

**The Effects of Consolidation on Price-Cost Margins in the Pulp and Paper Industry**

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# The Effects of Consolidation on Price-Cost Margins in the Pulp and Paper Industry

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## Summary

In recent years, the U.S. paperboard industry has experienced a series of mergers and acquisitions. For paperboard companies, the number of mergers in 1998 amounted to 35. From 1995 to 2000 inclusively, on average there were 20.5 mergers per year among companies involved primarily in paper production. Market concentration for the paperboard industry, measured by the percent of total capacity due to the top four producers, increased from 25 percent in 1990 to 35 percent in 2000. However, this concentration level is still relatively low in comparison with a 40-60 percent concentration ratio in the pulp market.

A natural question for the paperboard industry is whether further consolidation would improve firms' ability to increase operating profits. Firm consolidation is expected to improve efficiency by reducing production costs through greater economies of scale and as well as by technological innovations through larger R&D investments. In addition, consolidation may improve the ability to increase operating profits by helping to support product prices. Yet, it is unclear whether the industry has experienced these effects.

This study analyzes the effects of consolidation on price-cost margins in the pulp and paper industry. Based on data from 1970 to 2000 for pulp, paper, and paperboard industry, this study uses panel data to investigate the relationship between price-cost margins and concentration ratios and to test whether increases in concentration are associated with changes in price-cost margins.

## Introduction

Today's world is barely imaginable without the use of paper. Paper products and their derivatives are found everywhere in day-to-day life. The importance of the paper industry is hard to exaggerate in both economic and social contexts. In the economic realm, the US paper industry represents one-third of the global production in over 500 billion dollars of revenue or 300 million tons of world paper manufacturing, contributing almost five percent to the national GDP.<sup>1</sup> In 1990, the paper industry employed 647.2 thousand people, and despite its decline to 604.7 thousand workers in 2000, employment in paper and allied industries stayed at four percent of the total US manufacturing sector.<sup>2</sup> Additionally, the forest products industry, with paper industry at its front, is among the top ten employers in 43 out of 50 states.<sup>3</sup>

The socio-economic significance of the paper industry extends beyond its role in the labor market into the day-to-day life of an ordinary consumer. In the US alone, per capita consumption of paper is 700 pounds per year.<sup>4,5</sup> This transforms papermaking into

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<sup>1</sup> Statistics compiled in "About the Paper Industry, Today's Paper Industry—Its Character and Structure," Center for Paper Business and Industry Studies, 2003, available at:

<http://www.paperstudies.org/industry/character.html>.

<sup>2</sup> Total US manufacturing employment counted up to 17,695 thousand workers in 1990 and 17,263 thousand workers in 2000. The decrease in paper industry employment over 1990-2000 (from 647.2 to 604.7 thousand) constitutes a seven percent decrease. The decrease is more dramatic for pulp, paper and paperboard mills—the three sectors have reduced their workforce by 20 percent from 238.3 thousand in 1990 to 191.4 thousand in 2000. The numbers are extracted from the Bureau of Labor Statistics database available at: <http://www.bls.gov/data/home.htm>.

<sup>3</sup> From "About the Paper Industry, Today's Paper Industry—Its Character and Structure," Center for Paper Business and Industry Studies, 2003, available at: <http://www.paperstudies.org/industry/character.html>.

<sup>4</sup> From the introductory note "About the Paper Industry, Today's Paper Industry— Its History and Role in Society," of the Center for Paper Business and Industry Studies, 2003, available at: <http://www.paperstudies.org/industry/character.html>.

<sup>5</sup> James A. McNutt's remarks on the omnipresence of and therefore demand for paper products in our daily life: "...Paper and its related products—such as paperboard, packaging, tissue and newsprint—permeate the social fabric of modern civilization. Paper is in almost every product that we use: books and photocopies, tissue and sanitary products, newspapers and magazines, containers, catalogs, wallpaper, food packaging, gift wrap, and many other staples of everyday life. Paper fibers are in our computers and paper insulation is on our attics, car doors and floors. Paper is still considered the safest long-term way to store data. We even find paper's cellulose-based derivative products in surgical gowns, gas mask filters, ice

one of the country's strategic industries, and as such, its economic welfare becomes an important subject of academic study.

During the last decade, the performance of pulp and paper industry on the whole has been less than impressive. The Center for Paper Business and Industry Studies (CPBIS)<sup>6</sup> points out that the industry's massive increases in economies of scale during the 1980's have resulted in the chronic excess supply and the problems of pricing. Excess supply has been defined as too many producers, too many spending programs, adding too much capacity.<sup>7</sup> In search for working solutions firms have rejected the strategy of constructing new mills and have shifted to consolidation strategies—mergers and acquisitions of related operations. The process of consolidation has been on the rise since the 1980's. Yet, it is in the late 1990's that the strategy of mergers and acquisitions has been recognized and accepted as an effective price stabilization tool.<sup>8</sup> To this effect, the main question of this study is whether the changing structure of the pulp and paper industry has had significant, if any, effects on the overall industry's ability to generate operating profits.

The pace of change, measured by the number of mergers per year, has picked up for pulp and paper especially in the late 1990's. For paperboard companies, the number

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cream, our clothes, toothpaste, film base stock, and the plastics that are used everywhere.” From “Ways to Win In a Global League,” PIMA's 82th Annual International Management Conference, President's Panel, Baltimore, Maryland, June 27, 2001, Center for Paper Business and Industry Studies available at: [http://www.paperstudies.org/industry/010627\\_PIMA\\_Talk.html](http://www.paperstudies.org/industry/010627_PIMA_Talk.html).

<sup>6</sup> The Center for Paper Business and Industry Studies (CPBIS) is a joint venture between the Georgia Institute of Technology (Georgia Tech), the Alfred P. Sloan Foundation, and the Pulp and Paper Industry. It is hosted by the Institute of Paper Science and Technology at Georgia Tech. The official CPBIS web site can be found at: <http://www.paperstudies.org/>.

<sup>7</sup> About the Paper Industry, The Issues and the Need, Center for Paper Business and Industry Studies, 2003, available at: <http://www.paperstudies.org/industry/need.html>.

<sup>8</sup> Louis Uchitelle, “Who's Afraid Now That Big Is No Longer Bad?,” New York Times, November 5, 2000, available at: <http://www.som.yale.edu/faculty/zc25/finance-core/articles/AlliedSignal-Honeywell-GE.htm>. The article suggests that mergers stabilize prices in linerboard: “Linerboard has risen in price to \$475 a ton, from \$340 in 1998. That is still below the peak of \$525 in 1995, but the mergers and the shutdown of excess capacity have stabilized prices.”

of mergers in 1998 amounted to 35. From 1995 to 2000 inclusively, on average there were 20.5 mergers per year among companies involved primarily in paper production.<sup>9</sup> The industry concentration ratio, measured by the market share of the top four producers (CR4), has been climbing since the early 1990's. Pulp<sup>10</sup> exhibits the highest concentration with almost 60% of industry shipments held by the top four producers in 1997, with paper and paperboard's top four producers providing almost 35% of total industry shipments.<sup>11</sup> Since 1997, the concentration ratio in all three sectors has been increasing even further, with especially dramatic increases in paperboard, with the CR4 climbing up to 45%.<sup>12</sup> Industry price cost margins (PCMs), calculated using the Census data, also have been increasing steadily. Measured by 10-year averages, 31% pulp PCM in 1971-1980 increased to 34% in 1991-2000. Changes in paper and paperboard PCMs are more dramatic—from 25 to 34 percent in paper and from 28 to 36 percent in paperboard.<sup>13</sup>

Traditionally, studies on industry structure and PCMs use Census-based CR4s, which are published by the Census Bureau once every five years. To conduct annual tests, the five-year CR4 series typically are interpolated. In our study, in order to compare the performance of the interpolated Census CR4 series, we use the annual capacity data on all US pulp, paper, and paperboard mills collected by the Forest

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<sup>9</sup> Annual mergers by sector—pulp, paper, and paperboard—were calculated using the annual capacity database provided by the Forrest Products Laboratory (FPL). The FPL data render uniqueness to the current study and are described in the subsequent sections of the paper.

<sup>10</sup> Hereinafter, pulp is defined as market pulp, or pulp produced for external consumption.

<sup>11</sup> Bureau of Census publishes shipment-based CR4 for all industries classified according to the Standard Industrial Classification (SIC) every 5 years in the Census of Manufacturers. According to Pulp and Paper trade journal, in 1997 top five market pulp producers had 40 percent of total North-American, as opposed to strictly US, capacity.

<sup>12</sup> Forest Products Laboratory panel data on annual capacities of all US mills provides a unique opportunity to calculate a variety of industry concentration measures based on capacity vs. sales or shipments data. (Careful due to difference in definition)

<sup>13</sup> Based on the Annual Survey of Manufactures data, the three decade averages for 1971-1980, 1981-1990, 1991-2000 are respectively: pulp: 31, 32, 34, paper: 25, 30, 34, and paperboard: 28, 32, 36 percent.

Products Laboratory (FPL) in Wisconsin. In this manner we are able to (i) focus on sectors specific to the paper industry avoiding problems that stem from unaccounted differences across industries and (ii) compare the results provided by both the interpolated Census CR4s and CR4s calculated using the annual FPL capacity shares. In addition, using capacity-based concentration measures lets us bypass the problem of endogeneity, which stems from using data on annual product shipments to calculate Census CR4s.

## Methodology and Literature Review

The literature of industrial organization (IO) has a solid body of works devoted to the traditional structure-conduct-performance (SCP) paradigm, which tests effects of industry structure on its ability to earn profits, as measured by price-cost margins. The existing SCP literature is immense and any reasonable review would be incomplete. Therefore, after giving a short introduction of the SCP literature, we discuss only those works that influence our choice of methodologies and data. In essence, in reviewing and testing the SCP hypothesis on the US pulp and paper industry in 1970-2000 we follow the works of Domowitz, Hubbard, and Petersen (DHP) (1986a, 1986b) and Salinger (1990).

Early SCP works tended to have a positive and definitive stance on the profits-concentration relationships. In 1951 Bain (1951) first posited that seller concentration facilitates collusion—firms in highly concentrated industries should have above-normal profits. In 1956 Bain argued that high concentration and high entry barriers should provide firms with supra-high long-run profits. Already in the 1960's the hypothesis that higher concentration leads to increased profit margins and potential collusion had overwhelming empirical support. As reviewed by Weiss (1974), the majority of studies, testing Bain's (1951, 1956) SCP hypothesis showed a positive and significant effect of market concentration on profit margins. According to Salinger (1990), the empirical evidence in its turn had a substantial impact on policy. Salinger (1990, p.288) states that in 1969 the "so-called Neal report" recommended an active policy of "deconcentration" based on evidence of 15 percent of market share held by one firm and a 70 percent by four top firms.<sup>14</sup>

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<sup>14</sup> Salinger (1990) cites that this legislature was never enacted, yet during the late 1960's—early 1970's the findings may have induced both the Justice Department and Federal Trade Commission to bring a number

The basic functional form initially used by Collins and Preston (1966, 1969) and then by DHP (1986a, 1986b) is  $PCM = \beta_0 + \beta_1 CR4 + \varepsilon_2$ , where CR4 is the concentration ratio of top four producers within an industry. According to Salinger (1990, p.293), correlation between the concentration ratio and PCMs should provide at least a tentative indication of whether an industry operates in an oligopolistic market.

A number of authors point to the problem of simultaneity, which exists whether the unit of study is a firm or an industry. In the above profit-concentration equation there are two sources of endogeneity bias. First, concentration itself is endogenous. Concentration depends on the output decisions of individual firms, which in turn affect prices. According to Froeb and Werden (1991), the shares of output are never determined solely by market structure, but are also affected by basic long-term market conditions that can not be altered by firms, and by firm conduct, in effect causing simultaneity. In addition, determinants of demand and factor prices are measured with error resulting in correlation of concentration ratios with the error term. Typically,

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of major monopolization suits including the IBM, ready-to-eat breakfast cereals, and titanium dioxide cases.

In addition to examining the PCMs-concentration relationships, DHP (1987) and Salinger (1990) examine effects of changes in levels of concentration on prices. In the 1970's there appeared contending views that positive association in profit margins and industry concentration could be attributed to other causes, which in turn would have different policy implications. Of the decisive work was Demsetz (1973), who proposed that some firms, typically a few largest producers, are simply superior in producing and marketing their products, thereby earning above-normal profits. This was supported later by Peltzman (1977) that positive profits-concentration relationships reflected short-term price increases, resembling oligopolistic pricing, but were in effect indicative of returns to innovative activities, suggesting that markets are dynamically, but not perfectly competitive. Salinger (1990) extends the model of Peltzman (1977) done on 1954-1972 data to the period of 1972-1982. The finding of the original model is that high levels of concentration are associated with price and cost decreases, but increases, or positive changes, in concentration are associated with price and cost decreases.

In their separate reviews, Weiss (1989), Schmalensee (1989), and Werden (1991) state that by the 1990's over one hundred price-concentration studies have investigated specific industries, mainly airline, banking, advertising, and gasoline and grocery retailers. The studies provide strong support for positive and significant relationships between levels of concentration and prices. Werden (1991, p.7) notes that 72.8 percent of the studies and 62.8 percent of the data sets covered by Weiss (1989) showed positive and significant relationship between concentration and prices. However, in evaluating the overall effect among 121 data sets of the surveyed literature, Weiss (1989) also commented that the magnitude of price increases varied significantly from industry to industry.

endogeneity of concentration causes reduction in the measured correlation between concentration and PCMs, but that is not a necessary outcome.<sup>15</sup>

The literature offers a number of ways to treat the problem of endogeneity. First, Froeb and Werden (1991) suggest that the bias can be eliminated by measuring industry concentration by capacity shares rather than actual output data. Output reflects performance, rather than the structure of an industry, meanwhile capacity distribution is a better measure of industry structure. Most studies focusing on endogeneity of concentration, however, lack the data on capacity distribution. Hence, prior to this study there have been no grounds for discussing estimation of endogeneity bias caused by the usage of output vs. capacity concentration.<sup>16</sup> The FPL data utilized in this study provides us with a successful mechanism to address the problem of endogeneity inherent in the Census concentration measures.<sup>17</sup>

The second most common way to address endogeneity is to apply both the single-equation, ordinary least squares (OLS), and the instrumental variable (IV), or the two stage least squares (2SLS), estimation methods to the basic form and compare results of the two methods. The resultant evidence is inconclusive as to the magnitude and direction of the bias. In their reviews, both Weiss (1991) and Schmalensee (1989) suggest that the results using OLS and 2SLS techniques are similar and the bias is not necessarily of great magnitude.

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<sup>15</sup> For a more detailed discussion refer to Froeb and Werden (1991).

<sup>16</sup> Koller and Weiss (1989) use cement capacity-based concentration ratios, yet, their measure of performance is price, rather than the PCM. Additionally, they do not conduct tests of endogeneity. Thus, direct comparison of their results with the results of this study is unsubstantiated.

<sup>17</sup> Froeb and Werden (1991) further maintain that even when using capacity concentration there still will be a feedback bias, which in turn could be addressed by factoring in such feedback processes as investments in new capacity, research and development, and entry-exit. This can be done through instrumental variable estimation (IV) utilizing data on the above-mentioned factors as exogenous instruments. This study uses the number of mergers as an exogenous instrument, the results for which are reported in the section of result discussion.

Additionally, studies using multi-industry and multi-year, panel, data employ fixed effects (FE) estimation method to account for individual industry effects over time.

Using this approach the model to be estimated becomes:

$$PCM_{it} = \beta_1 CR4_{it} + \alpha_i + \varepsilon_{it},$$

where  $PCM_{it}$  and  $CR4_{it}$  is, respectively, price-cost margins and concentration in industry  $i$  at time  $t$ , and  $\alpha_i$  and  $\varepsilon_{it}$  are correspondingly industry-specific and industry- and time-specific disturbance terms. In this model the endogeneity bias is caused by the correlation of the concentration ratio with both disturbance terms. Using FE eliminates bias from correlation of industry-specific error term with the explanatory variable [ $\text{Cov}(\alpha_i, CR4_{it}) \neq 0$ ], yet it does not eliminate the bias stemming from correlation of a concentration measure and industry- and time-specific disturbance term [ $\text{Cov}(\varepsilon_{it}, CR4_{it}) \neq 0$ ]. The latter bias can be eliminated using a fixed effects model along with instrumental variables.

Such an approach was utilized by DHP (1986b) in their study of 284 industries over 1958-1981. However, the authors report IV fixed effects estimates only slightly higher than OLS fixed effects estimates. Evans, Froeb, and Werden (EFW) (1993) find a considerable negative bias in the study of airline data for 1,000 city-pairs defined as different markets for 1984-1988. Like DHP (1986b), EFW (1993) use a panel data approach, FE, as well as IV estimation to address endogeneity. The difference in two studies lies in the choice of performance measure: the earlier study focuses on PCM-concentration, while EFW (1993) are focused on price-concentration relationship.<sup>18</sup> In

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<sup>18</sup> Despite Demsetz-Peltzman critique that endogeneity affects mainly profits-concentration, EFW (1993) believe that it also affects price-concentration relations. As noted in EFW (1993), if markets converge

contrast to DHP (1986b) evidence of insignificant endogeneity bias, EFW (1993) suggest that the effect of Hirsch-Herfindalh Index (HHI), another measure of industry concentration,<sup>19</sup> on natural logarithm of price in fixed effects IV exceed the pooled OLS result by some 250 percent and fixed effects OLS by 150 percent.<sup>20</sup>

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instantly to long-run, free-entry equilibrium, than price could be positively related to concentration in the data.

<sup>19</sup> Hirsch-Herfindalh Index is calculated by summing up the squared market shares of all firms in an industry.

<sup>20</sup> Most subsequent works use IV method without estimating OLS regressions first, thereby omitting comparison of the two methods.

The choice of instrumental variables is driven by data availability. The common practice is to use lagged terms of concentration measures despite strong criticisms of their statistical illegitimacy due to collinearity. For instance, DHP (1986b, p. 26 and note 24, p.28) use unemployment rate, capital-output ratio, and capital-output ratio interacted with the unemployment rate (the interaction term that they include in their main functional form) “as exogenously predetermined with respect to the price-cost margin.” Hence, their list of instrumental variables includes lagged PCMs and concentration ratio. Likewise, EFW (1993) utilize lagged HHI itself or zero if the city pair route HHI was less than 1,000, and a dummy variable indicating whether the route was among the top, greater than 1,000, in the previous year. Additionally, Conyon and Machin (1991) and Haskel and Martin (1994) use multiple-lag of the concentration ratio in combination with various lag-length for other independent variables.

## **Data and Variables**

### **Data Summary**

Due to limited availability of the data on manufacturing concentration, typical concentration-profit margins studies focus on large groups of industries aggregated by the 4-digit standard industry classification (SIC) codes. The data usually come from the Annual Survey of Manufacturers and the 5-year Census of Manufacturers. The data used in this study come from the National Bureau of Economic Research (Bartlesman and Gray, 1998), which in effect is an enriched version of the Census data. In addition, we have used the US pulp and paper annual capacity panel data provided by the Forest Products Laboratory, US Department of Agriculture. The two in combination enable us to evaluate the performance of the Census-base industry concentration measure, Census CR4, as applied to a specific industry.

The primary advantage of the Census data is its relatively specific product aggregation based on production of individual plants rather than whole companies or corporations. This matters when firms are involved in widely diversified production (in this light, data “contamination” is a problem for consolidated firm-level information), or essentially different markets. In addition, Census measures avoid errors of varying corporate accounting rates. Weiss (1991) refers to the PCM obtained from the Census of Manufacturers data as possibly more reliable than various measures of rates of return on assets computed with the data reported by firms. As stated by Weiss (1991, p. 282): “In my judgment, the price-cost margin studies minimize the main problems—the inaccuracy of accounting profits, the assignment of diversified firms to their primary industries, and the inaccurate measurement of concentration.”

## Measure of Price-Cost Margin, Industry Costs

Price-cost margin is a measure of firm's operating profits. In effect, it measures the difference between product price and its average variable cost, or:  $PCM = \frac{(p - AVC)}{p}$ .

DHP (1986a, 1986b) argue that PCMs can be easily calculated using the Census data. In that view the expression (Value Added - Payroll)/(Value Added + Cost of Materials) calculates the margin over average materials and labor costs as a percentage of price and as such represents a good proxy for the price-cost margin. Census defines value added as the difference between the total value of shipments, or roughly sales, and cost of materials. The result of the subtraction is then adjusted for changes in inventory. Hence, the formula adjusts for the difference between sales and actual production and does not have the "inventory bias," as noted by DHP (1986b).<sup>21</sup>

The formula does not take into account fixed or sunk costs. As such PCMs can be interpreted as short-term returns on sales. Salinger (1990) finds strong statistical significance in correlation of Census' margins and investments and proposes the use of PCMs as measures of short-term equilibria. According to him, once fixed assets are invested (sunk) they should not affect the measurement of short-term marginal cost.

It is notable that this equation excludes such variable costs as general and administrative, advertising, and tax expenses. For example, Weiss (1991) suggests to include the general and administrative (including advertising) expenses. It is expected that in case of multi-plant companies, not all overhead costs are included. However,

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<sup>21</sup> DHP (1986a, 1986b) define inventory bias as failure to adjust output by inventory changes. Given Census' definition of Value Added, this expression can also be written as:  $PCM = (\text{Value of Sales} + \Delta \text{Inventories} - \text{Payroll} - \text{Cost of Materials}) / (\text{Value of Sales} + \Delta \text{Inventories})$ . For more detailed discussion on using Census data for PCM construction, refer to DHP 1986a, 1986b. For Census definition of Value Added and related Census variables refer to the Appendix on Data.

Census' value of shipments stipulates costs transferred from plant to plant within the same company at full economic or commercial value. The costs are not limited to strictly direct costs used in production, but include also "a reasonable proportion of 'all other costs' including company overhead."<sup>22</sup>

Many works using the Census data include a measure of advertising intensity to account for the omitted general and administrative overhead. In the paper industry, only tissue and some writing papers are considered consumer products, and as such, having a strong brand supported by advertising. The rest of the paper and paperboard grades are intended for producer markets. Additionally, general and administrative expenses usually are not recognized as of primary importance by industry experts as opposed to such variable costs as materials, labor, and energy.

Table 1 provides descriptive statistics on industry measures. The overall highest volatility is exhibited by market pulp. PCMs in pulp and paper industry stayed in the range of upper 20 percent until the late 1980's. Figure 1 shows that PCMs sharply increased around 1986 until 1990 with the second sharp increase around 1995. Same pattern of increases is repeated in commodity PPI's from the Bureau of Labor Statistics<sup>23</sup> (Figure 2). The graphic/visual similarity of the two series in Figure 3 demonstrates that

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<sup>22</sup> See Appendix on Data for Census variable definitions.

<sup>23</sup> The data was extracted from the BLS website, section on "Producer Price Index Commodity Data," with series ID's: WPS0911 for Woodpulp, WPS0913 for Paper, and WPS0914 for Paperboard. According to the BLS definition, sellers' (PPI Industry Data) and purchasers' (PPI Commodity Data) prices may differ due to government subsidies, sales and excise taxes, and distribution costs. In fact, commodity prices for pulp, paper, and paperboard are only slightly lower than producers' prices for the three product groups. The USDL calculates the PPI as:  $PPI_i = [\{\sum Q_0 P_0 (P_i/P_0)\} / \sum Q_0 P_0] * 100$ , where  $P_0$  is the price of a commodity in the base period,  $P_i$  is the price of a commodity in the current period,  $Q_0$  is the quantity of the commodity shipped during the base period with  $Q_0 P_0$  representing the weights in value form. In this form, the index is the weighted average of price relatives. In terms of the degree of how reflective BLS PPIs are, we have conducted a comparison of 42lb unbleached kraft linerboard prices published in Pulp and Paper Week, the industry trade journal, and 42lb unbleached linerboard PPI published by the BLS. For this purpose the actual transacted prices from the PPW have been indexed to the base of 1982, as the BLS PPI. The comparison shows that the two prices are virtually the same.

PCMs calculated with the Census data represent a reasonable depiction of the price patterns (Compare Figures 1 and 2).

Additionally, both data sets, Census PCMs and BLS PPIs, are consistent with the general movement, or growth of industry prices and/or price cost margins. In all three sectors the total percentage change over the 30-year period is positive (Table 1). Yet, PCMs and PPIs rank the three sectors slightly differently: according to the Census PCMs, the highest total percent increase is observed for paper mills with 57.1 percent of total increase, 8.4 and 7.1 percent increases for pulp and paperboard respectively. BLS PPI rank pulp PPI total percentage change as the highest. Finally, both Census PCM and BLS PPI average annual growth rates for the three sectors provide a more even playing field of 3.3, 2.1, and 0.9 percent increases for Census PCM, and 7.2, 5.2, and 5.4 percent increases for BLS PPIs for pulp, paper, and paperboard mills respectively. Hence, over the 30-year period, the industry has been experiencing a steady increase in its price and/or price-cost margins.

Table 1. Descriptive Statistics.

Variable	N	Mean	Standard Deviation	Min	Max	Total % Change 1970- 2000	Ave Annual % Change
All-Sector Variables							
Real Environmental Expenditures	28	624.2	287.8	220.3	1203.7		4.4
Unemployment Rate	31	6.3	1.4	4.0	9.7		0.4
Three Sectors Combined							
PCM, %	93	31.1	6.4	17.9	51.4		2.3
Commodity PPI, Base 1987	93	90.4	33.8	25.9	164.3		5.9
Real Value Added/Output	84	250.4	88.7	122.9	473.4		1.8
Census Real Value of Shipments/Output	84	545.8	172.0	311.4	923.7		0.9
Real Value of Shipments/Output	84	571.2	164.3	317.3	868.6		-0.5
Real Costs Materials/Output	84	296.8	92.9	165.2	464.4		0.7
Real Census Costs Materials/Output	84	402.9	235.4	118.5	1195.8		-7.3
Real Payroll/Output	84	82.2	30.4	40.7	146.7		-0.9
Real Energy Costs/Output	81	49.3	17.5	19.9	89.0		2.4
Capital Intensity, Real Capital/Output	84	730.2	242.7	301.1	1134.0		0.9
Import Intensity, %	87	17.0	14.1	0.0	44.2		9.2
Census CR4, %	84	35.3	11.0	21.0	59.6		0.6
Company-base FPL CR4, %	93	30.9	7.3	22.1	50.0		1.3
Ownership-base FPL CR4, %	93	32.4	8.5	22.0	50.8		1.4
Ownership-base Number of Mergers	93	7.6	7.1	0.0	35.0		
Ownership-base Number of Mills	93	350.4	90.0	198.0	490.0		0.2
Ownership-base Number of Companies	93	97.0	44.8	31.0	164.0		-1.0
Pulp Mills							
PCM, %	31	32.2	8.0	17.9	51.4	8.4	3.3
Commodity PPI, Base 1987	31	89.5	34.6	25.9	164.3	345.0	7.5
Real Value Added/Output	28	251.4	77.4	145.7	424.2	-32.7	2.4
Census Real Value of Shipments/Output	28	579.6	70.8	317.3	671.3	-29.2	0.5
Real Value of Shipments/Output	28	544.2	106.1	318.1	748.9	-52.1	-2.0
Real Costs Materials/Output	28	294.7	52.8	165.2	383.5	-30.6	0.3
Real Census Costs Materials/Output	28	386.4	189.8	118.5	861.8	-86.3	-5.7
Real Payroll/Output	28	72.3	10.7	40.7	92.8	-45.7	-1.1
Real Energy Costs/Output	27	43.3	14.4	19.9	65.3	46.8	3.6
Capital Intensity, Real Capital/Output	28	957.1	91.7	764.2	1134.0	17.1	1.1
Import Intensity, %	29	34.7	4.5	27.5	44.2	30.0	1.5
Census CR4, %	28	49.6	5.5	44.0	59.6	-0.5	0.0
Company-base FPL CR4, %	31	39.5	4.4	32.3	50.0	29.4	1.1
Ownership-base FPL CR4, %	31	42.7	3.4	36.3	50.8	17.8	0.7
Ownership-base Number of Mergers	31	1.7	1.8	0.0	6.0		
Ownership-base Number of Mills	31	234.5	14.8	198.0	260.0	19.1	0.8
Ownership-base Number of Companies	31	39.8	3.8	31.0	46.0	-14.0	-0.4

Table 1. Descriptive Statistics (Continued).

Variable	N	Mean	Standard Deviation	Min	Max	Total % Change 1970- 2000	Ave Annual % Change
Paper							
PCM, %	31	29.4	5.1	21.8	39.9	57.1	2.1
Commodity PPI, Base 1987	31	91.0	33.1	34.8	142.6	270.9	5.2
Real Value Added/Output	28	333.5	54.1	279.8	473.4	59.3	2.4
Census Real Value of Shipments/Output	28	757.5	38.4	688.8	868.6	44.6	1.7
Real Value of Shipments/Output	28	733.4	78.2	619.3	923.7	24.8	0.9
Real Costs Materials/Output	28	401.8	31.9	336.1	464.4	31.1	1.2
Real Census Costs Materials/Output	28	546.4	266.4	313.4	1195.8	-70.7	-4.3
Real Payroll/Output	28	121.4	9.9	108.6	146.7	-9.6	-0.3
Real Energy Costs/Output	27	65.6	13.9	40.2	89.0	45.2	1.9
Capital Intensity, Real Capital/Output	28	817.5	74.5	683.4	961.0	12.5	0.6
Import Intensity, %	29	15.4	1.4	13.2	17.9	10.0	0.3
Census CR4, %	28	26.7	4.2	21.0	33.6	38.7	1.3
Company-base FPL CR4, %	31	25.9	2.2	22.1	29.9	16.9	0.6
Ownership-base FPL CR4, %	31	26.3	2.6	22.0	31.0	23.2	0.8
Ownership-base Number of Mergers	31	9.6	7.5	0.0	27.0		
Ownership-base Number of Mills	31	447.3	22.4	411.0	490.0	-5.7	-0.2
Ownership-base Number of Companies	31	143.5	12.3	125.0	164.0	-23.2	-0.9
Board							
PCM, %	31	31.7	5.7	23.3	42.3	7.1	0.9
Commodity PPI, Base 1987	31	90.8	34.7	33.6	155.0	263.7	5.4
Real Value Added/Output	28	166.4	28.0	122.9	236.7	-7.7	0.8
Census Real Value of Shipments/Output	28	376.7	35.2	320.8	452.9	-0.2	0.4
Real Value of Shipments/Output	28	359.8	34.1	311.4	455.3	-14.4	-0.5
Real Costs Materials/Output	28	194.0	17.3	170.6	232.5	6.2	0.5
Real Census Costs Materials/Output	28	276.0	158.1	146.6	659.0	-77.8	-5.2
Real Payroll/Output	28	53.0	7.1	45.0	65.2	-30.1	-1.3
Real Energy Costs/Output	27	39.1	10.8	24.2	57.2	-24.8	1.6
Capital Intensity, Real Capital/Output	28	416.0	59.0	301.1	549.3	26.1	1.2
Import Intensity, %	29	1.1	1.2	0.0	3.6	7700.6	26.6
Census CR4, %	28	29.7	2.0	26.8	33.6	15.4	0.5
Company-base FPL CR4, %	31	27.4	5.1	22.5	41.9	80.7	2.1
Ownership-base FPL CR4, %	31	28.2	6.4	22.2	46.1	100.7	2.5
Ownership-base Number of Mergers	31	7.7	7.1	0.0	35.0		
Ownership-base Number of Mills	31	369.5	13.2	340.0	408.0	-10.5	-0.4
Ownership-base Number of Companies	31	107.8	15.9	76.0	128.0	-34.4	-1.5

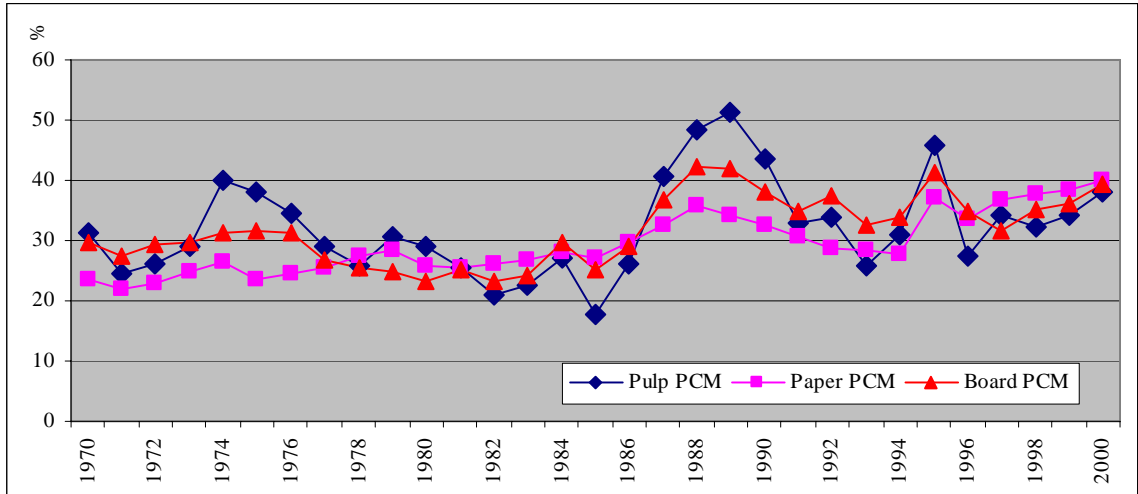


Figure 1. Price Cost Margins, 1970-2000.

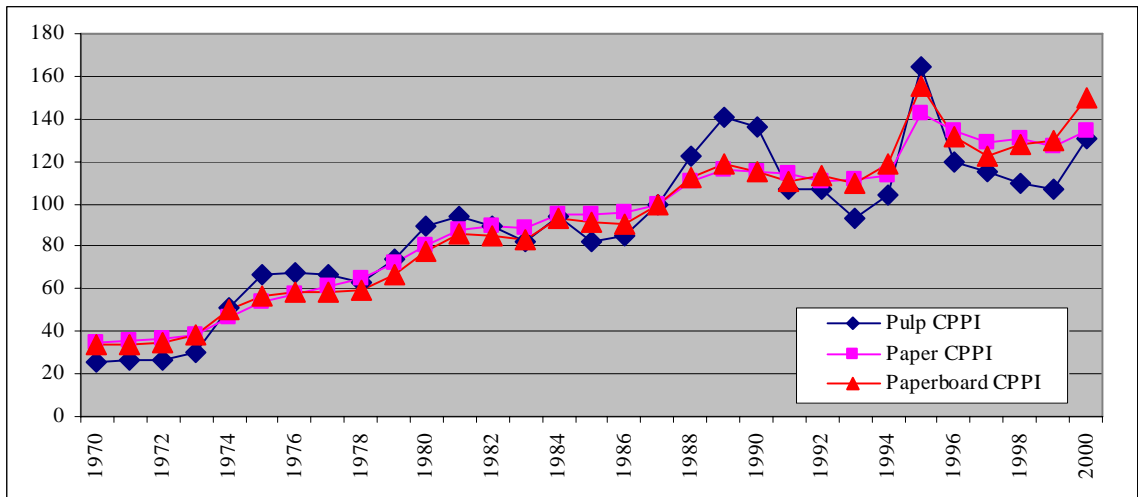


Figure 2. Commodity-based Producer Price Indices, 1970-2000.

Despite the relative stability of industry PCMs (Table 1), changes in the industry value added (Figure 3) and value of shipments have been quite dramatic.<sup>24</sup> Cost of

<sup>24</sup> Real value of shipments is derived in two ways giving two measures in Table 2—Census Real Value of Shipments, and Real Value of Shipments. The Census Real Value of Shipments is calculated using an internal NBER deflator developed especially for use with the Value of Shipments. The second, Real Value of Shipments, is deflated by the Implicit Price Deflator (IPD) as are the rest of variables used in the

materials and energy are combined in one category in the Census data—cost of materials. Figure 4 illustrates the real cost of materials per ton of output for 1970-1997. Among the three sectors, highest costs per ton are observed for the paper industry. The costs have neared the mark of real \$450/ton in the mid-1970's, in 1989 and 1995, years of the highest prices and PCMs. Yet, in general paper exhibits a fairly stable cost pattern (Table 1). Similarly, steady pattern is observed for paperboard with the lowest average costs—\$200/ton. The most volatile costs are in pulp. There was a sharp increase from 1972 to 1977, with the highest point of up to \$400/ton in 1977 with two other peaks of \$350/ton in 1990 and 1996. Additionally, the only sector that has exhibited an overall decrease in the costs of materials over the nearly 30-year period is pulp. Its overall 1970-1997 percentage decrease is 31 percent, meanwhile both paper and paperboard mills experienced increases of 31 percent and 6 percent increases for paper and paperboard mills respectively. Average annual percent increases from 1970 to 1997 are zero for pulp and paperboard mills, and one percent increase for paper mills (Table 1).<sup>25</sup>

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descriptive analysis: Cost of Materials, Payroll, Value Added. The IPD is from the Bureau of Labor Statistics.

<sup>25</sup> There is the second Cost of Materials measure, calculated as the second Value of Shipments, using an internal NBER deflator for cost of materials for each sector specifically. As in the case of the two measurements of shipments, the two measures of materials' costs differ dramatically. Table 2 lists both. The average values differ approximately by the magnitude of \$100 per ton of output. In all three sectors, the second measure is significantly higher.

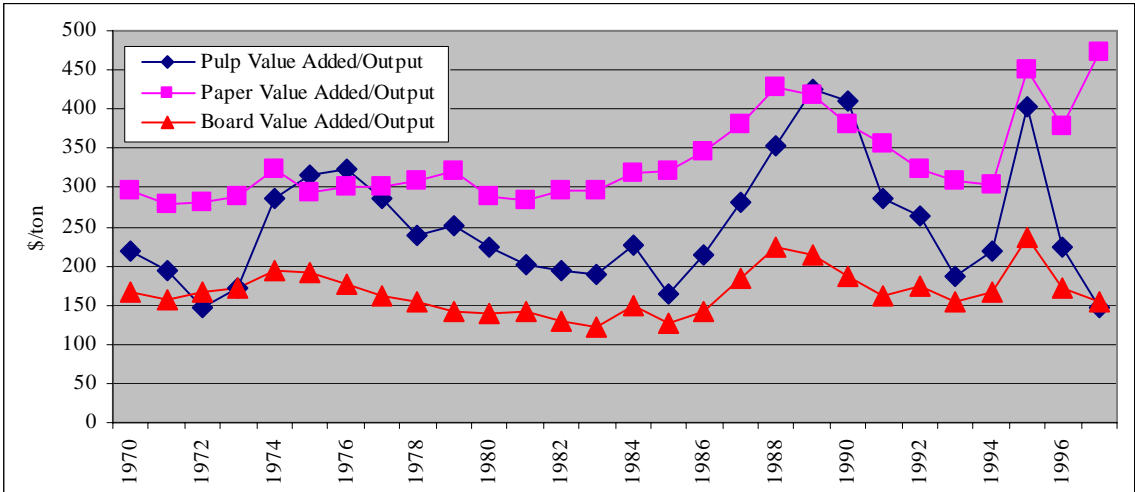


Figure 3. Value-Added Per Ton of Output, 1970-1997.

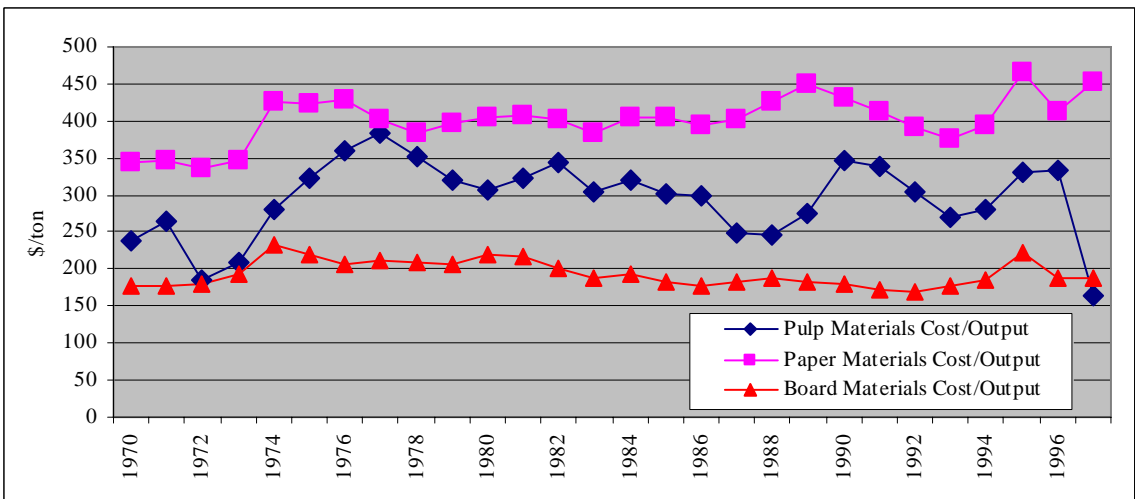


Figure 4. Cost of Materials Per Ton of Output, 1970-1997.

Average energy costs per ton of output for the whole industry is approximately \$50/ton. The highest energy costs are incurred by paper mills with the average of \$65 per ton of output, and the lowest are incurred by paperboard mills with \$40/ton.

The most labor-intensive among the three sectors is paper. In 1970, pulp mills incurred \$147/ton of payroll costs/payments. For the same year, both pulp and

paperboard mills paid in wages almost one half of the payroll costs incurred by paper mills—pulp mills paid only \$75/ton and paperboard mills only \$65/ton. In contrast to incurring increasing costs of materials and energy, mills managed to significantly decrease their payroll costs over 1970-1997. Costs decrease by 46, 10, and 30 percent in pulp, paper, and paperboard mills respectively. On average, pulp and paperboard mills have experienced one percent decrease in costs from year to year, and paper mills’ average annual percentage change is zero percent (Table 1 and Figure 5).

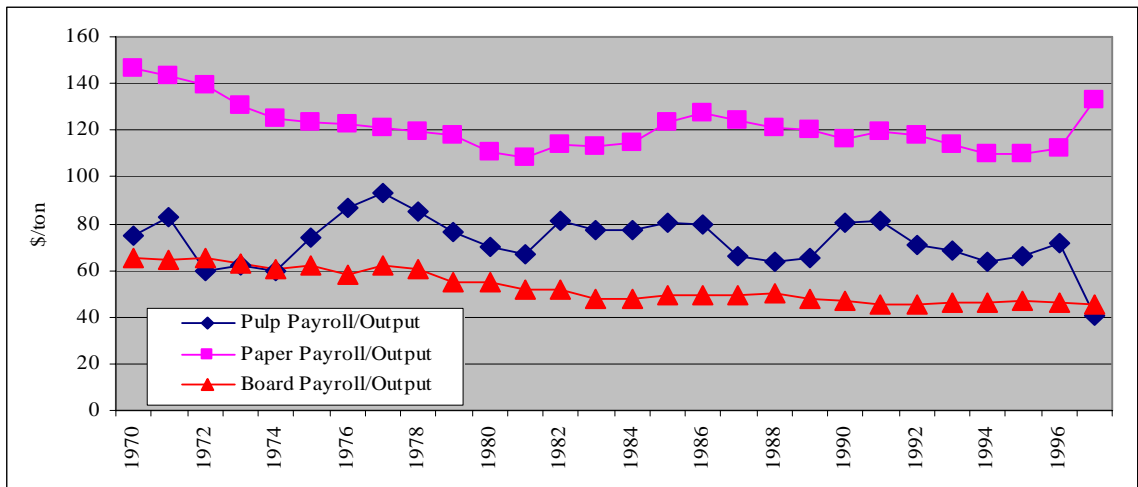


Figure 5. Payroll Per Ton of Output, 1970-1997.

### Concentration Measures

The current study utilizes two measures of industry concentration: the concentration ratio, or market share, of top four producers, CR4 from (i) the Census of Manufacturers, and from (ii) the Forest Product Laboratory (FPL) CR4. The Census Bureau publishes CR4 for each 4-digit level SIC industry once in five years. Previous studies, which focused mainly on a cross sectional analysis of large groups of industries, either conducted their tests only for the Census years, or interpolated the CR4 into annual series. In their panel,

multi-industry study, DHP (1986b) interpolate the ratio in a number of ways and conclude that the regression results do not vary depending on methods of interpolation of the ratio, and the linear method is sufficient.<sup>26</sup> Hence, we interpolate the Census CR4 using the linear method.<sup>27</sup> Finally and most importantly, the Census Bureau uses the data on value of shipments to calculate industry CR4s. In this manner, shipment information is reflected in both PCM and CR4, thereby causing potential endogeneity.

The FPL data fit the purpose to exploring the extent of potential endogeneity. The FPL is the panel data of more than 20,000 annual mill counts (for 500 mills for 30 years), collected by the Forest Products Laboratory of the US Department of Agriculture located in Madison Wisconsin. Capacity estimates by mill and process type were collected from industry directories, corporate reports, trade journal articles, and other sources.<sup>28</sup> The data contains capacity information for eight paper categories: newsprint, four writing and printing paper categories,<sup>29</sup> tissue and sanitary paper products, kraft packaging, linerboard, corrugating medium, solid bleached board, other recycled paperboard,<sup>30</sup> and market pulp that is used for papermaking. Hence, to match the Census

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<sup>26</sup> DHP (1986b, p.17) use the following interpolation methods: simple splines and nonlinear time trends. They report that "...econometric results are insensitive to the choice of interpolation..." and use the former method.

<sup>27</sup> To interpolate 5-year CR4 to annual series, missing points were estimated by calculating a line that passes through two data points,  $x_1, y_1$ , and  $x_2, y_2$ . Two points defining the line were calculated:  $m$ , the slope of the line, and  $b$ , the offset of the line as  $m = (y_2 - y_1) / (x_2 - x_1)$ , and  $b = y_2 - (x_2 * m)$  or  $y_1 - (x_1 * m)$ . Missing points were found by  $y = mx + b$  (or  $x = (y - b) / m$ ).

<sup>28</sup> For more detailed data description refer to "United States Paper, Paperboard, and Market Pulp Capacity Trends by Process and Location, 1970-2000," report compiled by the Forest Products Laboratory at Wisconsin, Madison under auspices of the USDA.

<sup>29</sup> The four major writing and printing paper categories are: coated and uncoated free sheet, and coated and uncoated groundwood. "Groundwood" is an outdated term that refers to the compositional context of a paper grade. Free sheet and groundwood have less than 10 and more than 10 percent of mechanical pulp fiber respectively.

<sup>30</sup> Kraft packaging includes only unbleached kraft and constitutes for the most part grocery bag and sack paper, shipping sack paper, and a relatively small proportion of unbleached kraft wrapping paper. Linerboard includes the grade of bleached kraft and represents outer walls of containerboard used mainly for shipping containers. Corrugating medium is an inside fluted layer of containerboard. Together linerboard and corrugating medium constitute containerboard. Finally, solid bleached board is used for

data, the eight paper categories are combined into one paper category, the four board categories into one paperboard category, and market pulp remains as it is.<sup>31</sup>

The depth and detail of the FPL data suggests at least one way in which to further investigate the issue of market power. The FPL data provides two measures of capacity concentration: (i) one, in which individual mills are aggregated according to company names, and (ii) another according to company ownership information. Specifically, in the first case the mill information is aggregated to company totals according to mill statutory names, and in the second case, company capacities are aggregated by corporate ownership.<sup>32</sup> The appropriateness of using concentration ratios based on corporate ownership rather than on individual subsidiary/division names stems from the fact that, when faced with important economic/strategic decisions, such as decisions of pricing and/or production volumes, large firms are likely to consider all of their existing resources, or capacity available in all corporate divisions and subsidiaries. Additionally, the concept of ownership is not limited to 49/51 percent stakes. In contrast, it is argued that as low as 20 percent ownership is enough for a subsidiary to be included in strategic calculations of its parent company.<sup>33</sup>

Table 2 shows the non-interpolated Census CR4s and ownership-base FPL CR4. Table 1 lists descriptive statistics for (i) interpolated Census CR4, (ii) company name-based FPL CR4, and (iii) ownership-based FPL CR4. As can be seen, there is significant

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boxboard, milk carton, and food service products such as paper cups, plates, etc. Recycled paperboard is merely the paperboard that is made solely from recycled materials.

<sup>31</sup> The following information is provided in the dataset: company name, unique mill code, mill location, and product capacities categorized by pulping process. Significant changes were executed in reference to identifying proper company names. There were numerous occasions when company names included such text extensions as “(Idle), (Idled), (Shut), etc.” as well as random misspellings. These were altered in Excel.

<sup>32</sup> For in-depth discussion on FPL data, please refer to Appendix on Data.

<sup>33</sup> Appendix on Data also includes discussion of ownership verification.

difference between Census and FPL CR4s. On average, the 3-sector Census concentration is higher than that of the FPL concentration—35.3 percent vs. roughly 32 percent respectively. Within specific industries, the two concentration measures differ to a significant degree only within the pulp sector. The average Census CR4 for pulp is almost 50 percent (Table 1), the FPL average is only 40 percent if measured by company name and 43 percent if measured by ownership. In both paper and paperboard sectors, the measures are much closer to each other (Table 1, and Figures 6 and 7).

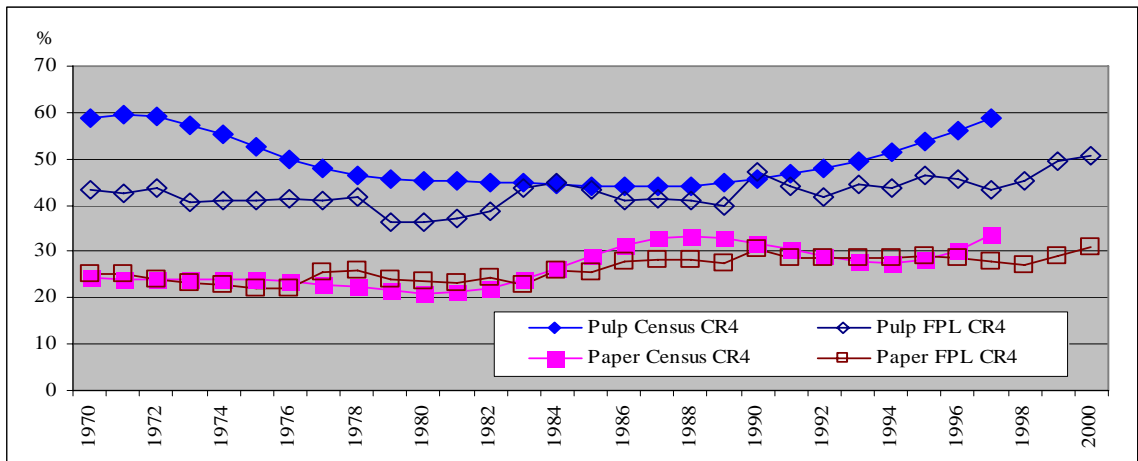


Figure 6. Census and FPL CR4s for Pulp and Paper, 1970-2000.

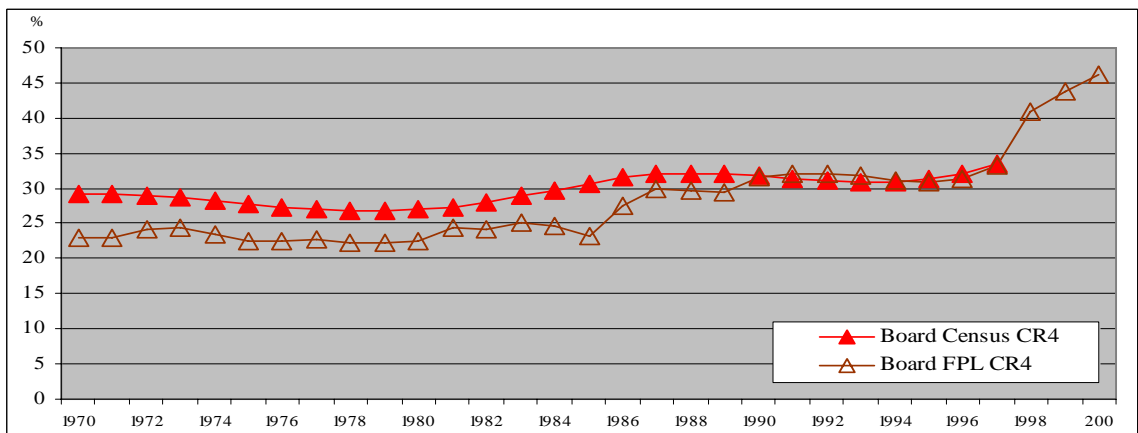


Figure 7. Census and FPL CR4s for Paperboard, 1970-2000.

Additionally, conflicting stories are told by the total percentage changes given by the Census and FPL concentration ratios (Table 1). While giving similar information on the average annual rate of growth, the two sources differ dramatically in their measures of the overall 30-year changes. For pulp mills, the Census CR4 gives 0.5 percent decrease, while the FPL CR4 increases by almost 18 % between 1970 and 2000. Similarly, paperboard industry concentration increases only 15 percent according to the Census data, and it doubles according to the FPL source. It is only in case with paper mills that the Census CR4 increases more than the FPL CR4; the increases are 39 percent for the Census data, and 23 percent for the FPL. Hence, the two data sets conflict as to the general direction of changes in industry concentration.

Finally, the FPL concentration ratios based on ownership are higher than the FPL company concentration ratios to a limited degree only. In particular, for paper and paperboard CR4s, the difference is only 4 and 6 percentage points respectively (Table 1). Hence, one can argue that the concentration ratio, differentiated by ownership, provides more accurate information on industry structure and market power than the industry concentration measures based on statutory titles of companies.

Table 2. Price-Cost Margins by Census Concentration, (1970-2000, Percentages).

Year	<u>Pulp</u>			<u>Paper</u>			<u>Paperboard</u>		
	Census CR4 I	FPL CR4 II	PCM III	Census CR4 IV	FPL CR4 V	PCM VI	Census CR4 VII	FPL CR4 VIII	PCM VI
1970		43.2	13.3		25.1	10.1		23.0	12.3
1971		42.7	10.7		25.1	9.7		23.0	12.2
1972	59.0	43.8	12.5	24.0	23.8	10.6	29.0	24.1	14.0
1973		40.6	15.4		23.1	12.6		24.4	15.6
1974		40.9	25.9		22.9	16.3		23.5	19.1
1975		40.9	26.9		22.2	16.1		22.6	20.9
1976		41.2	25.9		22.0	17.5		22.5	22.1
1977	48.0	41.1	22.3	23.0	25.4	19.1	27.0	22.7	19.8
1978		41.8	21.0		25.7	21.5		22.4	20.1
1979		36.3	27.6		24.2	24.3		22.2	21.3
1980		36.4	27.6		23.7	23.8		22.5	21.3
1981		37.2	25.5		23.2	24.8		24.4	24.1
1982	45.0	38.9	20.7	22.0	24.2	25.6	28.0	24.2	22.8
1983		43.9	22.9		23.0	26.5		25.0	24.1
1984		44.8	27.6		25.9	28.2		24.5	30.0
1985		43.3	18.0		25.5	26.9		23.3	25.1
1986		40.9	25.5		27.9	28.9		27.5	28.5
1987	44.0	41.5	40.6	33.0	28.3	32.6	32.0	29.8	36.8
1988		41.0	49.7		28.1	37.2		29.6	43.6
1989		39.8	53.9		27.3	36.4		29.5	44.2
1990		47.3	46.6		30.6	35.0		31.6	40.8
1991		44.1	35.4		28.4	32.8		31.9	37.0
1992	48.0	41.7	37.2	29.0	28.8	30.9	31.0	32.0	40.0
1993		44.3	30.1		28.6	31.2		31.8	35.8
1994		43.5	36.3		28.6	31.1		31.2	37.7
1995		46.5	52.4		29.0	42.5		30.9	47.0
1996		45.6	32.7		28.5	38.0		31.4	39.4
1997	58.6	43.5	40.0	33.6	27.9	41.4	33.6	33.2	36.1
1998		43.2	13.3		25.1	10.1		23.0	12.3
1999		42.7	10.7		25.1	9.7		23.0	12.2
2000	59.0	43.8	12.5	24.0	23.8	10.6	29.0	24.1	14.0

Additionally FPL provides us with the number of mergers for each industry. The most activity is observed in paperboard industry with the record 35 number of mergers in 1998. The least amount of merging activity was in pulp with 1.7 average annual number of mergers, vs. 9.6 among paper companies and 7.7 among paperboard companies (Table 1 and Figure 8).

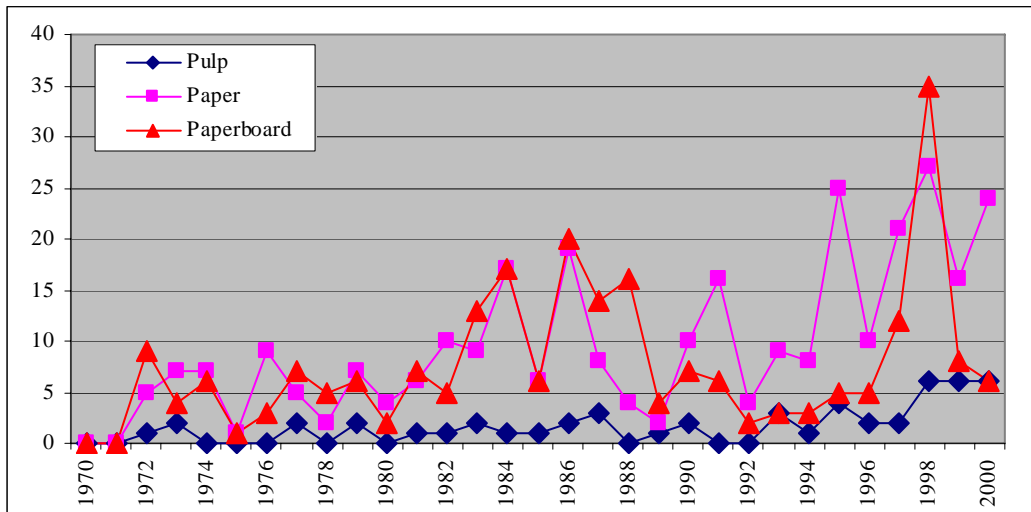


Figure 8. Number of FPL Mergers, 1970-2000.

### Capital Intensity

An often-used Census-based variable in structure-performance tests is the measure of capital intensity. Capital intensity captures the difference between capital-intensive vs. non-capital intensive industries and provide evidence if such differentiation had any effect on PCMs.<sup>34</sup> Given that the whole pulp and paper is highly capital-intensive, there

<sup>34</sup> Collins and Preston (1966, 1969), DHP (1986a, 1986b), and Salinger (1990) control for normal returns to capital measured by the Capital Intensity ratio, or value of real capital stock over output of an industry, K/Q. Such control is essential in studies encompassing all manufacturing sector to differentiate industries with varying capital structures. However, Weiss (1991) comments that if the capital intensity ratio is calculated using the Census shipment data, then potentially there is significant correlation between K/Q and CR4 as both are based on shipments. Such problem is avoided in this study. Pulp, paper, and paperboard

seems to be no rationale to include the variable in our model. The average capital intensity within the industry amounts to approximately \$730 per ton of output. The highest values are observed for pulp and paper mills with about \$960 and \$820 per ton of output respectively, and paperboard mills have the low \$415 real capital stock per output (Table 1 and Figure 9).

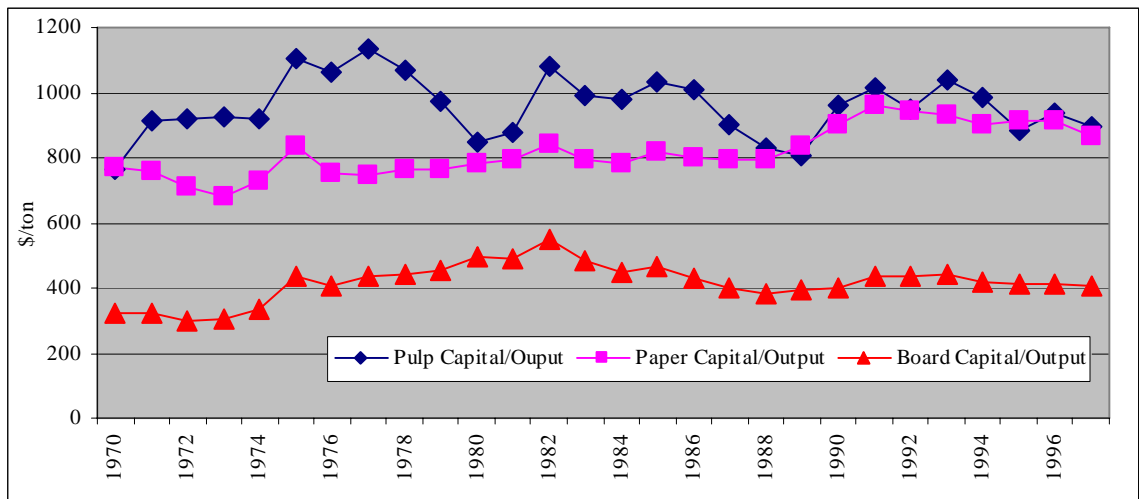


Figure 9. Capital Intensity, 1970-1997.

### Import Intensity

Increasingly, the global market for printing and writing paper needs to be considered.<sup>35</sup>

The literature treats import intensity in two ways. The first one is a simple inclusion of the import intensity ratio into the main equation as an independent variable. The second approach is to adjust concentration ratio, CR4, to import intensity, or to reduce CR4 by the share of imports. The ratio of import intensity is calculated in the following manner:

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mills have similar, highly intensive, capital requirements and there is no need to include the K/Q ratio into the basic form. In the following sections of the study we discuss environmental legislature affecting pulp and paper mills, and its effects on industry capital expenditures.

<sup>35</sup> A number of studies show that imports have had an increasing influence on industrial Census-based PCMs, and that such influence tends to be stronger in more concentrated industries. Ghosal (2000) selectively lists Katics and Petersen (1994), Pugel (1980), and Caves (1985) explicating such evidence.

$$\frac{I}{TS} = \frac{I}{(I + S)},$$

where  $I$  is annual imports,  $S$  is the value of domestic industry sales, measured by the value of shipments from the Annual Survey of Manufacturers, and  $TS$  is the sum of domestic industry sales and imports, or total industry sales. This is the form in which the ratio appears in the equation as an independent variable. The same ratio is used to adjust concentration ratio by the share of imports:

$$CR4i = CR4 * [1 - \{ \frac{I}{TS} \}],$$

where  $CR4$  is an original concentration ratio and  $CR4i$  is the adjusted concentration ratio.<sup>36</sup> The value of imports for the three sectors is taken from the annual compilation of Statistics of Paper, Paperboard and Woodpulp, published by AFPA (earlier as American Paper Institute).<sup>37</sup>

The total printing and writing paper imports have increased dramatically from 293.7 thousand tons in 1970, to 941.3 thousand tons in 1980, to 3,750.7 thousand tons in 1990, and finally to 7,908.7 thousand tons in 2000. Proportionately to total printing and writing paper production, imports grew from 11 percent in 1984 to 24 percent in 2000. Despite these dramatic increases in import of paper products, market pulp remains with the highest ratio of import penetration ranging from the lowest 28 percent in 1992 to

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<sup>36</sup> Salinger (1990) suggests that import intensity variable causes endogeneity in the basic functional form. Because import intensity is measured by imports and domestic shipments, the current value of both may be correlated with current business cycle, and especially the current domestic shipments are correlated with the dependent variable PCM, which causes endogeneity. To address this problem we use one-year lagged term of the import intensity ratio in both cases. Hence, the two measures become:  $\frac{I}{TS}_{t-1} = \frac{I}{(I + S)}_{t-1}$ ,

and  $CR4i_{t-1} = CR4_t * [1 - \{ \frac{I}{TS} \}_{t-1}]$ .

<sup>37</sup> The AFPA extracts the data from the Bureau of Census for December of each year and recompiles it to the Census production groups.

nearly 45 percent once in 1973 and second time in 1997.<sup>38</sup> The mean value of import-to-sales, or import intensity, ratio for pulp is 34.7 percent for the period of 1970 to 1997. In contrast for paper and paperboard the mean ratios are 15.4 and 1.1 percent (Table 1 and Figure 10). Yet, it is important to remember that market pulp comprises only about 15 percent of total US pulp production, and about half of it is exported.<sup>39</sup>

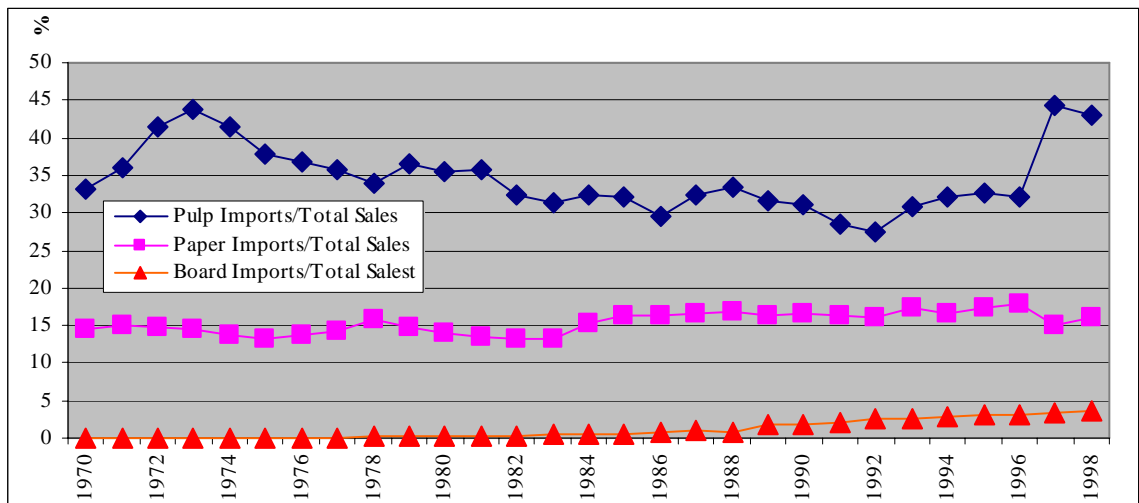


Figure 10. Import Intensity, 1970-1998.

### Unemployment Rate and Cyclicality of Margins

DHP (1988) use aggregate capacity utilization in manufacturing to proxy effects of exogenous changes in aggregate demand on margins. Additionally, they interact the capacity utilization term with the concentration ratio to allow the cyclical effect to vary with industry concentration. Bils (1987) and DHP (1986a, 1986b) use the aggregate

<sup>38</sup> According to the North American Fact Book on Pulp and Paper (NAFB), in 1998 over 5 million tons were imported to the US, 87 percent of which came from Canada. The rest of the imports came from Brazil, Chile, Finland, New Zealand, Portugal, Spain and Sweden.

<sup>39</sup> For more detailed capacity trends refer to “United States Paper, Paperboard, and Market Pulp Capacity Trends by Process and Location, 1970-2000,” report compiled by the Forest Products Laboratory at Wisconsin, Madison under auspices of the USDA.

unemployment rate as a measure of cyclical activity in their studies of intertemporal behavior of margins. Following their study we use the unemployment rate to capture cyclical activity in price margins.<sup>40</sup> According to the unemployment rate fluctuations, the 1970's have seen two periods of economic downturn (1973, 1975), and the 1980's (1982) and the 1990's (1992) have seen one recession each (Figure 11).

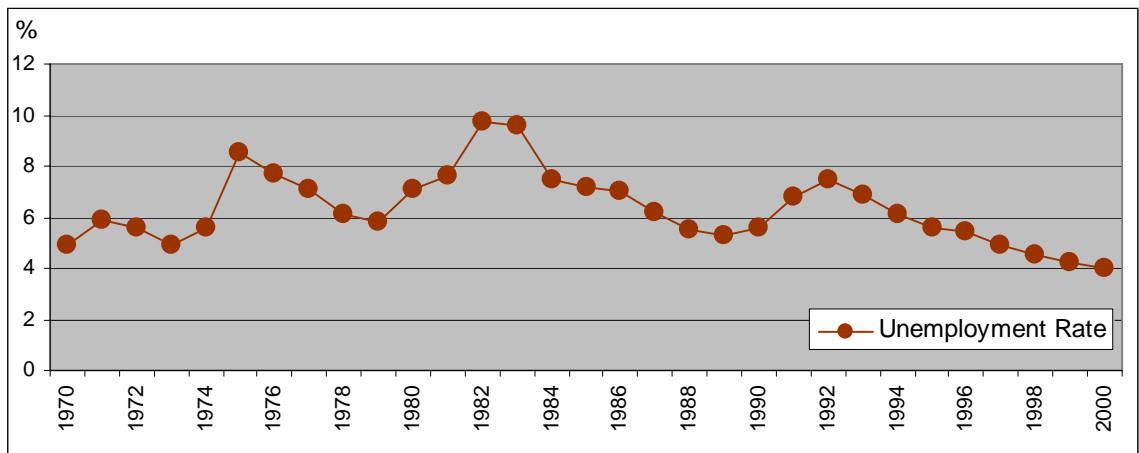


Figure 11. Aggregate Unemployment Rate, 1970-2000.

### Environmental Expenditures

The pulp and paper industry is one of the most environmentally heavily regulated industries. The first environmental acts have been introduced during late 1960's early 1970's. The main laws affecting the paper and pulp industry are regulations concerning air and water pollution, and the disposal of solid wastes. The Clean Air Act (Air Quality Act of 1967, CAA) requires paper and pulp companies to install the best available technology in its attempt to preserve and not to harm the quality of air resources. Such technology is referred to as the maximum achievable control technology (MACT).

<sup>40</sup> The unemployment rate is taken from the Current Population Survey published by the BLS. The rate measures the ratio of unemployed to civilian labor force consisting of persons of 16 years and older.

Under the Clean Water Act (Federal Water Pollution Control Act Amendments of 1972) mills are required to control and limit the amounts of pollutants discharged in waters.<sup>41</sup> The controls should be technology-based and employ the best available technology (BAT). Years 1973 and 1974 have seen the CAA amendments and Safe Drinking Water Act respectively. In our analysis, 1973 is the year during and after which we expect to see the effect of these amendments in the industry. The dummy variable, CWAA, reflects Clean Water and Air Acts of 1972-1974.

The third main component of the environmental regulations affecting the industry is the Solid Waste Disposal Act of 1980 (Resource Conservation and Recovery Act) has the most effect on day-to-day operations of paper and pulp mills (the original Solid Waste Disposal Act was enacted in 1965). Finally, the Cluster Rule is designed to put together Water and Air regulations and provide for a consistent, non-exclusionary body of rules. The regulations are staged in three phases with different deadlines. Mills are expected to install the maximum achievable control technology (MACT), that would cost the industry about \$1.8 billion, according to the Environmental Protection Agency. In contrast, the American Forest and Paper Association (AFPA) estimates that the costs will be up to \$2.6 billion plus the operating costs of \$273 million.<sup>42</sup>

Historically, the environmental legislature has had a profound effect on the paper and pulp companies. The total paper and pulp industry capital expenditures for environmental purposes have been highly unstable with steep increases in the years of an active legislature as well as a few years after the legislative changes. The periods of

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<sup>41</sup> All paper and pulp mills are subject to air and water regulations. Hence, the specific pulping processes subject to the environmental regulation are not listed.

<sup>42</sup> For more detailed discussion of environmental legislation and its effect on pulp and paper industry refer to North American Factbook.

environmental compliance are: 1970-1975, 1986-1991, and in 1995 there is a reversal towards further capital increases. From 1993 to 1997 the Environmental Protection Agency has worked to enact the new Cluster Rule that is considered to have the most serious impact on the pulp and paper industry in general (Table 1 and Figure 12).

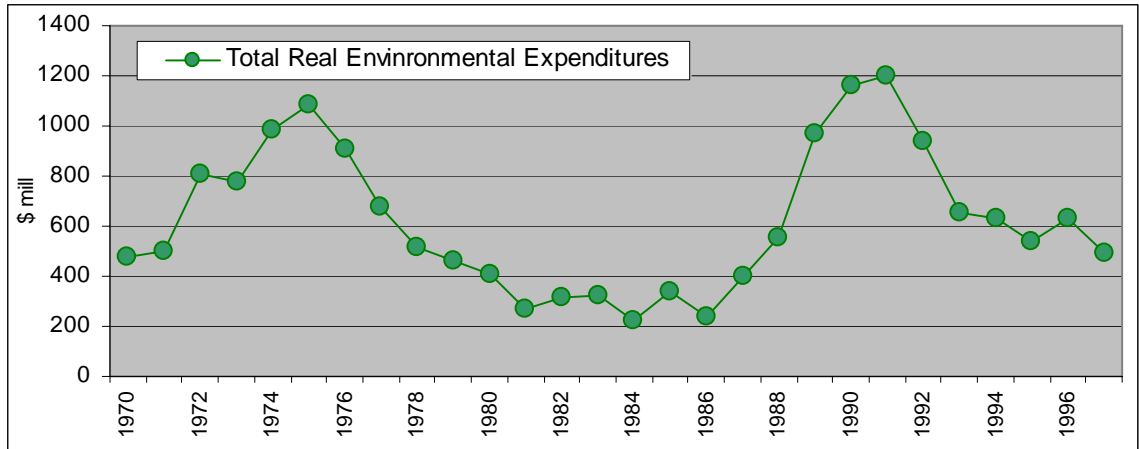


Figure 12. Total Environmental Expenditures, 1970-1997.

## Estimation Results

The discussion of estimation results is divided into: (i) estimating biases inherent in the output-based Census CR4 (Table 3), and (ii) cyclical fluctuations in PCMs (Tables 4 and 5). The models use 84 observations covering 1970-1997 period.

Table 3. OLS and IV Results: Census CR4 Vs. FPL CR4.

Column	I OLS	II OLS	III 2SLS Instrumental Variable: FPL CR4
Census CR4	0.28 (3.10)		0.47 (3.75)
FPL CR4		0.52 (4.09)	
FPL CR4 Import Adjusted			
Import Intensity	-0.14 (-1.99)	-0.21 (-3.22)	-0.26 (-2.83)
Environmental Expenditures	0.79 (4.11)	0.76 (3.94)	0.76 (3.32)
Constant Term	18.11 (7.73)	12.88 (4.44)	13.58 (3.96)
Sample Size	84	84	84
F-value	7.71	10.73	9.40
Adjusted R-sq.	0.20	0.26	0.23

Notes

1. Corresponding t-values are included in parentheses and are obtained through the White procedure.
2. In column III, Census CR4 is used as a regressor and FPL CR4 is used as an instrument.

Table 3 presents results for OLS, IV, and FE estimations comparing the Census and FPL CR4. The four models are consistent with the hypothesis of positive effect of industry concentration on price-cost margins. The best fit is provided by the models using the FPL CR4 (Columns II-IV, Table 3). Pooled OLS results using the Census CR4

(Column I, Table 3) suggest that in all three industry sectors an increase in one percent of shipments share of the top four firms increases industry PCMs by 0.28 percent. In contrast, an increase in one percent of capacity share of the top four firms offers an increase of 0.52 percent in industry PCMs (Column II, Table 3). Both coefficients are statistically significant—3.10 t-value for Census CR4 and 4.09 t-value for FPL CR4.<sup>43</sup>

As discussed previously, the current functional form using the Census CR4 may contain considerable endogeneity bias. 0.24 percent difference between the two estimated coefficients is preliminarily consistent with the endogeneity hypothesis. In addition, the interpolated Census CR4 may suffer from measurement errors, which may underestimate the true effect of concentration on the PCMs. To determine the extent of the biases, it is useful to instrument Census CR4 with the FPL CR4.<sup>44</sup> The coefficient of the instrumented Census CR4 increases to 0.47, with the t-value of 3.75. This is consistent with the hypothesis that the Census CR4 suffers from considerable measurement errors. Hence, in our further tests we use only the FPL CR4.

Import-adjusted FPL CR4 produces the highest coefficient of effect of concentration on the PCMs—0.79 implying that an increase in one percent of domestic capacity concentration adjusted to foreign competition produces 0.79 percent increase in the PCMs. Further, the negative sign of the lagged import intensity coefficients and their high statistical significance suggests that an increase in imports will decrease industry PCMs.

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<sup>43</sup> T-values are heteroskedasticity-autocorrelation (HAC) robust t-values and are obtained through White procedure.

<sup>44</sup> The initial stage of determining measurement error is to run an OLS with the average of the two concentration ratios—Census and FPL. The OLS coefficient for the average CR4 is 0.41 with the HAC t-value of 3.84, which confirms the hypothesis of significant measurement error in the Census data.

Environmental expenditures have positive and significant effect on industry PCMs both economically and statistically. On average, an increase in one hundred million of real dollars will increase industry PCMs by 0.76 percent (Table 3).

Finally, inter-industry differences are captured by the fixed effects model that uses import-adjusted capacity-based CR4 (Column IV, Table 3). As compared to the paperboard sector of the industry, the average PCMs are lower in pulp and higher in paper. However, the differences are statistically insignificant.

Imports intensity appears to be highly correlated with fixed effects because the fluctuations of the import intensity are small—on average negative 0.20 percent (Columns I, II, and III in Table 4). Hence, in FE models we use import-adjusted CR4 (Column 2, Table 4). The best fit is found in the FE model (Column III, Table 4). The results are consistent with the previously discussed OLS models.

The CR4 and environmental expenditures have strong positive and statistically significant effect—0.79 (with 4.026 t-value) and 0.74 (with 3.61 t-value) for CR4 and environmental expenditures respectively. In addition, the fixed effects do not seem to be significant. While on average pulp PCMs are smaller and paper PCMs are higher than paperboard PCMs, overall average PCMs for all industry are increasing.

Table 4. OLS, FE, and IV results: FPL CR4.

Column Variable	I OLS	II OLS	III FE	IV 2SLS	V 2SLS
FPL CR4		0.91 (5.38)		0.51 (3.53)	0.50 (3.47)
FPL CR4 Import Adjusted	0.79 (4.026)		1.12 (6.29)		
Import Intensity		-0.089 (-1.32)		-0.20 (-2.50)	-0.20 (-2.45)
Environmental Expenditures	0.74 (3.61)	0.67 (3.34)	0.70 (3.59)	0.76 (3.45)	0.76 (3.45)
FPL CR4 * Pulp		-0.24 (-2.83)	-0.98 (-2.12)		
Pulp Dummy	-0.38 (-0.23)		26.40 (2.13)		
Paper Dummy	0.72 (0.59)		2.16 (2.04)		
Constant Term	5.71 (1.26)	2.49 (0.65)	-2.73 (-0.64)	13.18 (3.57)	13.38 (3.63)
Sample Size	84	84	84	84	84
F-value	8.97	9.78	8.55	9.19	9.05
Adjusted R-sq.	0.28	0.30	0.31		
OverID Test					F-val: 6.29 Pr: 0.014

Notes

1. Corresponding t-values are included in parentheses and are obtained through the White procedure.
2. In Column IV, FPL CR4 is used as a regressor and lagged FPL CR4 is used as an instrument.
3. In Column V, FPL CR4 is used as a regressor and lagged FPL CR4 and lagged number of mergers are used as instruments.

Given especially high import intensity in pulp, we want to see whether the effect of the CR4 on PCM would be smaller in pulp. Interaction of CR4 and pulp dummy is consistent with this hypothesis (Columns II, and III in Table 4). In order to check the possibility of endogeneity of CR4, although it is unlikely given the long-term nature of investment in the pulp and paper industry, we use IV estimation using different instruments (Columns IV and V, Table 4). In the first model the instrumental variable is one-year lag of the CR4, and in the second model the instruments are: (i) lagged term of the CR4, and one-year lag of number of mergers. The results are close to the OLS estimates, indicating that endogeneity is not a problem. Additionally, the overidentification test strongly rejects the null hypothesis that the instruments are valid (F-value=6.29, Pr=0.014).

Table 5 presents tests of cyclicity of the PCMs. The models include variables of current and leading unemployment and their interaction with the CR4. The aggregate national unemployment rate is used as proxy for business cycles. The hypothesis is that during the periods of expansion, or decreasing unemployment, industry PCMs should increase. Likewise, during recessions, or increasing unemployment, PCMs decrease. Interaction of unemployment with the CR4 hypothesizes whether effects of concentration change during business cycles. The best fit is provided by the FE models and models using current unemployment rate.

Table 5. OLS and FE Results: FPL CR4.

Column Variable	I OLS	II OLS	III FE	IV OLS	V OLS
FPL CR4	1.11 (2.84)	0.57 (1.17)		0.79 (5.18)	0.66 (4.39)
FPL CR4 Import Adjusted			2.65 (3.32)		
Import Intensity	-0.18 (-2.88)	-0.17 (-2.38)		-0.18 (-2.92)	-0.16 (-2.39)
Environmental Expenditures	0.62 (3.44)	0.75 (4.033)	0.60 (3.18)	0.61 (3.43)	0.76 (4.14)
Current Unemployment	1.56 (1.037)		6.21 (2.24)		
Leading Unemployment		-0.46 (-0.23)			
Current Unemployment * FPL CR4	-0.097 (-1.83)		-0.31 (-2.65)	-0.050 (-3.51)	
Leading Unemployment * FPL CR4		-0.021 (-0.30)			-0.035 (-2.21)
Pulp Dummy			0.13 (0.081)		
Paper Dummy			0.13 (0.12)		
Constant Term	4.64 (0.42)	18.0011 (1.28)	-29.93 (-1.58)	15.052 (5.42)	14.93 (5.044)
Sample Size	84	84	84	84	84
F-value	9.95	7.80	9.52	12.26	9.85
Adjusted R-sq.	0.35	0.29	0.38	0.35	0.30

Notes

1. Corresponding t-values are included in parentheses and are obtained through the White procedure.

The coefficient of current unemployment has positive effect on price-cost margins (Column I, Table 5). This suggests that an increase in the unemployment rate by one percent increases the industry PCMs by 1.56 percent. Yet, the negative coefficient of the interacted CR4 with the current unemployment is consistent with the hypothesis that during the periods of increasing unemployment, the effects of concentration on the PCMs are lower. Column II in Table 5 presents the results of using leading, or one-step ahead, unemployment rate, and they are more consistent with the hypothesis of pro-cyclical margins. Leading unemployment and its interaction with the CR4 give negative, although statistically insignificant effect

Low economic significance of the unemployment terms may be caused by multicollinearity. Columns IV and V in Table 5 provide results that use the unemployment rate interacted with the CR4 only. The results are consistent with the hypothesis that when unemployment is high, the CR4 effects on PCM are lower—both coefficients are negative and statistically significant. This is consistent with DHP (1986b) findings of positive effect of the unemployment rate and negative effects of its interaction with the CR4.

## Conclusion

The main finding of the study is that in the pulp and paper industry capacity concentration tends to increase industry PCMs. The study shows that the interpolated Census CR4 suffers from considerable measurement errors. The CR4 coefficients using the annual capacity-based shares are higher than the CR4 estimates using the Census shipment data. In addition, industry-specific environmental regulations have statistical and economic positive and significant effects on the PCMs. Likewise, the PCMs are procyclical, or increasing during the periods of economic expansion, and decreasing during the periods of economic recession. Finally, increasing import competition decreases the ability of firms to increase their operating profits.

Among the policy implications of this study are that industry concentration measured by capacity distribution, vs. output distribution, provides a different picture of the firm behavior and industry performance. For the period of 1970 to 1997, capacity consolidation in the pulp and paper industry had an increasing effect upon the industry operating profits, all else equal. Additionally, pulp and paper firms' ability to generate higher operating profits is affected by: (i) environmental regulations, (ii) import competition, and (iii) general economic conditions. Environmental regulations have the strongest impact, and general economic conditions—the weakest.

## **Appendix on Data**

### **A. Census CR4 Interpolation**

#### **Linear Interpolation (Using Excel):**

Census of Manufacturers publishes the concentration ratio of top four industry producers only once every 5 years. To interpolate CR4 to annual series missing points were calculated by calculating a line that passes through two data points,  $x_1, y_1$ , and  $x_2, y_2$ . Two points defining the line were calculated:  $m$ , the slope of the line, and  $b$ , the offset of the line as  $m = (y_2 - y_1) / (x_2 - x_1)$ , and  $b = y_2 - (x_2 * m)$  or  $y_1 - (x_1 * m)$ . Missing points were found by  $y = mx + b$  (or  $x = (y - b) / m$ ).

### **B. Selective Census Definitions**

#### **Value Added**

This measure of manufacturing activity is derived by subtracting the cost of materials, supplied, containers, fuel, purchased electricity, and contract work from the value of shipments (products manufactured plus receipts for services rendered). The result of this calculation is adjusted by the addition of value added by merchandising operations (difference between the sales value and the cost of merchandise sold without further manufacture, processing, or assembly) plus the net change in finished goods and work-in-process between the beginning- and end-of-year inventories.

For those industries where the value of production is collected instead of value of shipments, value added is adjusted only for the change in work-in-process inventories between the beginning and end of year. For those industries where value of work done is collected, the value added does not include an adjustment for the change in finished goods or work-in-process inventories.

“Value added” avoids the duplication in the figure for value of shipments that results from the use of products of some establishments as materials by others. Value added is considered to be the best measure available for comparing the relative economic importance of manufacturing among industries and geographic areas.

### **Value of Shipments**

This item covers the received or receivable net selling values, f.o.b. plant (exclusive of freight and taxes), of all products shipped, both primary and secondary, as well as all miscellaneous receipts, such as receipts for contract work performed for others, installation and repair, sales of scrap, and sales of products bought and sold without further processing. Included are all items made by or for the establishments from material owned by it, whether sold, transferred to other plants of the same company, or shipped on consignment. The net selling value of products made in one plant on a contract basis from materials owned by another was reported by the plant providing the materials.

In case of multiplant companies, the manufacturer was requested to report the value of products transferred to other establishments of the same company at full economic or commercial value, including not only the direct cost of production but also a reasonable proportion of “all other costs” (including company overhead) and profit.

In addition to the value for SIC/NAICS defined products, aggregates of the following categories of miscellaneous receipts are reported as part of a total establishment’s value of shipments:

- Reported contract work—Receipts for work or services that a plant performed for others on their materials.

- Value of resales—Sales of products brought and sold without further manufacture, processing, or assembly.
- Other miscellaneous receipts—Such as repair work, installation, sales of scrap, etc.

Industry primary product value of shipments represents one of three components of value of shipments. These are:

- Primary products value of shipments.
- Secondary product value of shipments.
- Total miscellaneous receipts.

### **Cost of Materials**

This term refers to direct charges actually paid or payable for items consumed or put into production during the year, including freight charges and other direct charges incurred by the establishment in acquiring these materials. It includes the cost of materials or fuel consumed, whether purchased by individual establishment from other companies, transferred to it from other establishment of the same company, or withdrawn from inventory during the year.

Included in this item are:

- Cost of parts, components, containers, etc. Includes raw materials, semifinished goods, parts, containers, scrap, and supplies put into production or used as operating supplies and for repair and maintenance during the year.
- Cost of products bought and sold without further processing.
- Cost of fuels consumed for heat and power. Includes the cost of fuel consumed, whether purchased by the individual establishment from other companies,

transferred to it from other establishments of the same company, or withdrawn from inventory during the year.

- Cost of purchased electricity. The cost of purchased electric energy represents the amount actually used during the year for heat and power. In addition, information was collected on the quantity of electric energy generated by the establishment and the quantity of electric energy sold or transferred to other parts of the same company.
- Cost of contract work. This term applies to work done by others on materials furnished by the manufacturing establishment. The actual cost of material was reported on the cost of materials, parts, and containers line of this item. The term “Contract Work” refers to the fee a company pays to another company to perform a service.

### **Payroll**

This item includes the gross earnings of all employees on the payrolls of operating manufacturing establishments paid in the calendar year. Respondents were told they could follow the definition of payrolls used for calculating the Federal withholding tax. In includes all forms of compensation, such as salaries, wages, commission, dismissal pay, bonuses, vacation and sick leave pay, and compensation in kind, prior to such deductions as employees’ social security contributions, withholding taxes, group insurance, union dues, and savings bonds.

### **C. The FPL Data and Its Treatment**

The panel data of more than 20,000 annual mill counts (for 500 mills over 30 years) was collected by the Forest Products Laboratory of the US Department of Agriculture located

in Madison Wisconsin. Capacity estimates by mill and process type were collected from industry directories, corporate reports, trade journal articles, and other sources.<sup>45</sup> The FPL data is unique in a number of ways.

In order to understand the value of this data, it is necessary to consider all other existing and potentially available information on pulp and paper industry. The existing industry data are of two kinds. The first kind provides capacity, or any other indicator, for individual firms. Therefore, the smallest unit of analysis is a company, not an individual mill or plant. While useful, consolidated company information is ridden with problems of product and regional market differentiation. For example, a number of industry-specific publications, such as North American Factbook, Pulp & Paper, Paper and Pulp Week, and Official Board Markets, present financial figures for top corporations, but they do not differentiate between their pulp, paper, or paperboard operations, not to mention various paper and paperboard grades. In terms of coverage of various geographic markets, industry-specific sources can present regional information, yet again the data will be aggregated at regional levels omitting detailed mill-company information.

The second kind of information successfully segregates various pulp, paper, and paperboard grades, but provides such data only at an industry level, amassing all US companies together. This is more commonly available in various government agencies such as Bureau of Labor Statistics, Census Bureau, and Standards & Poor Register of Corporations. Government indices usually allow for high-frequency time series analysis,

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<sup>45</sup> For more detailed data description refer to “United States Paper, Paperboard, and Market Pulp Capacity Trends by Process and Location, 1970-2000,” report compiled by the Forest Products Laboratory at Wisconsin, Madison under auspices of the USDA.

but only at the national level. Neither of the two types of information provides product-mill-city-state data.

Potentially, there is a third source of data with detailed production and financial information that can be classified by products, plants, companies, and various regional units. Such data is believed to exist within private entities such as business consulting firms. While such data are potentially a lot more complete and sophisticated than the FPL data, unlike the FPL, they remain private and not available to general public.

Given the above-mentioned shortcomings of other industry data sources, there is one more aspect of the FPL data that requires attention. While expansive and detailed, the FPL data is also accurate. The authors/compiler of the data compare the FPL annual capacity figures with those maintained by the leading industry trade organization, American Forest and Paper Association (AF&PA). In doing so, they present the difference between FPL's and AF&PA's aggregated capacities for paper, paperboard, market pulp as well as their total.<sup>46</sup> According to them, the largest discrepancy in total capacities for the whole industry is noted for 1988 of only 2.9 percent, while for market pulp, paper, and paperboard industries individually, the differences are rarely more than 5 percent.

In summary, the FPL data provides information at the mill level and enables us to distinguish capacity according to various pulping processes. This, in turn, allows for data manipulation at various levels: mill, company, state, and region, all of which can be reported for various groupings of products: single grades, commodity categories (for example, according to the Standard Industrial Classification, SIC), and total capacities.

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<sup>46</sup> The AF&PA's mill data is not publicly available, which precludes comparison of the two data sets in greater detail.

In terms of grade distribution, the FPL data contains capacity information for eight paper categories: newsprint, four writing and printing paper categories,<sup>47</sup> tissue and sanitary paper products, kraft packaging, linerboard, corrugating medium, solid bleached board, other recycled paperboard,<sup>48</sup> and market pulp. Finally, technical description of the data can be briefed to the following fields: company name, unique mill code, mill location (postal code, city, state, region), and product capacities categorized by pulping process as well as their totals. There are over 20,000 observations, with capacity estimates for each mill for a 30-year period.

Despite our assurance in the accuracy of total FPL capacities, we believe that comparison of the FPL and AF&PA data sets at the national aggregated level does not guarantee the accuracy at a company level. The correctness of estimates for the total capacities lets us infer that tonnage is accurately recorded at the level of individual mills. Additionally, geographic information is expected to be correct. The only potentially serious problem may arise when one needs to present capacity information for corporations in their statutory title and ownership. This becomes the focus of our data discussion and its improvement.

The current study uses the FPL data for calculating individual company capacities—summing up capacities of individual mills by types of pulping processes or

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<sup>47</sup> The four major writing and printing paper categories are: coated and uncoated free sheet, and coated and uncoated groundwood. “Groundwood” is an outdated term that refers to the compositional context of a paper grade. Free sheet and groundwood have less than 10 and more than 10 percent of mechanical pulp fiber respectively.

<sup>48</sup> Kraft packaging includes only unbleached kraft and constitutes for the most part grocery bag and sack paper, shipping sack paper, and a relatively small proportion of unbleached kraft wrapping paper. Linerboard includes the grade of bleached kraft and represents outer walls of containerboard used mainly for shipping containers. Corrugating medium is an inside fluted layer of containerboard. Together linerboard and corrugating medium constitute containerboard. Finally, solid bleached board is used for boxboard, milk carton, and food service products such as paper cups, plates, etc. Recycled paperboard is merely the paperboard that is made solely from recycled materials.

grades. Once company capacities are identified, they are used to calculate measures of industry or market concentration—concentration ratios. To properly appraise the resultant FPL concentration ratios, we first need to examine data on industry structure available elsewhere.

Using publicly available references, we have identified two sources of information on industry structure. The first is the concentration ratio of top four industry producers (CR4), based on total shipments, published by the Census Bureau every five years. The CR4's are assembled by major commodity groups according to the Standard Industrial Classification (SIC) codes: pulp (SIC 2611), paper (SIC 2621), and paperboard (SIC 2631). The series present two aspects that can undermine reliability of empirical results. The first concerns the infrequent nature of five-year intervals. Previously this problem has been managed by interpolation. The second drawback of the Census data is the level of product aggregation—we can not examine the concentration-margins effects across individual grades.

The second public source of concentration ratios is a monthly industry trade journal, Pulp and Paper (P&P), which publishes CR5 and CR10, or concentration of top five and ten producers respectively, as well as top capacity company rankings and total market capacities for individual paper and paperboard grades. Unlike the Census CR4 however, Pulp & Paper capacity data (1) do not provide information for aggregated industry groups (pulp, paper, and paperboard), and (2) alternate the US and North-American markets for different grades.<sup>49</sup> Therefore, the CR4s that are calculated using P&P capacities, are still incompatible with the Census CR4s.

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<sup>49</sup> In the P&P, total capacity of each of the thirteen product grades covers different markets. Specifically, total capacity for all board grades (liner, recycled, bleached boards, and corrugating medium) are given for

Given these characteristics of the available data sources, the main criteria, by which we compare the data are: (1) periodicity, (2) grade distribution or level of product aggregation, and (3) geographic market coverage. According to these criteria, the concentration ratios from the Census of Manufacturers (Census CRs) are published once every five years for three US industry segments—pulp, paper, and paperboard. Concentration ratios calculated using P&P capacity (P&P CRs) information are annual, covering both US and Canadian markets for disaggregated product groups—market pulp, eight paper grades, and four board grades. Finally, the FPL ratios (FPL CRs) offer annual US data for both aggregated and disaggregated product groups, which ensures adequate comparison between (1) the FPL and Census, and (2) FPL and P&P concentration ratios.

For the purposes of our empirical examination, we are interested in computing capacity concentration ratios for individual grades as well as for commodity groups, which coincide with the SIC codes. Accurate measures of industry concentration rely on company information and, in our case, on mill ownership. Since in the FPL every mill is assigned its unique number, computing concentration ratios, according to various grades and/or regions, does not present a problem. Accordingly, one would expect that the field

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the US market only. Market pulp, newsprint, uncoated groundwood and freesheet, coated freesheet, and specialty and packaging paper have only North-American total capacity. Only tissue, coated groundwood, and kraft paper have both US and North-American capacity totals. To verify CR5 and CR10 published in the P&P, we have used the capacity rankings and total capacity figures to recalculate CR5 and CR10. The two sets of concentration ratios, published and estimated, are slightly divergent in those cases when total capacities are published for both North-American and US markets. For example, for tissue market of 1998 the published CR5 is 0.72, while the CR5, estimated using the US total capacity is 0.80 and North-American is 0.75. Similarly, for coated groundwood the published CR5 for 2000 is 0.75, and the estimated CR5 is 0.88 for the US market and 0.72 for North-American. Therefore, in these two cases, the CR5s are calculated using North-American capacities. At the same time, the P&P CR5s for all board grades are accurately estimated using the US capacity. In summary, for nine of the thirteen P&P product categories we have CR5s that are based on the North-American market and four on US capacity.

“Company,” should contain unique company identification. While in most cases this is true, we find that the “Company” field may contain some inaccuracies.

There are three main scenarios, in which the FPL’s company identification might be problematic. The first is the situation when, instead of the statutory corporate name, the mill carries its local or division name. For example, the FPL data lists an Erie mill in Pennsylvania under its local name “Hammermill” through 1970-2000. However, in the 1990’s both Lockwood and NAFB<sup>50</sup> identify the mill as International Paper. The exact Lockwood print shows: “International Paper Co. Hammermill Papers, Erie Plant.” Therein, Lockwood identifies that this is the same mill, Hammermill, but it had been acquired by International Paper in 1986. Consequently, this seemingly unimportant misstatement results in an understated capacity for International Paper from 1986 to 2000 as well as understated industry concentration measures.

The second arrangement, under which company capacities might be misstated, is when a company, while going through some sort of restructuring, changes its name. This can happen whether it acquires more mills, or just reincorporates under a different name. An example of this situation can be demonstrated by Specialty Paperboard Inc., which in 1997 incorporates as FiberMark Inc., while acquiring Custom Paper Group. In such

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<sup>50</sup> There are three main sources used to identify mill/company names and ownership. The first one is the Pulp & Paper’s annual almanac, North American Factbook (NAFB), which provides a list of major acquisitions in pulp and paper industry. The second is Lockwood-Post’s Directory of the Pulp, Paper, and Allied Trades (Lockwood). Lockwood provides with (1) an alphabetical company listing with all subsidiaries and divisions; (2) geographical listings of mills by state and city; and (3) starting with 1995, it also provides the list of “Recent Mergers and Acquisitions,” a much more detailed record than in the NAFB. Both NAFB and Lockwood are published by Miller Freeman Publications Inc. In both mergers lists, NAFB and Lockwood, acquisitions of the 1970’s are hardly reported. Finally, the third source of our data is Phillips Paper Trade Directory, Mills of the World (Phillips), published by Benn Business Information Services Limited (member of Association of British Directory Publishers, and European Association of Directory Publishers).

situations, although FiberMark's capacity (assets) will increase substantially during that year, its headquarters, key managers and owners, can remain the same.

The last and most contentious is a case of interlocking corporate ownership arrangements. The most common situation is when a larger company acquires majority voting stock in a smaller company, thereby becoming its main shareholder. Such companies are listed as **subsidiaries**, whose majority shares are owned by **holding** companies. Additionally, there are **wholly-owned subsidiaries**, under full control of a parent company, and **affiliates**, or companies for which only minority voting stock is owned by holding companies. The example of Western Kraft Corporation (or Western Kraft Paper Group) illustrates the situation where a bigger company owns majority voting stock for another company for a number of years. Western Kraft is listed in the FPL as a stand-alone company until 1982. Yet, the Phillips Paper Trade Directory (Phillips) directory of 1977-1981 lists each of four "Western Kraft Paper Group" mills as a "subsidiary of Willamette Industries Inc.," and company web-pages on its history indicate that Western Kraft was opened as a subsidiary of Willamette in 1955.<sup>51</sup> Additionally, there are some cases of double, or two-tiered, ownership. In such arrangements, usually a big conglomerate holds interest in smaller firms through mid-sized companies. It would not be an overstatement to say that concentration ratios, based on actual holding interests of parent companies, might provide a much more interesting view.<sup>52</sup>

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<sup>51</sup> The FPL lists four Western Kraft Group mill locations for 1977-1981: Port Hueneme, CA, one pulp and one paperboard mills at Hawesville, KY, Campti, LA, and Albany, OR. Phillips 1977-1981 lists the four locations, yet for Hawesville, KY, it lists only the pulp mill. On-line information on the history of Willamette industries also indicates that the first mill of Western Kraft was opened as a subsidiary of Willamette in 1955 in Albany, OR; available at: <http://www.wii.com/history.htm>.

<sup>52</sup> There are a number of other less frequent problems with the data: missing mills, double counting (two cases only), inaccurate company information (simply incorrect), and consistently lagging years of 1990's acquisitions.

In terms of reflecting effective years of ownership transfers, the general trend in the FPL is that in the 1970's and 1980's the years of mergers and acquisitions are reported accurately, or in accordance with the NAFB merger listing. Yet, for the 1990's, it is found that changes in ownership lag 1-3 years. An illustrative example is given by the merger of Jefferson Smurfit and Stone Container in 1998. In the FPL, the merger is reported for 2000, and top industry capacities, calculated using the original FPL data, contain all three company titles: the merged Smurfit-Stone Container, and individual Jefferson Smurfit and Stone Container, with all three appearing among the top ten paperboard capacities.<sup>53</sup> To correct for this we change years of mergers, where necessary, as they appear in the NAFB. An additional incentive to use years of ownership changes as closely to the announcement date as possible, assuming that the NAFB provides such information, is the potential to capture market anticipation of price changes.<sup>54</sup>

Although costly, accurate depiction of company names and years of acquisition improves quality of the data and its performance. A detailed analysis of corporate ownership patterns and their effect can add much more to our understanding of the industry and its market dynamics. To our knowledge, academic literature on pulp and paper industry lacks studies that include market concentration/structure factors into their models. Also, the SCP (structure-conduct-performance) literature is generally short of empirical tests that use industry concentration information based on actual capacity

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<sup>53</sup> Although it may appear that ownership changes are consistently reflected in the FPL for the next consecutive year, this is not the case.

<sup>54</sup> To double-check the NAFB's timing of mergers, we also used the LexisNexis Academic Universe Database and selectively verified some of the mergers. This was especially useful for smaller firms with less-known acquisition deals.

shares (vs. shipments used in Census CR4s), and are deprived of analyses that account for tiered ownership patterns.

### **Calculating Ownership Capacities**

The effects of our data transformation can be traced by using three variants of capacity concentration ratios. The first would use the original FPL record of company capacities. The second one will use capacity shares adjusted for local vs. corporate names, name changes resultant from mergers and acquisitions—name and merger adjustments. Finally, the third one, in addition to name and merger adjustments, will reflect tiered ownership—name, merger, and ownership adjustment.

The decision criteria whether to adjust parent capacities or not is made on the amount (percentage) of interest a holding company owns in a subsidiary. If it holds majority-voting shares, then all of subsidiary's capacity is added to the parent company. If, in contrast, the parent holds only minority interest, the subsidiary, or more accurately the affiliate, is left as a stand-alone entity. Traditionally, effective shareholding ownership/control over a company is determined whether a shareholder owns 51 percent of company stock. Yet, in general the majority interest is considered to be any share that is larger than individual stakes of other shareholders.

Alternatively, it is possible to determine specific percentages of ownership and calculate weighted subsidiary capacities to be added to parent's capacity. Even though such approach constitutes a more accurate measure of ownership distribution, we believe that costs of obtaining such information outweigh benefits. The cost emerges from having to obtain share information for each subsidiary mill/company through all years.

Additionally, it is arguable whether owning 49 vs. 51 percent (or even 40 vs. 80) dictates the degree to which a subsidiary is willing to abide by decisions of its parent company.

### **Technical Notes**

The three sources used for verification of ownership, described in footnote 4, are divergent in the time span they cover. For the first run (Aselia: June 2003), we used the following issues of Lockwood and Phillips directories: Lockwood 1986, 1988, 1990, 1992, 1993, 1994, 1995, 1996, 1998, 1999 and 2001; Phillips 1977, 1979, 1981, 1992, 1984, 1987, 1989, 1991, 1993, and 1997. Lockwood 1986 and Phillips 1977 are the earliest issues of the two publications readily available from the IPST. From our experience, we believe that while Lockwood presents more timely information on mills, Phillips gives more consistent information on corporate ownership. For example, Lockwood may identify a change in name accurately, but it will not say whether the name change is resultant from transfer of ownership. Therefore, using both sources is complementary. Finally, the NAFB's and Lockwood's lists of mergers are used to confirm years of major acquisitions in the industry.

Given this combination of sources, it is relatively easy to verify information of the 1990's and hard for the 1970's. Since the earliest directory is for 1977, we assume that the FPL's mill/company title information is correct starting with year 1977. The process of verification itself is/should be documented in the following manner: in the field "comments" we put in the information that appears in the source for selective mills. The entries range from "listed as here" to "mill/city not listed." Hence, the information on ownership, change in ownership or name is reflected in detail in the "comments" as well.

In some cases, it is necessary to identify the parent company with the full list of its subsidiaries, which can change from year to year as well.

In cases where it was hard to verify the ownership of mills by their names and location (a number of mills in the same city with the same zip code), we used the capacity figures provided in both Lockwood (annual) and Phillips (daily, multiplied by about 350 of assumed operating days) to compare with mill capacities in the FPL. Additionally, there are a number of cases when Lockwood may report a number of mills/machines, while the FPL will treat those as one mill (reporting both market pulp and paper/board capacity). Under these circumstances, we add up the separate capacities in Lockwood to compare to the FPL capacity. Also, attention should be paid to how many machines are listed in Lockwood: if only one, then it is definitely just one mill; when there are pulp and paper/board in the FPL, Lockwood should have at least two machines.

## References

- Bain, J. S. (1951), "Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940," *Quarterly Journal of Economics*, 65(3):293-324.
- Bain, J. S. (1956), Barriers to New Competition, Cambridge, MA: Harvard University Press.
- Bartlesman, E., Gray, W. (1998), "The Manufacturing Industry Productivity Database," National Bureau of Economic Research.
- Caves, R. (1985), "International Trade and Industrial Organization: Problems. Solved and Unsolved," *European Economic Review*, 28:377-395.
- Collins, N. R., Preston, L. E. (1966), "Concentration and Price-Margins in Food Manufacturing Industries," *Journal of Industrial Economics*, 14(3):226-242.
- Collins, N. R., Preston, L. E. (1969), "Price-Cost Margins and Industry Margins," *Review of Economics and Statistics*, 51(3):271-286.
- Coyon, M., Machin, S. (1991), "The Determination of Profit Margins in UK Manufacturing," *Journal of Industrial Economics*, 39(4):369-382.
- Demsetz, H. (1974), "Industry Structure, Market Rivalry, and Public Policy," *Journal of Law and Economics*, 16(April):1-10.
- Domowitz, I., Hubbard, G. R., Petersen, B. C. (1986a), "Business Cycles and the Relationship Between Concentration and Price-Cost Margins," *Rand Journal of Economics*, 17(1):1-17.
- Domowitz, I., Hubbard, G. R., Petersen, B. C. (1986a), "The Intertemporal Stability of the Concentration-Margins Relationships," *Journal of Industrial Economics*, 35(1):13-34.
- Evans, W. L., Froeb, L. M., Werden, G. J. (1993), "Endogeneity in the Concentration-Price Relationship: Causes, Consequences, and Cures," *Journal of Industrial Economics*, 41(4):431-438.
- Froeb, L. M., and Werden, Gregory J. (1991), "Endogeneity in the Concentration-Price Relationship: Causes and Consequences," Economic Analysis Group Discussion Paper 91-7, Antitrust Division, Department of Justice.
- Ghosal, V. (2000), "Product Market Competition and the Industry Price-Cost Markup Fluctuations: Role of Energy Price and Monetary Changes," *International Journal of Industrial Organization*, 18:415-455.

- Haskel, J., Martin, C. (1994), "Capacity and Competition: Empirical Evidence on UK Panel Data," *Journal of Industrial Economics*, 42(1):23-44.
- Ince, P. J., Li, X., Zhou, M., Buongiorno, J., and Reuter, M. (2001), "United States Paper, Paperboard, and Market Pulp Capacity Trends by Process and Location, 1970-2000," Research Paper No. 602, Forest Products Laboratory, United States Department of Agriculture.
- Katics, M. M., Petersen, B. C. (1994), "The Effect of Rising Import Competition on Market Power: A Panel Data on U.S. Manufacturing," *Journal of Industrial Economics*, 42(3):277-286.
- Koller, R. H. II, Weiss, L. W. (1989), "Price Levels and Seller Concentration: the Case of Portland Cement," in Concentration and Price Ed. Leonard W. Weiss, Cambridge, MA: The MIT Press.
- McNutt, J. A. (2001), "Ways to Win In a Global League," PIMA's 82th Annual International Management Conference, President's Panel, Baltimore, Maryland, June 27, 2001.
- Peltzman, S. (1977), "The Gains and Losses from Industrial Concentration," *Journal of Law and Economics*, 20(October):229-263.
- Pugel, T. (1980), "Foreign Trade and US Market Performance," *Journal of Industrial Economics*, 29:119-129.  
Pulp and Paper North-American Factbook, Paperloop Publications, 2001.
- Salinger, M. A. (1990), "The Concentration-Margins Relationship Reconsidered," *Brookings Papers: Microeconomics*:287-335.
- Schmalensee, R. (1989), "Inter-Industry Studies of Structure and Performance," Handbook of Industrial Organization, eds. R. Schmalensee and R. Willig, North Holland: Amsterdam.
- Uchitelle, L., "Who's Afraid Now That Big Is No Longer Bad?," *New York Times*, November 5, 2000.
- Weiss, L. W. (1989), "Concentration and Price," ed., M.I.T. Press, Cambridge, Mass.
- Werden, G. J. (1991), "A Review of Empirical and Experimental Evidence on the Relationship between Market Structure and Performance," Economic Analysis Group Discussion Paper 91-3, Antitrust Division, Department of Justice.