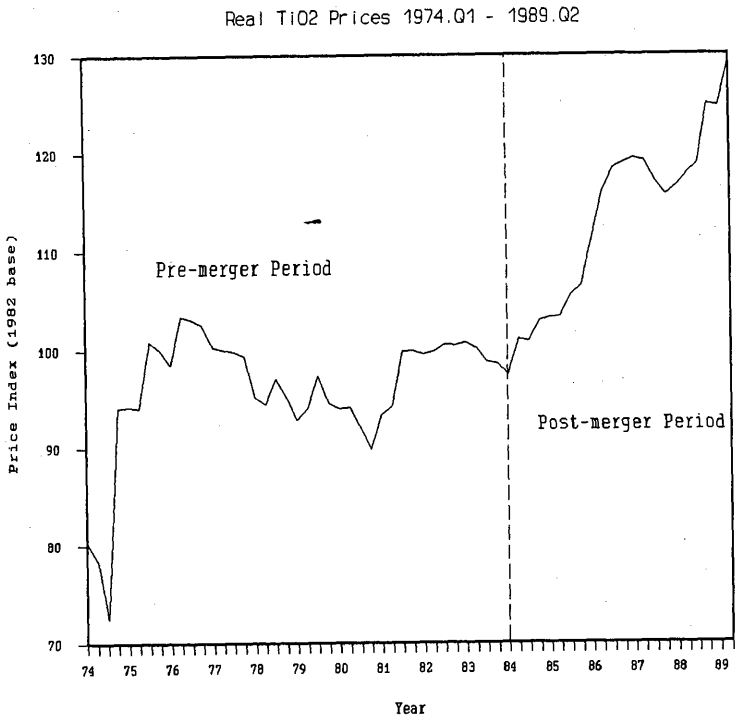
Real TiO2 Prices 1974.Q1 - 1989.Q2
Price Index (1982 base)
130
120
110
100
90
80
70
Pre-merger Period
Post-merger Period
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
Year

Figure V.1

C. Empirical Results

Specification V.1 in Table V.2 reports the results from the estimation of the reduced-form price equation. DUM84 is a dummy variable that equals 1 during the post-merger period beginning the first quarter of 1984 and 0 otherwise. In Specification V.1, the coefficient on DUM84 measures the change in the constant term in the price equation resulting from the merger, and the coefficients on the product of DUM84 and the exogenous variables measure changes in the effects of these variables on TiO_2 prices following the merger. The effect of the merger on TiO_2 prices is measured by the difference quotient $\Delta\ell nP/\Delta DUM84$, which, based on the results reported in Table V.2, is:

$$\Delta\ell nP/\Delta DUM84 = 0.38 - 0.18*L\bar{P}AINT^{\ddagger} + 0.12*LPLASTIC + 0.20*LPAPER + 0.29*LW281 - 0.09*LCHL + 0.57*LPOWER - 0.05*LSULFUR - 1.27*LRXA + 0.01*LRXG + 3.19*LRXC + 1.13*LDISC.^{54}$$

Table V.3 reports the average values of the exogenous variables during the post-merger period (1984:Q1 - 1989:Q2). When evaluated at these values of the exogenous variables, $\Delta\ell nP/\Delta DUM84$ equals 0.3187 and its t-statistic equals 1.8979, which is statistically significant at the .10 level. This result indicates that following SCM's acquisition of Gulf & Western's TiO_2 facilities the price of TiO_2 rose by 37.5%.

The merger involved the combination of the second and fifth largest firms, and the post-merger market share of the combined firm was 22%.[55] Although a merger such as this might warrant competitive concerns, a price increase of practically 38% seems surprisingly high. The value of $\Delta\ell nP/\Delta DUM84$ and its level of significance depend directly

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[54] To insure the appropriateness of the difference quotients, we used a likelihood ratio test to test the joint significance of the coefficients on DUM84 and the DUM84 interaction terms. The χ^2 statistic for this test is 57.96 with 12 degrees of freedom, which is statistically significant at less than the .05 level.

[55] As discussed above, these market share figures are based on domestic capacity having removed Gulf & Western's Gloucester City, N.J. plant from operation.

Table V.2

Dependent Variable: Log of Deflated TiO_2 Price Index
(t-statistics in parentheses)

Variable	Specification V.1	Specification V.2
C	3.0196 (1.5889)	1.3352 (0.6007)
LPAINT‡	0.1311 (0.7274)	0.1001 (0.4675)
LPLASTIC	0.5224 (1.3192)	1.1001** (2.2994)
LPAPER	-0.8750 (-1.2583)	-1.6112** (-2.0929)
LW281	0.2229 (0.2346)	-0.4294 (-0.4188)
LCHL	0.3537 (0.7704)	0.6153 (1.2155)
LPOWER	0.5857 (0.5983)	0.7920 (0.7804)
LSULFUR	0.0232 (0.0302)	-0.6209 (-0.6787)
LRXA	-0.8910** (-2.3717)	-0.3662 (-0.7683)
LRXG	0.2940 (0.5978)	0.5939 (1.0597)
LRXC	1.5229** (2.3777)	2.0532** (2.9582)
LDISC	0.4114 (0.7754)	0.8979 (1.5185)
LPAINT‡*DUM84	-0.1778 (-1.0538)	-0.1354 (-0.4504)
LPLASTIC*DUM84	0.1181 (0.2164)	2.8382** (2.2475)
LPAPER*DUM84	0.2031 (0.2815)	-2.7356* (-1.9164)

Table V.2 -- Continued

Dependent Variable: Log of Deflated TiO_2 Price Index
(t-statistics in parentheses)

Variable	Specification V.1	Specification V.2
LW281*DUM84	0.2936 (0.1983)	-5.3058 (-1.5944)
LCHL*DUM84	-0.0878 (-0.1236)	3.3674* (2.1066)
LPOWER*DUM84	0.5662 (0.4511)	3.1164 (1.3972)
LSULFUR*DUM84	-0.0505 (-0.0802)	-0.0617 (-0.0708)
LRXA*DUM84	-1.2735** (-2.2369)	0.9423 (0.9622)
LRXG*DUM84	0.0130 (0.0389)	0.7388 (1.3892)
LRXC*DUM84	3.1892** (3.1716)	-0.1333 (-0.0804)
LDISC*DUM84	1.1330 (1.5745)	0.5361 (0.6102)
LPAINT*TIME	0.0005 (0.1345)	-0.0039 (-0.9267)
LPLASTIC*TIME	-0.0252* (-1.7795)	-0.0495** (-2.8051)
LPAPER*TIME	0.0375 (1.5351)	0.0684** (2.4309)
LW281*TIME	0.0291 (1.1083)	0.0356 (1.2689)
LCHL*TIME	-0.0233 (-1.2706)	-0.0364* (-1.7845)
LPOWER*TIME	-0.0208 (-0.6016)	-0.0165 (-0.4598)
LSULFUR*TIME	0.0011 (0.0434)	0.0157 (0.5246)

Table V.2 -- Continued

Dependent Variable: Log of Deflated TiO_2 Price Index
(t-statistics in parentheses)

Variable	Specification V.1	Specification V.2
LRXA*TIME	0.0355*	0.0081
	(2.3588)	(0.4137)
LRXG*TIME	-0.0086	-0.0205
	(-0.5653)	(-1.1387)
LRXC*TIME	-0.0558*	-0.0754**
	(-2.1008)	(-2.5882)
LDISC*TIME	-0.0336	-0.0483**
	(-1.6927)	(-2.2362)
Q1	0.0590	0.0013
	(0.9611)	(0.0173)
Q2	0.0969	0.0078
	(1.1916)	(0.0792)
Q3	0.0549	0.0027
	(0.9421)	(0.0396)
DUM84	0.3781	-12.3730
	(0.1124)	(-1.5029)
R^2	0.9901	0.9899
Adjusted R^2	0.9741	0.9652
F-statistic (37,23)	62.1075**	-----
F-statistic (37,15)	-----	40.0204**

*Significant at 0.10 level
**Significant at 0.05 level

†Each specification is estimated using the Beach and MacKinnon (1978) adjustment for first-order autocorrelation.

LPAINT‡ is fitted values from the regression of LPAINT on the log of real GNP, LPOWER, LDISC, Q1, Q2, and Q3. See footnote 42 and related text.

Specification V.1 covers the entire post-merger time period ending 1989:Q2 while Specification V.2 is truncated at 1987:Q2 to avoid the capacity constrained period.

Table V.3

Price Effect of SCM's Purchase of Gulf & Western's

Titanium Dioxide Facilities: Specification V.1

(t-statistics in parentheses)

$\Delta \ell nP/\Delta DUM84$
0.3187*
(1.8979)

*Significant at 0.10 level
**Significant at 0.05 level

Difference Quotient Evaluated at the

Average Post-Merger Values of Exogenous Variables

1984:Q1 - 1989:Q2

Variable	Post-Merger Average
LPAINT	4.5973
LPLASTIC	5.4422
LPAPER	4.9292
LW281	-2.0576
LCHL	0.1936
LPOWER	0.0852
LSULFUR	-0.0529
LRXA	0.1309
LRXG	-0.6388
LRXC	-0.0720
LDISC	0.0787

on the values of the exogenous variables used to evaluate them. We believe that the average values of the exogenous variables during the post-merger period are reasonable values to evaluate $\Delta \ell nP/\Delta DUM84$; nevertheless, the use of these particular values for this purpose is admittedly arbitrary.

To test the robustness of this result, we evaluated $\Delta \ell nP/\Delta DUM84$ using the values of the exogenous variables for each quarter over the five year period beginning the second quarter of 1984 and ending the first quarter of 1989. These 20 values of $\Delta \ell nP/\Delta DUM84$ and their corresponding t-statistics are reported in Table V.4, and they suggest that the merger altered the process determining TiO_2 prices so as to increase the market prices. All 20 are positive; 17 of the 20 values of $\Delta \ell nP/\Delta DUM84$ exceed 0.20, and 10 exceed 0.35. Nine of the 20 t-statistics exceed the .10 critical level of 1.714 for 23 degrees of freedom, and 7 exceed the .05 critical level of 2.069.

Although the F-statistic for Specification V.1 is highly significant and the Adjusted R^2 statistic is 0.97, few of the individual coefficients are significant. In part, this is a result of considerable collinearity introduced as a result of the interactions with the time trend and with DUM84. This is particularly a problem for the demand-side variables. For example, the correlation between LPAINT*DUM84 and LPLASTIC*DUM84, LPAPER*DUM84, and LW281*DUM84 are 0.999, 0.999, and -0.998 respectively. A number of other variables have correlation coefficients that exceed 0.95. Although the multicollinearity makes interpreting the individual coefficients difficult, our concern is with how price changes when all of the exogenous variables change as a result of the merger. That is, we are concerned with $\Delta \ell nP/\Delta DUM84$, and not the individual coefficients on the right-hand-side variables.

These results from Specification V.1 suggest that the SCM/Gulf & Western merger may have substantially lessened competition among domestic TiO_2 producers. Nevertheless, $\Delta \ell nP/\Delta DUM84$ may overstate the effects of the merger because, over the relatively long post-merger period, other events may have confounded the effects of the SCM/Gulf & Western merger. In particular, trade reports indicate that

Table V.4

Price Effect of SCM's Purchase of Gulf & Western's
Titanium Dioxide Facilities: Specification V.1
Evaluated at Actual Post-Merger Values of the Exogenous Variables

	Quarter	ΔlnP/ΔDUM84	t-statistic
1.	1984:Q2	0.0463	0.8563
2.	1984:Q3	0.1665	2.4198
3.	1984:Q4	0.1434	2.3655
4.	1985:Q1	0.2473	2.3024
5.	1985:Q2	0.2947	2.6486
6.	1985:Q3	0.3237	2.9735
7.	1985:Q4	0.2441	1.6654
8.	1986:Q1	0.3520	2.1322
9.	1986:Q2	0.3415	2.0412
10.	1986:Q3	0.4807	2.1713
11.	1986:Q4	0.4644	1.9042
12.	1987:Q1	0.4232	1.4386
13.	1987:Q2	0.2679	1.0682
14.	1987:Q3	0.3851	1.3696
15.	1987:Q4	0.4412	1.3797
16.	1988:Q1	0.4658	1.4703
17.	1988:Q2	0.3036	1.0883
18.	1988:Q3	0.3975	1.4817
19.	1988:Q4	0.3872	1.3250
20.	1989:Q1	0.3613	1.3853
MAXIMUM		0.4806	2.9734
MINIMUM		0.0463	0.8563
AVERAGE		0.3188	1.7743

during 1988, and perhaps late 1987, unexpectedly high demand for TiO_2 resulted in a capacity "crunch" that completely eliminated excess capacity in the U.S. and much of the rest of the world and led to TiO_2 shortages.[56]

Levels of capacity and capacity utilization are not included in our price equation because over the long-run they are endogenous variables. Firms choose capacity levels based on current and expected future product prices. If firms believe that demand will grow to levels that will profitably accommodate expanded capacity, then they will build more plants or expand current plants to meet the expected growth in demand. If firms believe that demand will fall in the future, then they will contract capacity through depreciation or through conversion to other uses. In both cases, price acts as a signal to firms to alter production levels and capacity. Nevertheless, building new plants or expanding old ones can take years to complete. In the case of chemicals such as TiO_2 that produce dangerous waste byproducts, securing permits to allow construction of new capacity can add substantial delays to the construction of new capacity. Consequently, if demand increases unexpectedly by an amount sufficient to eliminate all excess capacity, then we might see sharp increases in price during the periods of time necessary to install new capacity. Over these periods, capacity is essentially fixed and might be considered exogenous.

Such a binding capacity constraint during a period of rising demand can result in an increase in price similar to that expected from an anticompetitive merger and not be fully explained by the normal influences of factors that shift demand and supply. A temporary binding capacity constraint

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[56] See, for example, Chemical Marketing Reporter, November 6, 1989. Private discussions with industry analysts indicated a consensus view that during 1988 a supply/capacity "crunch" occurred due to unexpectedly high demand. Whether or not the capacity constraint was binding during 1987 was somewhat less certain. Trade reports described supply as "tight" as early as 1984 [see American Paint and Coatings May 21, 1984]. Tight supply is, of course, perfectly consistent with a lessening of competition as well as a capacity constraint created by an unexpected increase in demand.

would alter the coefficients in our reduced-form price equations. The estimated coefficients on the demand-side variables would be larger than they would be otherwise since, during periods in which the market supply curve is vertical, price increases resulting from increased demand cannot be dampened by increases in output. Similarly, the coefficients on the cost variables would be less than they would be otherwise since, during the time in which the industry supply was vertical, small changes in cost factors would have no effect on price.

We could account for a temporary binding capacity constraint by including in the reduced-form price equation a dummy variable equal to one during this period and zero otherwise, as well as the product of this dummy variable and each of the exogenous variables. Unfortunately, we do not have a sufficient number of observations during the period to estimate these additional coefficients. Instead, we re-estimate the reduced-form price equation over the truncated period beginning the second quarter of 1974 and ending the second quarter of 1987. The results from this regression are reported as Specification V.2 in Table V.2.

In the case of Specification V.2, the effect of the merger on TiO_2 prices is

$$\Delta \ell nP/\Delta DUM84 = -12.37 - 0.13*LPAINT^{\ddagger} + 2.83*LPLASTIC - 2.73*LPAPER - 5.30*LW281 + 3.36*LCHL + 3.11*LPOWER - 0.06*LSULFUR + 0.94*LRXA + 0.74*LRXG - 0.13*LRXC + 0.54*LDISC.$$[57]

Table V.5 reports the average values of the exogenous variables over the post-merger period beginning the first quarter of 1984 and ending the second quarter of 1987. When $\Delta \ell nP/\Delta DUM84$ is evaluated at these levels, it equals 0.2495 and its t-statistic is 2.1643. This indicates a post-merger price increase of 28.3% that cannot be attributed to the 1988

[57] For Specification V.2, the χ^2 statistic for the likelihood ratio test of the joint significance of DUM84 and the DUM84 interaction terms is 43.91 with 12 degrees of freedom. Again, this statistic is statistically significant at less than the .05 level.

Table V.5

Price Effect of SCM's Purchase of Gulf & Western's

Titanium Dioxide Facilities: Specification V.2

(t-statistics in parentheses)

ΔmP/ΔDUM84
0.2495**
(2.1643)

*Significant at 0.10 level
**Significant at 0.05 level

Difference Quotient Evaluated at the

Average Post-Merger Values of Exogenous Variables

1984:Q1 - 1987:Q2

Variable	Post-Merger Average
LPAINT	4.5780
LPLASTIC	5.3417
LPAPER	4.9330
LW281	-2.0651
LCHL	0.2198
LPOWER	0.1006
LSULFUR	-0.0470
LRXA	0.0555
LRXG	-0.7566
LRXC	-0.1199
LDISC	0.0997

capacity "crunch."[58]

To test the robustness of $\Delta\ell nP/\Delta DUM84$ evaluated at post-merger average values of the exogenous variables, we calculated its value using the actual values of the exogenous variables for each quarter over the 1984:Q1 - 1987:Q2 period. These 14 values of $\Delta\ell nP/\Delta DUM84$ and their t-statistics are reported in Table V.6. As was the case with Specification V.1, all 14 are positive. Eight of the 14 values of $\Delta\ell nP/\Delta DUM84$ exceed 0.20, and 12 exceed 0.15. Nine of the 14 t-statistics exceed the .10 critical level of 1.753 for 15 degrees of freedom, and 7 exceed the .05 critical level of 2.131.

The values of $\Delta\ell nP/\Delta\bar{DUM84}$ from Specification V.2 tend to be somewhat lower on average than those reported for Specification V.1. This result is consistent with the view that part of the Specification V.1 post-merger price increase was the result of a binding capacity constraint. Nevertheless, the results from the estimation of Specification V.2 strongly suggest that TiO_2 prices rose by both statistically and economically significant amounts following SCM's purchase

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[58] If, during the period following the merger, demand increased due to some factor left out of our equations, then we might see a post-merger price increase that would not be properly attributed to a decrease in competition. In this case, we would expect the increase in price to be accompanied by an increase in quantity consumed. In the case of an anticompetitive price increase, we would expect the price increase to be accompanied by a decrease in quantity consumed. To examine this issue, we re-estimated Specifications V.1 and V.2 using the U.S. Department of Commerce's "apparent consumption" of TiO_2 as the dependent variable (apparent consumption is defined as domestic production plus imports less exports). These regressions indicated quantity declines that were substantial in magnitude, but statistically insignificant. With Specification V.1 (post-merger period ending 1989:Q2), quantity declined by 33.5%, though the t-statistic was only -0.5675; with Specification V.2 (post-merger period ending 1987:Q2), quantity declined by nearly 60%, with a t-statistic of -1.4356. An increase in foreign demand might explain both the increased domestic price and the decrease in domestic consumption. Although we do not have the data to test this explanation directly, it does appear inconsistent with data on domestic exports and imports of TiO_2. If domestic prices were rising and consumption falling due to a surge in foreign demand and resulting increases in foreign prices, we would expect domestic exports to exceed imports and imports to fall. Although exports rose by an average of 10% a year during the period from 1983 through 1988, imports also rose during this period by a similar percentage, on average, each year. Moreover, imports exceeded exports in each year by an average of 77% during this period.

Table V.6

Price Effect of SCM's Purchase of Gulf & Western's
Titanium Dioxide Facilities: Specification V.2
Evaluated at Actual Post-Merger Values of the Exogenous Variables

	Quarter	ΔlnP/ΔDUM84	t-statistic
1.	1984:Q1	0.0535	0.9528
2.	1984:Q2	0.0768	1.5343
3.	1984:Q3	0.1716	2.7750
4.	1984:Q4	0.1582	2.9360
5.	1985:Q1	0.1960	1.9905
6.	1985:Q2	0.2545	2.5366
7.	1985:Q3	0.2991	3.0454
8.	1985:Q4	0.1619	1.1860
9.	1986:Q1	0.3676	2.4675
10.	1986:Q2	0.3301	2.1760
11.	1986:Q3	0.4335	2.1651
12.	1986:Q4	0.4273	1.9272
13.	1987:Q1	0.3571	1.3168
14.	1987:Q2	0.2130	0.9205
Maximum		0.4335	3.0454
Minimum		0.0535	0.9205
Average		0.2497	1.9950

of Gulf & Western's TiO_2 production facilities.[59]

A price increase of over 28% following a particular merger seems remarkably large. One would expect that such a large increase in prices would result in striking increases in profits. TiO_2, however, is produced by relatively large, diversified chemical corporations that typically report operating income and profits at relatively aggregated levels (such as a firm's "industrial chemical group" or "chemical division" or 'inorganic chemical group") and not at the level of an individual chemical product such as TiO_2. Despite this potential problem, financial information from some TiO_2 producers indicates substantial post-merger profit increases. That such firms typically report income and profits at aggregate levels underscores the fairly remarkable turnabout that occurred in TiO_2 prices during the period immediately following SCM's purchase of Gulf & Western's Ashtabula plant.

According to SCM's 1983 Annual Report, the operating income, return on sales, and return on average assets of SCM Chemicals (its chemical division) declined in 1983, and this decline was specifically attributed to "severe price competition" in TiO_2. The SCM/Gulf & Western acquisition took place at the end of 1983, and [according to SCM's 1984 and 1985 Annual Report] TiO_2 prices began to rise in 1984. SCM's 1985 Annual Report specifically attributes record levels of operating income earned by SCM Chemicals to the performance of its TiO_2 business.

Kerr-McGee, another producer of TiO_2, reports significant increases in operating income and net income for 1985. Although the firm produces a large number of industrial chemicals, only one, TiO_2, is specifically mentioned in the firm's Annual Report as contributing to the increase in the firm's earnings. According to Kerr-McGee's Annual

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[59] It may be the case that firms anticipated the capacity constraint before it became binding so that prices reflected this constraint sometime before the end of 1987. If this is the case, we may overstate the effects of the merger. Nevertheless, to the extent that the capacity "crunch" was anticipated well before the end of 1987, it would not be properly considered exogenous. Firms will expand capacity if they anticipate a future need.

Report, "Titanium dioxide pigments achieved record levels of operating income" in 1985. In each subsequent year through 1989, the earnings of Kerr-McGee's chemical division increased, with this increase specifically attributed to TiO_2, the division's "most profitable product [1989], "highest income producer" [1988], and "top performer" [1987].

Economists generally accept that accounting profits do not measure the "economic profits" created by monopoly power,[60] and the evidence provided by the SCM and Kerr-McGee annual reports is, at best, anecdotal. Nonetheless, that these firms, which produced a large assortment of industrial chemicals, would specifically cite just one, TiO_2, as responsible for substantial increases in earnings during the period following SCM's purchase of Gulf & Western's TiO_2 facilities is notable. This is certainly consistent with results suggesting that this acquisition may have reduced competition in the domestic TiO_2 market.[61]

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[60] See Fisher and McGowan (1983).

[61] Since SCM's purchase of the Gulf & Western Ashtabula TiO_2 plant, no other domestic producers of TiO_2 have merged with one another. Slightly less than a year after SCM purchased the Ashtabula plant, SCM acquired the TiO_2 assets of Laporte Industries PLC, a British manufacturer of TiO_2 with plants in England and Australia. In 1985, Kemira Oy, a Finnish producer of TiO_2, purchased American Cyanamid's TiO_2 production facilities (after NL Industries dropped its proposed acquisition of these assets). Both LaPorte and Kemira Oy were very small fringe suppliers of TiO_2 in the U.S. prior to these acquisitions, and the affects of these acquisitions on domestic concentration was negligible. Thus, it is difficult to believe that the SCM/Laporte and the Kemira Oy/American Cyanamid acquisitions could have contributed to such a large increase in domestic TiO_2 prices.

VI. Summary and Conclusions

This report presents three case studies examining the effects of horizontal mergers on market prices. The purpose of the study is to offer some insight into a number of issues important to antitrust enforcement. In all three cases examined here, the price effects of the mergers (or, in the case of Weyerhaeuser/Menasha, the hold-separate order) appear strikingly large given the circumstances of each case. As in most empirical research, results must be qualified to account for limited data and lack of experimental control. Nevertheless, given the scarcity of empirical research in this area, research such as that contained in this report is a step in furthering our understanding of the price effects of horizontal mergers.

The first study that we present examines the price effects of the purchase of Menasha Corporation's North Bend, Oregon corrugating medium mill by Weyerhaeuser Co. This acquisition was one component of Weyerhaeuser's purchase of Menasha's entire west coast paperboard and container operations. The Federal Trade Commission initially opposed the transaction, but ultimately dismissed its complaint after an administrative trial. Although the FTC was unable to prevent consummation of the merger prior to trial, the court did issue a "hold-separate" order that allowed Weyerhaeuser to own, but not control the North Bend mill during the four-year period in which the case was in administrative adjudication. The mill continued to operate under the Menasha plant managers. To the extent that these managers perceived a positive probability that Weyerhaeuser would ultimately thwart the antitrust complaint and viewed their future as possible Weyerhaeuser employees, they may not have acted fully independently of Weyerhaeuser's interest. As a result, the hold-separate order may not have prevented a lessening of competition.

The specific hold-separate order issued in this case also prevented Weyerhaeuser from receiving any preference in the distribution of the mill's output. Consequently, the hold-separate order may have prevented certain vertical efficiencies from being created by the merger.

The results from this study show that the merger generated a small and statistically insignificant increase in corrugating medium prices. However, during the period in which the hold-separate order was in place, prices rose by a substantial and statistically significant amount. These results are consistent with the conjecture that the particular hold-separate order in this case may have functioned poorly. By allowing Weyerhaeuser to acquire the North Bend mill, the hold-separate order may have allowed any anticompetitive effects by creating a strong incentive for the management of the mill to pursue the best interests of Weyerhaeuser. On the other hand, by preventing Weyerhaeuser from receiving preferential distribution of the North Bend mill's output, the hold-separate order may have prevented the reductions in medium prices resulting from vertical integration that eventually returned the market price of medium to pre-merger levels following the removal of the order. This finding suggests that antitrust authorities should not assume hold-separate orders to be necessarily benign with respect to competition and prices.[62]

The second study examines the effects of the merger of the Hawaiian cement operations of Kaiser Cement Corp. and Lone Star Industries into Lone Star Hawaii. This merger is interesting because Kaiser and Lone Star were the only firms that produced cement in Hawaii. Since imports generally did not have a significant presence in the Hawaiian cement market over the twenty-year period preceding the merger, one might be tempted to view this acquisition as an anticompetitive merger to monopoly that would result in higher Hawaiian cement prices.

The study finds no persuasive evidence that the creation of Lone Star Hawaii increased the price of cement in

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[62] Our result suggests that maintaining the acquired firm as a viable entity under independent management is not identical to the pre-merger status quo and should not be treated as such. A hold-separate order may result in higher product prices and lower output, and should be used judiciously. We do not mean to suggest, however, that a hold-separate order is necessarily improper. By facilitating divestiture, a hold-separate order can be an important tool in antitrust enforcement, and, in many cases, it may represent the most practical arrangement prior to settlement of an antitrust case.

Hawaii. In fact, once Japanese factors affecting the residual demand curve faced by Hawaiian producers (which implicitly control for imports) are included in the model, we find a large and statistically significant decline in price following the merger. This result suggests that the merger created real efficiencies. Moreover, following the merger, imports remained at or above the relatively high levels achieved during the years immediately before the merger. These results suggest that when imports are easily accessible, they may have an important impact on price following a merger.

The third study examines the purchase by SCM Corp. of Gulf & Western's titanium dioxide manufacturing facilities. This acquisition is interesting for a number of reasons. On the one hand, the TiO_2 industry is relatively concentrated, and has a history of antitrust litigation. On the other hand, the acquisition facilitated a transfer of technology that may have created substantial technical efficiencies at the former Gulf & Western plant.

The results of this study indicate that following SCM's purchase of Gulf & Western's TiO_2 facilities, TiO_2 prices rose by both economically and statistically significant amounts. The merger involved the combination of the second and fifth largest firms, and the post-merger market share of the combined firm was 22%. Although a merger such as this might warrant competitive concerns, a price increase of over 28% seems surprisingly high. Yet, this price increase is not explained by increases in input prices or demand factors that are controlled for in our price equation. Nor can the price increase be explained by positing that the merger merely coincided with an unexpected capacity "crunch" that may have occurred in 1988 and late 1987.[63] Nor can the price increase be explained by other domestic mergers. Our results also suggest that efficiencies, such as those that may have been created through the transfer of technology facilitated by

[63] As previously noted in Section V (see footnote 59), it may be the case that firms anticipated the capacity constraint before it became binding so that prices reflected this constraint sometime before the end of 1987. If this is the case, we may overstate the effects of the merger. Nevertheless, to the extent that the capacity "crunch" was anticipated well before the end of 1987, it would not be properly considered exogenous. Firms will expand capacity if they anticipate a future need.

this acquisition, will not necessarily prevent post-merger price increases when mergers take place in highly concentrated industries. Consequently, we conclude that the evidence is consistent with the merger lessening competition in the domestic TiO_2 market.[64]

[64] A merger resulting in lower costs and higher prices need not reduce social welfare. If demand is sufficiently inelastic, the welfare gain from a small decrease in cost could offset the welfare loss even from a large increase in prices. See Williamson (1968). Measuring the effects on social welfare of the three mergers that we study is, however, beyond the scope of this report.

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