

Executive Summary

In this summary, we will briefly summarize our main findings and outputs/deliveries as a result of this project. This summary covers three different types of output: practical tools for the industry, findings from reviews, and findings from research. The practical tools refer to our interactive project website. The review includes our review of the industry and forecasting practice in the pulp and paper industry. Research findings include price behavior, demand pattern, and the impact of industry consolidation on profitability. All detailed discussions related to this summary can be found in the related reports or papers.

1. Online Forecasting Tools—Interactive Web Site

We have built project web site for this research project "Price Behavior in the Pulp and Paper Industry." It serves as a clearinghouse for general information about the project, and it serves as a platform for historical and current price information. Moreover, the project web site also provides live forecasting tools to for short-term forecasting needs, such as forecasting sales, inventory, and even short-term price movement. The project web site can be found at:

<http://www.paperstudies.org/research/projects/price/forecasting/price/index.asp>.

The major functions of the project web site are following:

1) **Project information:** provide general information on the project, including research reports and working papers.

2) **On line price charts:** provide live graphs on current price and historical price movement on linerboard, semi-chemical medium, hardwood pulp and softwood pulp.

Live Forecasting Tools: provide interactive forecasting tools for short term forecasting. Industry users can input data online and make live short-term forecast, e.g., for sales, inventory, and even short-term prices. There are three different forecasting tools available on the web site. The first one is for data that do not have seasonality and

obvious upward or downward trend; and the second one is for data without seasonality but with trend. In general, the first two tools are used for annual data. If the data have both trend and seasonality, the third tool is more appropriate. Our exercises have shown that this type of simple forecasting tools work reasonably well in short-term forecasting.

After inputting the data (either manually or by uploading the data file), a users just needs to supply information on how many steps ahead forecasts needed to produce. A user also has a choice of whether to generate a graph. The forecasting tools are easy to use, and they are secure for users because the data inputted are not saved on the server.

2. Review of the Containerboard Industry

This review covers a number of important aspects related to the containerboard industry, including its market concentration, demand/supply structure, price movement, and related government regulations.

The market concentration for paperboard, measured by the share of capacity/shipments of the top four companies, is relatively low and lies in the range around 30% since early 1980s. The Herfindahl-Hirschman Index (HHI) for the paperboard industry is below 500, which is considered to be unconcentrated. Within the paperboard industry, the market for bleached paperboard (solid bleached sulfate) has relatively higher concentration, with its HHI mostly within the range of 1000-1800. However, since early 1990, the market concentration for paperboard has been rising, mainly due to increasing merger and acquisition activities. There is an increasing trend in the number of mergers in the pulp and paper industry since late 1970s.

The total paperboard production capacity in the U.S. has been increasing since 1970s. The U.S. is the largest containerboard producer in the world, accounting for approximately 42% of the world capacity; and is also the largest exporter of kraft linerboard with about 10% of its linerboard output sent abroad. In the meantime, the competition from foreign producers has also been increasing. The import of paperboard has been rising, and at an accelerated speed since early 1990. In addition to the foreign competition, plastic products are also penetrating the paperboard markets. For

containerboard, returnable plastic containers (RPC) have made inroad into traditional packaging markets.

The price of linerboard only shows a slight upward trend since 1970, with the highest price occurred in 1995. It appears that inventory level and price displayed an inverse relationship.

The relevant research report is “Containerboard Industry Review 1970-2000”.

3. Review of Price Movement and Price Forecasting in the Industry

Linerboard price behavior was hardly predictable especially over the last decades. The industry-wide linerboard price could increase more than 60% in one year. Unpredictable price behavior could lead to a number of serious consequences for the containerboard industry, such as excess capacity, financial losses, and difficulties in long-term financial planning. In this study, we employ advanced time series techniques to analyze linerboard price movements and apply different methods to forecast future prices.

We first analyze the historic pattern of containerboard price, focusing on the existence of trend and seasonality, stationarity property, and the casualty relationship between price and inventory. Secondly, we evaluate the performance of the existing industry price forecasts using different objective measures. Third, we forecast prices using various forecasting methods and compare with the published forecasts in the industry. In addition to univariate models, we also apply system forecasting method such as Vector Autoregressive Model (VAR) to forecast linerboard price by incorporating inventory into the forecasting system.

The main findings can be summarized as follows. First, regarding the nature of price movement, both nominal price and real price contain a slight upward trend, but they increased at a slower speed due to the negative quadratic trend component. The upward trend of the real price is flatter than that of the nominal price. Neither nominal nor real prices contain seasonality. The unit root test rejected the existence of unit root. Therefore, we proceed with the assumption that the nominal price is stationary and ARMA and VAR models can be applied to price level.

Second, the results of Granger test showed that there was bi-directional causality between previous month inventory and current price. When inventory change is utilized instead of the levels, lagged inventories found to be an important factor explaining changes in current price fluctuations. Contrary to that, price change does not Granger cause inventory movements. Third, for short term forecasting, when price variation is small, Holt-Winters exponential smoothing renders the most adequate performance. For long term forecast and when the price varies considerably, the VAR model performs better than all other forecasting techniques. The ARIMA model forecasts outperform the published forecast as well.

As an exercise, we also produce quarterly linerboard price extrapolation forecasts for year 2003 to 2005 using different forecasting methods. The price information used is up to the first quarter of 2003. The forecasted quarterly prices based on ARIMA approach for 2004, i.e., 4- to 7-step-ahead forecasts, are \$425, \$426, \$428, \$429 for quarter 1 to 4.

Clearly, the performance of price forecasting depends on the characteristics of price movement and forecasting horizon. Due to the complicated nature of price movements, it is preferable to generate forecasts using alternative methods. Hence, mixed forecasts, combining different techniques, are likely to produce better results in price forecasting for containerboard.

The relevant research report is “Forecasting Containerboard Prices”.

4. Demand and Supply Structure and Linerboard Price Behavior

Starting from the 1980's, the U.S. paper and paperboard industry has recorded an increasing degree of consolidation through mergers and acquisitions. This strategy, combined with voluntary downtime, is adopted by producers as a mean to tackle excess capacity and to reduce costs in order to improve profitability. The five largest linerboard companies in 1980 had about 34.1 percent of the total capacity and the top ten companies had about 57.5 percent. In 2001, however, the top five U.S. linerboard producers managed 66.5 percent of U.S. linerboard capacity. Consequently, market concentration for the paperboard industry, measured by the percent of total capacity due to the top four

producers, steadily increased over the period of 1980 to 2000, from 29 percent in 1980 to 40 percent in 2000.

In light of increasing mergers and acquisitions in the U.S. paper and paperboard industry, concerns of market power and price manipulation arise. By contrast, industrial analysts believe that stiff competition remains in the U.S. linerboard industry, even though the industry is only comprised of a few homogeneous products and the concentration level in this industry is rising. They argue that many paperboard products are selling into markets so full of competition that large producers enjoy little leeway to raise prices. Given the on-going antitrust litigation against Smurfit-Stone Container Corporation (SSCC), questions of whether market power exists, to what extent the market power reaches, and what its impact is on price are of particular importance to the U.S. linerboard industry.

A few studies have been conducted to understand what factors determine the price of paper and paperboard products. Yet few addressed the relationship between price and industry consolidation in a dynamic demand/supply system. We attempt to fill the gap in the literature by investigating the impact of industry consolidation on price in the linerboard industry. We estimated a dynamic demand/supply system to examine the relationship between demand, costs, and price, using monthly data from January 1982 to December 1999. One unique feature of our approach is that we develop a simultaneous equations model and explicitly incorporate mark-up factor into the model and assume this mark-up factor to be a function of operating rate and concentration ratio.

The empirical results are quite robust across different model specifications. Price is mainly influenced by linerboard shipments and material cost, and shows strong rigidity. More specifically, when the demand increases by one percent, the price will increase by approximately 0.1%. Moreover, only the price of pulpwood, one major raw material, has a positive and significant effect on linerboard price. If the current pulpwood price increases by 1%, the current linerboard price will increase by 0.18-0.32%. In long-term, however, the increase in pulpwood price seems to be fully passed on to linerboard customers. In contrast, the prices of other inputs such as labor and energy do not seem to affect the price.

The elasticity of linerboard demand with respect to total industrial production is in the range of 0.60 to 0.73 and highly significant, suggesting the demand for linerboard is sensitive to macro-economic activities. This is because that the demand for linerboard is mainly determined by the shipments of manufacturing and durable goods. The price elasticity of linerboard demand lies in the range of -0.11 to -0.18. Plastics appear to be penetrating into the containerboard market, but the impact seems to be small. In particular, when the price of plastics decreases by one percent, the demand for linerboard will decrease by 0.12-0.14%.

Our results also show that operating rate has a positive and significant impact on price. In particular, one percentage point increase in operating rate in the previous month will increase the price by 0.2~0.3%. It seems that as the operating rate gets higher, buyers are concerned about future supply and thus buy even more, which drives up the price.

However, the market concentration does not show any statistically significant effect on price. This finding suggests that very little market power exists in linerboard industry. Therefore, the continued merger and acquisition activities in the linerboard industry have not shown any effects on price. Combining our findings with some existing studies that find that consolidation has increased the price-cost margins in the pulp and paper industry, it is possible that industry consolidation may have helped to reduced costs.

The relevant research paper is “Industry Consolidation and Price: Evidence from the U.S. Containerboard Industry” (Haizheng Li and Jifeng Luo), currently under review for publication at *Southern Economic Journal*.

5. Industry Consolidation and Profit-Cost Margins

In recent years, the U.S. pulp and paper industry has experienced an increasing degree of consolidation through a series of mergers and acquisitions. In the mean time, price-cost margins (PCMs) in the pulp and paper industry have modestly increased. A natural question is whether industry consolidation increased firms’ abilities to generate operating profits. Industry consolidation is expected to improve efficiency by reducing

production costs through greater economies of scale, as well as by technological innovations through larger R&D investments. In addition, consolidation may cause market power and thus result in higher prices. Therefore, the impact of consolidation on profit margins as well as on market power has important implications for the industry and for government regulatory agencies.

Based upon a traditional structure-conduct-performance model and using panel data for the pulp, paper, and paperboard sectors from 1970 to 1997, we investigate the effect of industry structure on price-cost margins. Unlike previous studies, which rely on an interpolated concentration measure calculated from output values, this study uses a measure of concentration based upon actual annual productive capacity. This concentration measure helps to reduce measurement errors and thus the resulting attenuation bias. Moreover, it also large reduces the concern of endogeneity in the regression model.

We found that on average when market concentration measured by the share of top four producers in the industry increases one percentage point, the price-cost margin will increase 0.5 to 0.6 percentage points. It is possible that consolidation has improved efficiency by lowering costs, and thus increase price-cost margin, because our study on the linerboard industry find that market concentration has not had any effect on prices. The effect of market concentration on price-cost margins, however, fluctuates with business cycle and show a pro-cyclical pattern. It becomes 0.69 when the economy is expanding and 0.19 when the economy is in recession.

In addition, increasing import competition reduces the ability of firms to increase their operating profits. When import intensity increases by one percentage point, the price-cost margin will decline by 0.16 to 0.21 percentage points.

Finally, our results show that industry-specific environmental regulations have positive and significant effects on the industry's price-cost margin. This is likely to be caused by shifting the environment protection costs to consumers. On average, when the total expenditures on environment protection increase by 100 million dollars, the PCM will rise by 0.62 to 0.76 percent points.

In the past three decades, price-cost margins generally show a slight trend of increase in all three sectors of the pulp and paper industry. Measured by 10-year

averages, the price-cost margin in the pulp sector averaged 31% in 1970s, slightly increased to 32% in the 1980s, and rose to 34% in 1990s. Changes in paper and paperboard PCMs are more dramatic – averaging 25%, 30%, and 34% in the paper sector and 28%, 32%, and 36% in the paperboard sector. However, when it comes to actual profits and returns to investment, the trend has not been so optimistic. It is generally viewed that the profitability for the whole industry is not getting better. The profit rate, measured by the ratio of net profits after taxes to net worth, for paper and allied industries has been flat since 1970. One explanation in the literature for the joint occurrence of relatively high price-cost margin and low actual profit rates is chronic excess capacity (Hall 1986; CPBIS 2003). In the pulp and paper industry, since capital recovery and fixed costs are a large part of the costs, excess capacity can cause a large amount of interest cost, and thus lowers profits rate.

The relevant research paper is “Industry Consolidation and Price-Cost Margins: Evidence from the Pulp and Paper Industry” (Haizheng Li, Patrick McCarthy and Aselia Urmanbetova), currently being revised for submission for publication.

6. Paper and Paperboard Demand in China

China possesses a huge market potential for paper and paperboard products, has an increasing impact on the U.S. pulp and paper industry. In this paper, we investigate product demand patterns in China and explore the impact of structural changes associated with China's economic reforms and integration into the world market. Our analysis focuses on the paper and paperboard segment of the pulp and paper industry, a traditional industry that has undergone significant transformation during the economic transition and globalization in China. Continuing economic reforms are dramatically changing the Chinese economy. These changes are having a great impact on traditional industries. Additionally, traditional industries are facing increasing competition from international producers as China gradually opens its markets.

Chinese total paper and paperboard consumption is currently ranked second in the world, only behind the U.S. The consumption of paper and paperboard products in 2001 reached 42.6 million metric tons, increasing at an average annual rate of 10.4% over the

last 20 years. By comparison, the average growth rate of the U.S. paper and paperboard consumption over the same period is 1.85%. China's imports of paper and paperboard products grew at an average annual rate of 12.7%, and the share of imports in consumption increased from 9% to 17% for the same period.

As implied by economic theory, Gross Domestic Product (GDP) has a significant impact on the demand for domestic products and for imports in China. Our results show that the demand for domestic paper and paperboard in China grows at almost the same rate as GDP. On the other hand, the elasticity of imports with respect to GDP is 0.89 (and is significant at the 5% level). More specifically, when GDP increases by one percent, paper and paperboard imports increase by 0.89 percent (also statistically indifferent from one). Therefore, as the Chinese economy continues to grow, the demand for paper and paperboard products will grow rapidly.

Interestingly, we find that the demand response to both domestic price and international price changes is statistically insignificant before 1993, indicating that Chinese consumers of paper and paperboard products, mostly industrial consumers, were not responsive to price changes. In the early stage of China's economic reforms, most firms were state owned, and thus had much weaker incentives to meet market criteria for continued operation. Moreover, in the early stages of economic reform, a dual pricing system existed for the same good, a market determined price and a price set by the planning system. State-owned enterprises (SOEs) usually enjoyed the privilege of paying for goods and services at planned prices, which were much lower than the corresponding market price. For these reasons, it is not surprising to find that, in the early stage of economic reform, the demand for paper and paperboard products was relatively insensitive to price changes. This situation has changed after 1993 and the demand becomes more sensitive to price changes. According to our study, after 1993, the own-price elasticity of demand is -0.69 and statistically significant. The economic reforms have contributed to the increasing price responsiveness.

As China becomes more integrated into the world economy, the demand for domestic paper and paperboard products becomes subject to the vicissitudes of the international markets. Although insensitive to international market in the early stages of economic reform, the demand of domestic paper and paperboard products does respond

to international market after 1993. The related price elasticity is 0.59 and statistically significant, suggesting that imports are a substitute for domestically made products. The response of import demand to changes in the international price is -0.60. This relatively inelastic response to price suggests that relatively few substitutes are available for imported paper and paperboard products as a whole. This observation is also confirmed by the insignificant cross-price elasticity. More specifically, the import demand does not seem to be affected by the domestic price. Therefore, these results are consistent with the notion that imports are a substitute for domestically produced paper and paperboard products but that domestically produced products are not a substitute for imports. Such a difference can almost certainly be attributed to quality differences.

As the economic reforms deepened after 1993, the import demand response to international prices becomes even less price elastic (the difference of 0.10 percentage point is significant at the 10% level). One explanation is that as China's ability to produce higher quality products has increased (for example, due to foreign direct investment; replacing small inefficient mills with state-of-the-art mills), its imports are increasingly targeted on some specific grades of products. Thus, demand becomes even less sensitive to price. If this is case, we may expect that the income elasticity of imports for high quality imports will increase as the economic transition continues.

Overall, as economic transformation progresses, the Chinese economy is becoming an increasingly market-oriented system. This is particularly evident from the increasing demand response to both domestic and international prices.

The relevant research paper is "Economic Transition and Demand Pattern: Evidence from China's Paper and Paperboard Industry" (Haizheng Li, Jifeng Luo and Patrick McCarthy), currently under review for publication at *China Economic Review*,

7. Demand for Printing and Writing Paper in China

In 2000, China only consumed a small part of the world wide newsprint and printing & writing papers, representing 4.2% or 7.9% of the world production. However, if we look at annual growth rate, China outruns many other countries in the consumption of newsprint and printing & writing papers.

Additionally, despite the fairly high tariff and rapid expansion of domestic capacity, China's imports of newsprint and printing & writing papers continues to grow at a very fast pace, with an average growth rate of 28-29% in the last 10 years. Given its rapid growth and great potential, the Chinese paper market will have big impact in the world newsprint and printing & writing paper industry. In this report, we review the Chinese Newsprint and Printing & Writing Paper Industry, focusing on domestic demand, capacity expansion and international trade.

In addition, we also forecast the demand for newsprint and for printing and writing paper in China up to 2020, using Autoregressive Integrated Moving Average (ARIMA) models. Moreover, several other related industries besides paper industry, such as newspaper industry, information Technology industry, and advertising industry are also examined. The impact of technology, especially information technology, on paper industry is also analyzed.

The relevant research report is "Chinese Newsprint and Printing & Writing Paper Industry" (Jifeng Luo).