

**FINAL REPORT**

**PROFILING BEST PRACTICES: AN EXPLANATORY ANALYSIS OF BOX-  
PLANT TRUCKING LOGISTICS IN THE PAPER INDUSTRY**

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## **ABSTRACT**

Firms in many sectors have achieved significant economies by taking advantages of opportunities made possible by innovation in trucking logistics. Transportation usually represents the single most important component in trucking logistics costs for most firms. Transportation costs are particularly important to the corrugated container industry. Averaging an estimated 12 to 20% of total costs, transportation costs are a vital factor in the geographical scope of the markets producer can serve in addition to affecting the prices of production inputs and outputs.

A natural question for the corrugated container industry is how improvements in the trucking logistics impacts a firm's overall operating rate. The literature contains very little information on the relative costs and benefits of alternative logistic operations, including outsourcing, long term contracts, and private carrier. This research seeks to identify practices in trucking logistics that box plants might utilize to obtain materials and disburse products more economically.

## **I. INTRODUCTION**

In today's dynamic and highly competitive economic environment, market leadership has changed from the ability to supply products to the ability to add more and more value to the end customer. This situation can be regarded as the basic cause of the evolution of the supply chain management (SCM) concept from traditional materials management. Supply chain is understood as the bridge between supply and demand. It can be defined as the process umbrella which encompasses a huge network of facilities and logistic distribution options that perform the functions of procurement of materials, transformation of these materials into intermediate and finished products, and dispatches to the concerned customer.

In fact the various functions such as purchasing, warehousing, and transportation are now being seen as the integrated process chain and as part of the organization's overall supply chain management strategy. Within the supply chain management strategy, transportation plays a key because products are rarely produced and consumed in the same location. Transportation usually represents the single most important component in logistics costs for most firms. Transportation costs are particularly important to the corrugated container industry. Averaging an estimated 12 to 20% of total costs, transportation costs are a vital factor in the geographical scope of the markets producer can serve in addition to affecting the prices of production inputs and outputs.

This report provides a broad overview of the performance of the paper manufacturing industry's SCM adding an important component to the analysis of the corrugated container sector's logistics operations. At a more specific level, the report will analyze the structure of varying mill's logistics operations for inbound and outbound

transport. Combining information from the existing literature and secondary data sources with observation-based data collected from box plant logistics managers, detailed case studies for three box plant logistics operations are developed. Because the corrugated container industry's products are comparable across plants and manufactured by the same fundamental process comparisons across companies while limiting uncontrollable variation is possible.

The report provides important insights on the transport logistics operations at box plants in the paper industry. Among the results of the study are: identifying factors that underlie alternative governance structures (e.g. outsourcing versus leasing or arm's length) observed in the industry; a set of best practices benchmarks for evaluating box plant transport logistics operations; and an estimated sensitivity of box plant costs and profits if best practice benchmarks can be achieved.

## **II. CHARACTERISTICS OF THE PAPER INDUSTRY**

This chapter provides a broad overview of the performance of the paper industry, which includes critical competitive, technological, and regulatory factors that affect the present structure and performance of the industry. Issues discussed include industry structure, trends in capacity expansion and contraction, demand growth, profit volatility, and environmental and regulatory trends as they relate to the paper industry. The implications of how these issues affect performance and the opportunities and challenges for the paper industry are discussed.

## Overview

Worldwide, the pulp and paper manufacturing industry is comprised of mills whose primary purpose is to manufacture pulp, paper, and converted paper products. Offering over 300 million tons of products, this sector's global annual revenue exceeds 500 billion dollars, of which an estimated one-third is attributed to U.S. firms.<sup>1</sup> Constituting nearly 5% of the U.S. manufacturing sector's contribution to GDP, the pulp and paper manufacturing industry is a key component to the health of the U.S. economy.<sup>2</sup> Indeed, the ninth largest manufacturing sector in the U.S., the Forest Products industry, of which the paper industry is a major part, plays a vital role in most regions of the U.S., where it ranks among the top 10 employers in 43 of 50 states.<sup>3</sup>

Industries in the pulp and paper manufacturing sector make pulp, paper, or converted paper products. The manufacturing of these products is grouped together because they constitute a series of vertically connected processes where more than one process is often carried out in a single mill. There are essentially three activities: 1.) pulp manufacturing which involves separating the cellulose fibers from other impurities in wood or used paper; 2.) paper manufacturing which involves matting these fibers into a sheet; and 3.) converting operations which produce products from paper and other materials by various cutting and shaping techniques and include coating and laminating activities.

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<sup>1</sup> "Profits Leap Ahead in '99", Paper and Forest Products Industry Survey: Standard & Poor's, New York, April 13, 2000 pg.1

<sup>2</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>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>.

The pulp and paper manufacturing sector is subdivided into two industry groups, the first for the manufacturing of pulp, paper and paperboard and the second for the manufacturing of converted paper products.<sup>4</sup> Paper making is treated as the core activity of the commodity sector. Therefore, any establishment that makes paper (including paperboard), either alone or in combination with pulp manufacturing or paper converting, is classified as a paper or paperboard mill. Establishments that make pulp without making paper are classified as pulp mills. Pulp mills, paper mills, and paperboard mills comprise the first industry group.

The geographic distribution of pulp and paper mills varies according to the type of mill. Pulp mills are located primarily in regions of the country where pulp trees are harvested from natural stands or tree farms: the Southeast, Northwest, Northeast and Northern Central regions. Paper mills, however, are more widely distributed, located in proximity to pulping operations and/or near converting sector markets. The distribution of paperboard mills follows the location of manufacturing in general since such operations are the primary market for paperboard products.

Establishments that make products from purchased paper, paperboard and other materials make up the second group, the converted paper manufacturing sector. This general activity produces corrugated boxes, folding cartons, envelopes, and stationery

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<sup>4</sup> The grouping of pulp, paper, and paperboard manufacturers is known as the commodity sector. In the paper "United States Paper, Paperboard, and Market Pulp Capacity Trends by Process and Location, 1970-2000" Peter Ince *et. al.* define the paper commodity group to include: newsprint, four categories of printing and writing paper, tissue and sanitary paper products, unbleached kraft paper, and other specialty packaging and industrial paper products. The paperboard commodity group includes four conventional commodity categories: linerboard and corrugated medium, solid bleached board, and other recycled paperboard. The market pulp commodity group includes primarily hardwood and softwood kraft market pulp, deinked market pulp based on recycled fiber, and relatively small amount of bleached chemithermomechanical market pulp.

products. The average paper converting plant is smaller than the pulp, paper, and paperboard mills, employing fewer than 100 people and grossing about \$10 million or less per year.<sup>5</sup> However, the total converting sector of the industry is not so small. In fact, when sales of all converting sectors are combined, they exceed the total dollar value of all pulp, paper, and paperboard shipments.

The geographic distribution of the converting sector is located primarily in the regions of the Southeast, Southwest, and West. This distribution reflects the movement of industry activity from the older manufacturing regions, such as the Northeast and Midwest, to the “Sun Belt” region.

### **Trends of the North American Paper Industry**

The North American paper manufacturing industry is a capital intensive sector with large facilities, larger capital requirements, and a manufacturing cycle that traditionally fluctuates with the current state of the U.S. economy. As such, the peak of the most recent industry cycle was reached in 2000, when total sales in the U.S. paper and allied products industry hit \$184.5 billion.<sup>6</sup> The recent U.S. economic downturn starting in March 2001 was spawned by a steep rise in the exchange rate of the U.S. dollar, which ultimately affected the record trade deficit in goods and the consequential decline in U.S. industrial output (Figure 2.1).

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<sup>5</sup> “North American Industry Overview,” Pulp and Paper North American Fact book, 1999. Miller Freeman, San Francisco, 1999.

<sup>6</sup> The National Bureau’s Business Cycle Dating Committee maintains a chronology of the U.S. business cycle. The chronology identifies the dates of peaks and troughs that frame economic recessions or expansions. The period from a peak to a trough is a recession and the period from a trough to a peak is an expansion. According to the chronology, the most recent peak occurred in March 2001, ending a record-long expansion that began in 1991. Information regarding total sales in 2000 was taken from the Pulp and Paper North American Fact book, 1999.

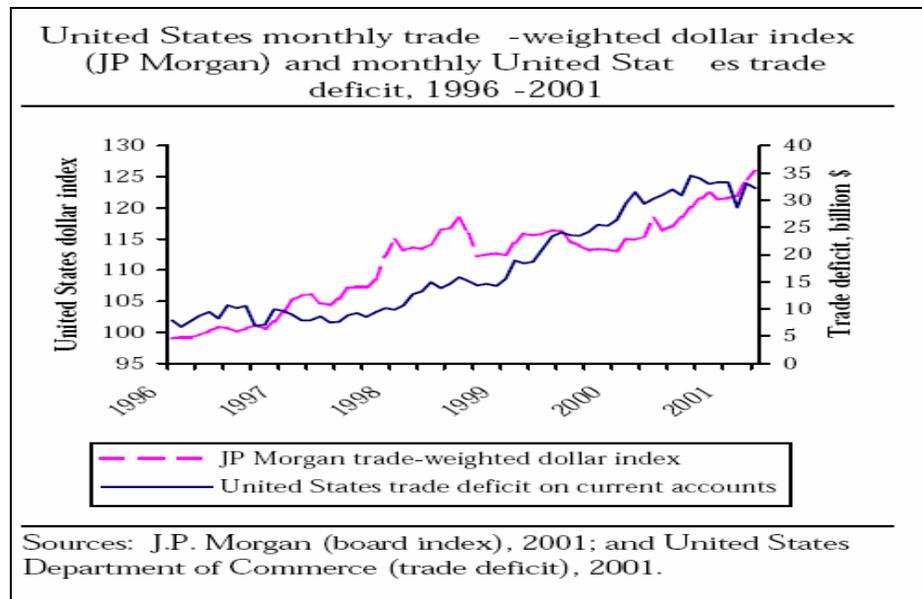


Figure 2.1 U.S Weighted Dollar Index and Monthly Trade Deficit

The decline in United States manufacturing, business growth and investment activity beginning in 2000 also precipitated a broad decline in domestic demand for printing, advertising, packaging and other business applications of paper and paperboard products. Domestic purchases and production of paper and paperboard in the United States declined through 2000, 2001, and into 2002, dropping more than 10% off the peak historical levels of 1999 (Figure 2.2).



Figure 2.2 U.S paper and paperboard purchases and production, 1996-2002

By the first quarter of 2002, United States paper and paperboard production and consumption on an annual basis were running about 11% below the peak volumes of 1999. Thus, the recent downturn ranks among the most significant for United States paper and paperboard markets in the past 50 years, exceeded only by the downturn that occurred during the energy crisis of the 1970s.<sup>7</sup> With domestic demand and production falling in 2001, industry-wide profits for the entire United States paper and allied products industry also fell to extremely low levels.

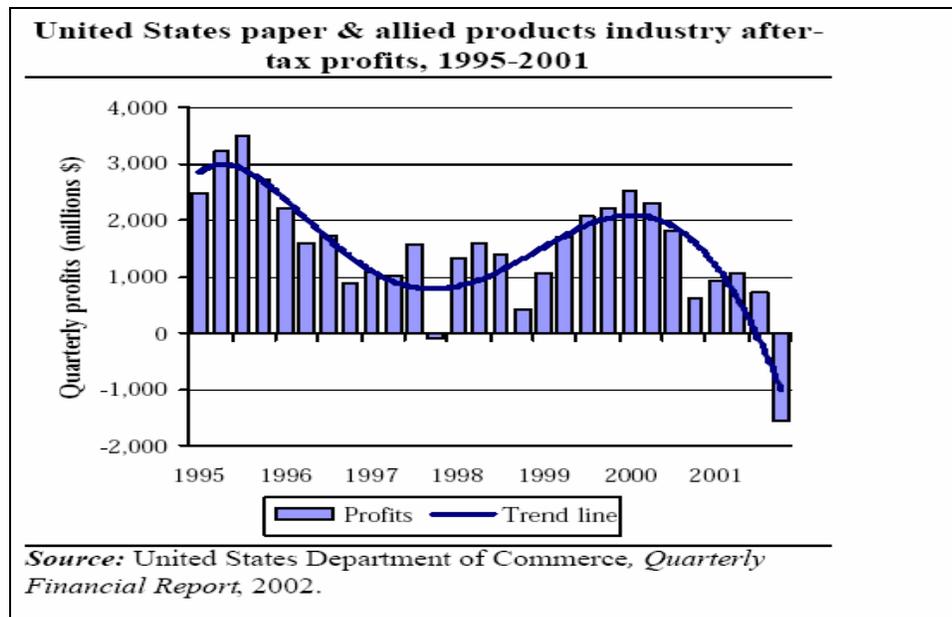


Figure 2.3 U.S Paper Industry After Tax Profits

The recent downturn in the U.S. economy also reduced demand for corrugated packaging and put downward pressure on box prices. During the past few years, demand for corrugated packaging has closely tracked the general trend of the U.S. economy and the overall paper industry. Of course, this meant that shipments increased steadily at double-digit rates during 1994-95 but weakened during the second half of 1995 and into 1996-97. Markets remained weak in 1998 but showed improvement toward the end of

<sup>7</sup> The energy crisis occurred when annual United States consumption dropped by 17% and production fell by 15% between 1973 and 1975.

the year, and then gained steadily in 1999 and 2000. The corrugated box price index increased by 11 index points in 1999 and 18 index points in 2000. Containerboard production dropped by 4.9%, from 30.9 million m.t. in 2000 to 29.4 million m.t. in 2001, roughly in line with the drop in United States industrial production. Other categories of paper and paperboard used for packaging and other industrial applications dropped by 3.4%, from 17.6 million m.t. in 2001.

Producer investment in large new paper machines and mills during industry upturns also contribute to the extremely cyclical nature of the paper industry, as these large, modern capacity additions inevitably oversupply the markets, disrupting supply/demand balances. This was exemplified in 1990 when the paper markets began to deteriorate as significant capacity additions and a recession in North America led to an unfavorable supply/demand balance. As such, traditional paper industry firms have been predominantly vertically integrated with very long time horizons at play for generating returns from the investments in capital assets and forests' establishment across time. The growth trend among integrated operations picked up by 1997 with the number of companies choosing to keep their operations as non-integrated decreasing from 208 in 1963 to 150 in 1997.<sup>8</sup> In the U.S. this began to change somewhat with the increased use of recycled waste paper in the 1980s – which in turn allowed firms to add new, efficient, less vertically integrated and lower capital cost capacity near urban centers.

The environmental legislature has also had a profound effect on the paper manufacturing industry with capital expenditures for environmental purposes highly

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<sup>8</sup> “The Effects of Consolidation on Price-Cost Margins in the Pulp and Paper Industry”, Aselia Urmanbetova, 2003

unstable with steep increases in the years of active legislature as well as a few years after the legislative changes.

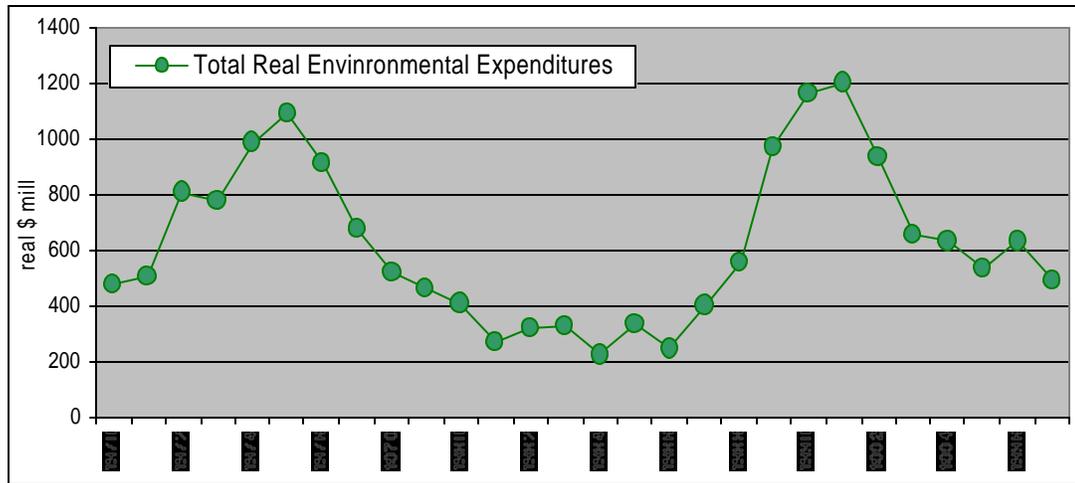


Figure 2.4 Total Real Environmental Expenditures

The first environmental acts were introduced in the early 1970s. The main laws affecting the paper manufacturing industry are regulations concerning air and water pollution. The Clean Air Act<sup>9</sup> requires paper and pulp companies to install the best available technology possible in the attempt to preserve and not to harm the quality of air resources. This legislation was soon followed by the Clean Water Act<sup>10</sup>, which requires mills to control and limit the amounts of pollutants discharged in waters. The third main component of the environmental regulation that was successful in influencing the day-to-day operations of paper and pulp mills was the Solid Waste Disposal Act of 1980<sup>11</sup> that defined dioxin, chlorine and chlorine derivatives as hazardous waste substances that must be disposed according to the federal requirements. Finally, the Cluster Rule is designed to put together Water and Air regulations and provide for a consistent, non-exclusionary

<sup>9</sup> For more information please refer to the Air Quality Act of 1967

<sup>10</sup> For more information please refer to the Federal Water Pollution Control Act Amendments of 1972

<sup>11</sup> For more information please refer to the Resource Conservation and Recovery Act of 1980

body of rules. The regulations are staged in three phases with different deadlines. Mills are expected to install the maximum achievable control technology (MACT), which 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.

On the whole, the production capacity of the U.S. paper manufacturing industry expanded from 1970 to 2000 at an average compound annual increase of 2.1%, although the rate of growth gradually decelerated. From 1970 through 1980, the annual growth rate of the total capacity for paper, paperboard, and market pulp was about 2.4%. It slowed to 1.9% from 1990 to 2000 and to 1.3% in 2002.<sup>12</sup> This decelerating trend in growth occurred for all three principle commodity groups, but the slowdown in capacity growth was more pronounced for the paper commodities than for paperboard commodities. Geographically, capacity growth shifted from the West to the East, and particularly to the South. Significant expansions occurred in production capacity based on recycled fiber, especially from the late 1980s to the late 1990s. The rate of overall capacity has slowed since the late 1990s, with corporate consolidation and numerous mill closures, but average mill capacity more than doubled between 1970 and 2000.<sup>13</sup>

### **III. THE CORRUGATED CONTAINER INDUSTRY**

The objective of this analysis is to understand the production process and prototypical supply chain movement of materials which will provide a foundation for the

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<sup>12</sup> “Paper Industry Survey Shows Capacity Fallout”

<sup>13</sup> “United States Paper, Paperboard, and Market Pulp Capacity Trends by Process and Location, 1970-2000” Peter Ince et al.

later chapter's model on transportation. Our analysis begins in the next section with an overview of corrugated industry and the material flows in the supply chain associated with the production of corrugated containers.

### **Industry Background**

Corrugated containers are the “workhorses” of the worldwide packaging industry. More goods and products are shipped in corrugated containers than in any other type of packaging. According to the Fibre Box Association (FBA), the value of industry shipments of corrugated products was about \$25 billion in 2000. The major end-use markets for corrugated products are food, beverage, and agricultural products (41%); paper products (21%); petroleum, plastic, synthetic, and rubber products (9%); glass, metal, pottery, and metal containers (6%); electrical and electronic machinery and appliances (4%).

Corrugated containers are made by combining two grades of containerboard—linerboard and corrugating medium. Linerboard provides the burst and crush strength components of the container that provide stacking strength of the finished box, while the corrugating medium gives it rigidity or stiffness.

Corrugated products are produced by about 500 companies operating approximately 1,500 plants in the US and Canada, according to the FBA and US Department of Commerce. There are basically three kinds of corrugating and converting packaging plants: corrugating plants, sheet plants, and sheet suppliers. Corrugator plants combine containerboard into corrugated board. Typically these plants also have equipment that converts the corrugated board into finished corrugated products: boxes, shipping containers, point-of-purchase displays and other kinds of protective and

distribution packaging. There are approximately 607 corrugator plants in the United States and Canada.

Plants that purchase already-combined corrugated board, called sheets in corrugated industry terms, and convert these into boxes, shipping containers, and displays are called sheet plants. These plants are usually smaller than corrugator plants, but they can also be highly specialized in their product mix - high-end graphics, inner-packing and other items to serve customer needs. There are more than 807 sheet plants in the United States and Canada. The last type of corrugated plant is called a sheet supplier. This plant's specialty is combining corrugated board into corrugated sheets exclusively for purchase by sheet plants. They have no other converting equipment to make finished boxes, shipping containers, point-of-purchase displays or other corrugated product. There are approximately 50-60 sheet suppliers in the United States and Canada.

In 2000, 83% of the industry's total corrugated box shipments came from corrugator plants and 17% came from sheet plants. Most converting facilities are located close to their markets and sell within a 150-mile radius, competing with other corrugated producers in their local markets.

The corrugated container industry is highly integrated with paper companies that also produce linerboard and corrugating medium. In terms of the corrugated box industry, about 80% of corrugated box capacity in the U.S. is integrated with companies that produce containerboard, while the remaining 20%<sup>14</sup> consists of independent converters. Vertically integrated firms typically operate several linerboard or corrugating medium mills and between 30 and 60 corrugated plants. The larger, multiplant integrated

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<sup>14</sup> In 2003 there was an estimated 800 independent corrugated converter and sheet plants.

companies mostly serve larger, national accounts that purchase corrugated packaging for all of their location on a consolidated basis.

The fastest growing business in the corrugated industry is graphics packaging, where retail customers want marketable multi-color displays and boxes for selling their consumer products. Graphics packaging includes litho-laminated products, preprinted linerboard, and flexo-direct printing with four or more colors. Interestingly, most of this demand is supplied through independent converters. While the integrated suppliers have not been reinvesting, the independent converters have been buying the latest printing and gluing equipment due in large part to their ability to make decisions much more quickly on capital purchases needed to handle special customer requirements.

### **Production in the Supply Chain**

The key to successful exploitation of economies of scale is the coordination of production flows throughout the vertical production supply chain, from raw materials acquisition, through production, to finished goods distribution. The following section describes the supply chain for producing corrugated containers starting at linerboard raw material acquisition and ending at the shipment characteristic of finished corrugated containers.

### **Linerboard Production:**

Corrugated containers are made by combining two grades of containerboard-linerboard and corrugating medium. Softwood chips are the primary furnish for making linerboard, along with old corrugated containers (OCC), and new double-lined corrugated clippings (NDLK). Most kraft and recycled linerboard is produced on wide<sup>15</sup> fourdrinier

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<sup>15</sup> In this paper, we define a wide fourdrinier paper machines to be 220-348 inch trim

paper machines. Normally the wet end of the fourdrinier machine used to manufacture linerboard has two forming devices, or head boxes, that make two plies, or layers, of fiber. The primary layer, comprising up to 85% of the fiber furnish, contains coarse, strong, high-yield kraft fiber. The top layer contains higher-quality pulp (either highly refined or of lower fiber yield) with better sheet properties for a good printing surface. In some grades, the top layer may be bleached fiber used to produce a mottled white, oyster white, or fully white appearance over an unbleached base sheet.

Special chemical additives are either mixed into the pulp slurry or extruded onto the surface of the formed sheet to give linerboard its unique properties. The most common additives are size and wet-strength agents used to develop desired sheet strength and moisture resistance. The most common surface additive is starch, which is applied at a size press on the paper machine to seal the surface of the sheet for increased strength and printing smoothness.

Unbleached kraft linerboard is produced at large, integrated mills located close to supplies of softwood, including Southern pine, Douglas fir, and eastern pines and spruces. The long and flexible softwood fibers assured good tensile strength in linerboard enhancing the burst test performance of corrugated boxes. An estimated 76% of US unbleached kraft linerboard mill capacity is in the South, with an estimated 20% located west of the Mississippi River. By contrast, recycled linerboard mills are typically smaller, less capital intensive, and are located near urban areas in the East and Midwest, where recovered paper supplies are abundant and can be easily shipped.<sup>16</sup> Linerboard is sold in rolls, where the roll width is determined by corrugator width and trim.

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<sup>16</sup> Figure 3.1 can be found in Peter Inces report

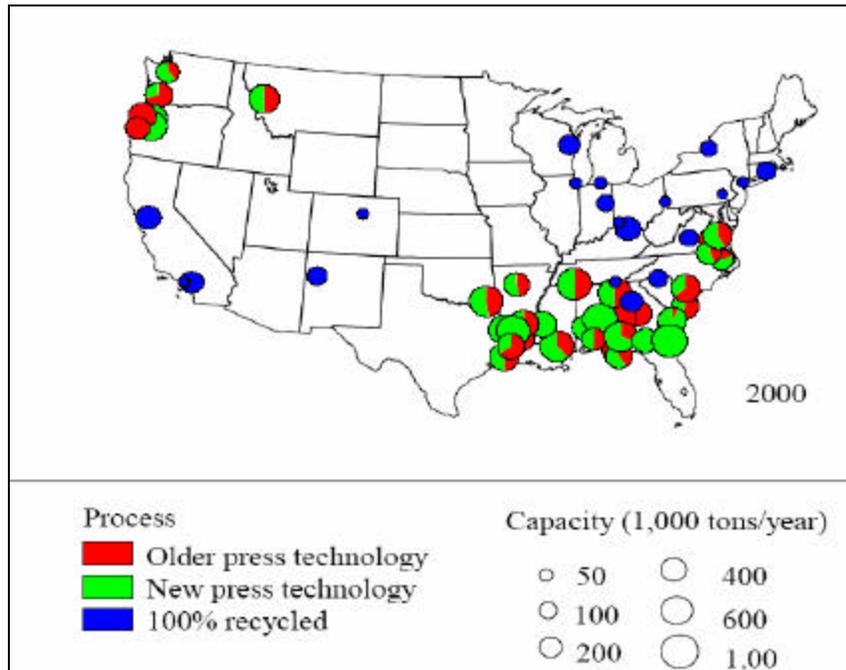


Figure 3.1 Linerboard Production Regions in the U.S

### Corrugated Medium Production

Corrugating medium is distinguished from linerboard by product characteristics as well as differences in regional distributions of production capacity. Whereas linerboard has been required to meet standards related primarily to tensile strength and box compression strength, corrugated medium is rated primarily on its ability to keep the linerboard facings separated (concora crush test).

Corrugating medium is made from semichemical pulp using hardwoods and recycled fiber. Hardwood chips are the main furnish, along with old corrugated container (OCC), and new double lined corrugated cuttings (NDLK). The semichemical pulping includes a mild chemical pulping of chips prior to mechanical defibrating. This produces a material with high yield -60%-80%- as well as intermediate strength level.

Semichemical medium is normally manufactured on conventional fourdrinier paper machines, although some mills use twin-wire machines. Semichemical medium contains some long fibers to improve paper machine run ability and lessen the tendency of medium to crack and break upon corrugating. Because recovered corrugated containers contain contaminants (tape, latexes, asphalt, and waxes), mills use cleaning equipment to remove the contaminants from the stock. Additives such as modified starches and gums are used to improve strength of recycled medium. Corrugated medium is shipped in unfluted rolls, where the roll width is determined by the corrugator width and trim.

Unlike the linerboard industry, which has been concentrated mainly in the South, US corrugating medium mill capacity have been distributed more evenly across all regions with a large share of capacity in the North. About one-third of US semichemical medium capacity is located in the upper Midwest, while the South Atlantic region is another important production area. Recycled medium mills are typically located near major eastern urban areas and are generally close to recovered paper suppliers and box converters, giving the mills an advantage in transportation costs. Both linerboard and corrugated medium are produced at typically large paperboard mills that ship these commodities in large bulk rolls to corrugating and converting plants.<sup>17</sup>

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<sup>17</sup> Numerous smaller plants across the country that combine linerboard and corrugating medium and convert them into corrugated containerboard and corrugated containers. Again, the figure illustrating corrugated medium production regions are taken from Peter Inces report

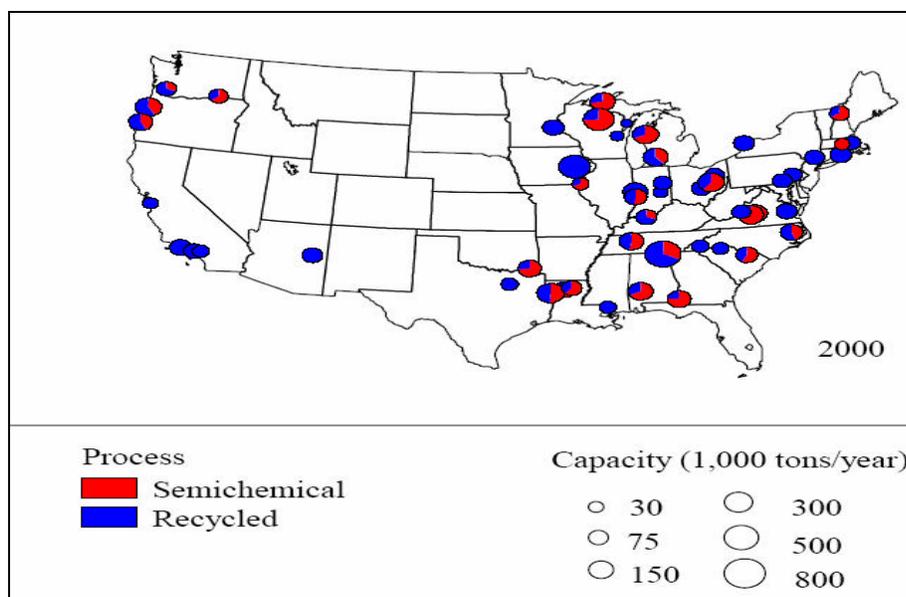


Figure 3.2 Corrugated Medium Production Regions in the U.S

### Corrugated Container Production

Corrugated board is produced on a corrugated that simultaneously flutes the corrugating medium and bonds linerboard to the top and bottom of the medium. The first step involves preconditioning the corrugated medium through preheating and steam addition. Fluting the corrugated medium occurs next as appropriately-shaped gears imprint the appropriate size flute based on the specialized strength and size needed for the corrugated containers. Flute size is determined by the size and number of teeth on a corrugating roll and is measured in flutes per linear foot. The larger flutes generally offer greater stacking strength, and the smaller flutes offer greater puncture resistance. The four most commonly used flutes, in order of individual size are:

A flute > C flute > B flute > E flute (a micro flute)

Of the traditional three larger flutes, the B flute gives the most flutes/m and therefore provides good resistance to penetration for the exterior wall in multi-ply corrugated cases. The C flute is usually used for the inner wall, while the A flute provides good

stacking performance and helps to reduce the thickness of heavy duty board. The E flute is a finer flute used for folding carton end-uses. Adding adhesive glue to the tip of each flute follows.

The appropriate fluting with the appropriate preconditioned linerboard combines for the next stage in the production process as seen in Figure 3.1. Combined as corrugated board, they can take the following structures: single face corrugated board, single wall board, double wall board, and triple wall board.

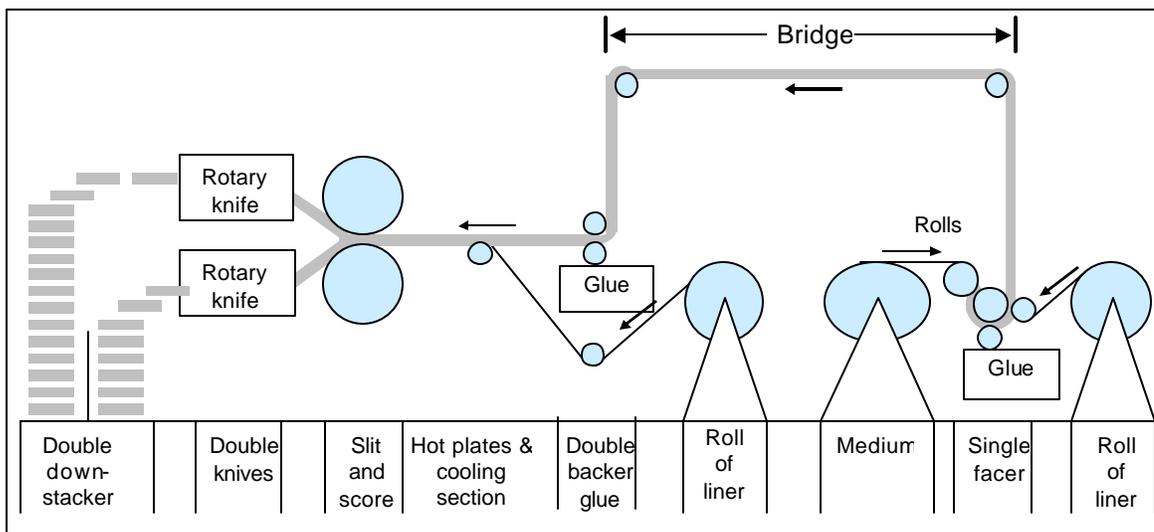


Figure 3.3 The Production Process of Corrugated Containers

In the production process the single face is first formed by combining a small diameter (5 inches, 127mm) corrugating roll with a large diameter (48 inch, 1,219 mm) bonding roll. A double backer for the second liner or a triple backer if necessary can follow this. The resulting sandwich is cut into sheets. After passing through a vacuum feeder which removes dust, the sheet is next sent to the flexo printing unit where up to five color stations can be printed onto the sheet if necessary. The sheets then move to the creaser-slitter (slitter-scorer) where a pre-crease flattens the board along the score line

helping in the future of accurate folding. Following this step, the sheets shift to either a rotary or flatbed die cutter where the scrap cut out is automatically removed. The folder-gluer section folds the sheets as well as gluing the units with ethylene vinyl acetate. Alternatives to gluing the panels are stitching or stapling. A unit combining these stages currently incorporated at varying facilities is a flexo-folder-gluer. Finally squaring the containers occurs and a counter-collector, or counter-ejector, ejects the stack at the desired bundle count. The containers are then transported in flat form. Again, it is important to emphasize that these activities may be done at the same plant as the corrugator or at a separate sheet plant.

#### IV. COST FACTORS IN GOVERNANCE STRUCTURES

Because any supply chain's success is closely linked to the efficient use of transportation, this chapter will discuss selection factors that impact transportation costs and affect overall supply chain responsiveness and efficiency.

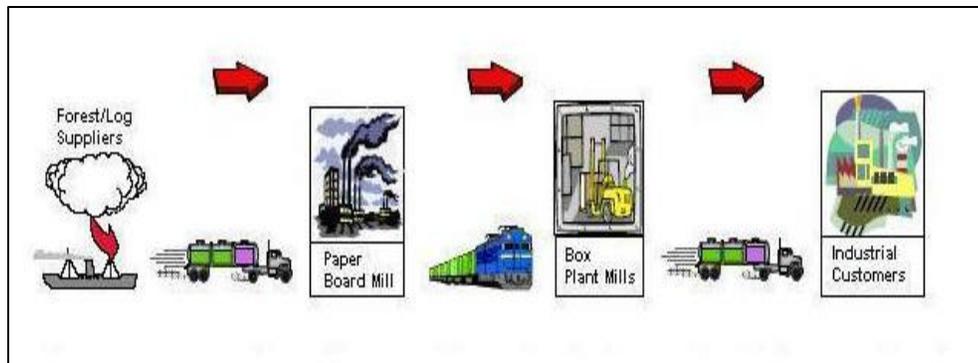


Figure 4.1 Supply Chain Movements in Corrugated Container Industry

As illustrated in Figure 4.1, transportation is an important factor in the flow of input and output materials in the corrugated container industry. The transport decision

begins with an identification of the cost and the service goals of the transport service to be provided. The relevant selection factors include transport cost, transit time and reliability, flexibility, pricing terms, and information coordination capacity.

### Transport Cost

Price (transport cost) of transport service to a shipper is simply the line-haul rate for transporting goods plus any accessorial or terminal charges for additional service provided. In the case of for-hire service, the rate charged for the movement of goods between two points plus any additional charges, such as for pickup at origin, delivery at destination, insurance, or preparing the goods for shipment, makes up the total cost of service. When the service is owned by the shipper, the cost of service is an allocation of the relevant costs to the shipment in question. Relevant costs include such items as fuel, labor, maintenance, depreciation of equipment, and administration costs.

The transport cost varies from mode to mode because of the different cost structures of the modes, whereas the cost variation among carriers within a mode is less because the carriers have similar cost structures.

Table 4.1 gives the approximate cost per ton-mile for the five modes of transportation.

Table 4.1 Transportation Facts

Mode	Freight Expense (\$Billions)	Intercity Ton-Miles (Billions)	Intercity Tonnage (Millions)	Revenue/ Ton-Mile (cents)	Average Length of Haul (miles)
Air	22.67	13.87	16.3	56.25	1,260
Truck/ TL	401.68	1,051	3,745	9.13	289
Truck/LTL				26.12	629
Rail	35.35	1,421	1,972	2.40	722

Water	25.35	473	1,005	0.73	Rivers/canals 481
					Great Lakes 509
					Coastwise 1,653
Pipeline	8.74	628 (Oil)	1,142	1.37	Crude 761
					Products 394

Source: Transportation in America, 1998.

Air freight is the most expensive, and pipe and water 1.37 carriage are the least costly. Trucking is about seven times more expensive than rail, and rail is about four times as expensive as water or pipeline movement.

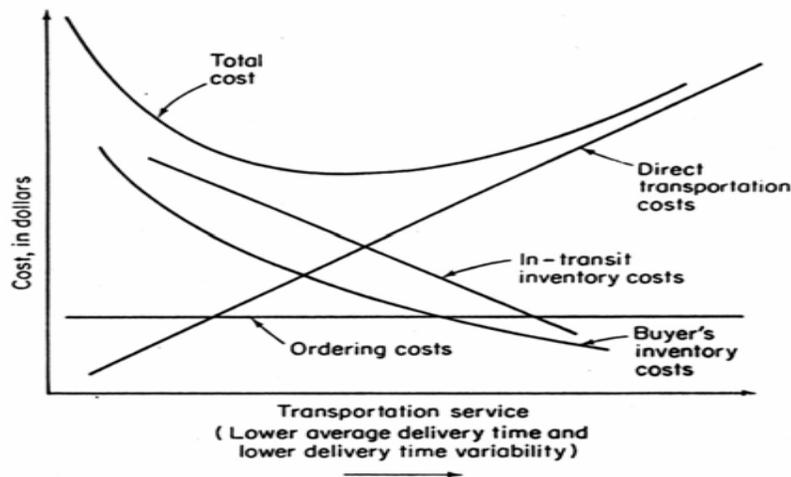
These figures are averages that result from the ration of freight revenue generated by a mode to the total ton-miles shipped. Over long distances rail and air shipments approach constant average transit times, whereas truck transit times continue to increase. Of course, on the average, air freight is the fastest mode for distances of more than 600 miles, with truckload, less-than-truckload, and rail following respectively. For distances less than 600 miles, air and truck are comparable. For very short distances of less than 50 miles, the transit time is influenced more by the pickup and delivery operation than the line-haul transit time.

While these average costs may be used for general comparisons, cost comparisons for the purpose of transport service selection should be made on the basis of actual charges that reflect the commodity being shipped, the distance and direction of the movement, and any special handling required.

## Transit Time and Reliability

Delivery (transit) time is usually referred to as the average time it takes for a shipment to move from its point of origin to its destination. Transit time and reliability of transit time are two transport service qualities that affect inventory costs and stock out costs. The longer the transit time, the higher the inventory levels and the higher the inventory carrying costs. Again, money tied up in inventory can not earn interest and the longer it takes to ship boxes-which are perishable-the more the boxes depreciate. The higher inventory levels and resulting increased inventory carrying cost impact direct transportation costs, moving the total logistics cost point to the right as illustrated in Figure 4.2.<sup>18</sup>

Figure 4.2 Generalized cost trade-offs for transportation services



Therefore, the total cost impact associated with a longer transit time is higher inventory carrying costs. Likewise, the reliability of transit time affects the level of

<sup>18</sup> This graph is derived in the paper "Benefit-Cost Analysis of Highway Improvements in Relation to Freight Transportation: Microeconomic Framework" by the ICF Consulting in the Louis Berg Group.

inventory required. Unreliable transit time requires an increase in the level of inventory to guard against stock out conditions and the resultant cost of lost profit or lost productivity associated with not having the product available to meet the demand. Unmet demand can further hurt a company not only through lost sales but also through lost customers who demand more reliable sources of supply.

Queuing theory also gives insight into the relationship between a goods turnover rate and inventory levels. Queuing theory takes information about arrival and service rates to determine the statistical properties of the queue.<sup>19</sup> A key result of queuing is that as the arrival rate increases, the seller is able to carry a smaller excess inventory in percentage terms to maintain a fixed rate of stock outages. The corollary of this result is that if one fixes excess inventory in percentage terms, then higher arrival rates are associated with lower rates of stock outages.<sup>20</sup> Viewed from a logistic perspective, reliable transit time affords the buyer the opportunity to reduce or control both inventory and stock out costs. Thus, using a carrier that provides reliable transit time provides the seller with a marketplace advantage.

### **Flexibility**

Flexibility is the measure of responsiveness to specific customers needs. Again, the less flexible and less responsive a company is to a customer, unmet demand will result in lost profit and lost productivity. Flexibility thus impacts the level of safety inventory that the firm will have to carry.

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<sup>19</sup> Queuing theory defines the arrival rate as the rate at which customers enter the queue and service rates as the rate at which customers leave the queue because they have obtained the desired good or service.

<sup>20</sup> Besanko, 1996.

### **Pricing terms**

Pricing terms include the allowable time delay before payment has to be made and any quantity discounts offered by the supplier. Allowable time delays in payment to suppliers save the buyer working capital. The cost of working capital savings for each supplier can be quantified. Price terms also include discounts for purchases above certain quantities. Quantity discounts lower the unit cost but tend to increase the required batch size and as a result the cycle inventory.

### **Information coordination capability**

The information coordination capability of a supplier impacts the ability of a firm to match supply and demand. Good coordination will result in better replenishment planning, thus decreasing both the inventory carried as well as the sales lost because of lack of availability. Good information coordination also decreases the bullwhip effect and results in lower production, inventory, and transportation costs while improving responsiveness to the customer. The value of better coordination will be linked to the amount of variability introduced into the supply chain because of the bullwhip effect.<sup>21</sup>

## **V. GOVERNANCE STRUCTURES**

Taking these selection factors into consideration, governance structure measures are identified along the four dimensions of cost, coordination, contracts, and asset

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<sup>21</sup> The bullwhip effect occurs when demand variability increases as one moves up the supply chain away from the retail customer, and small changes in consumer demand result in large variations in orders placed upstream. Eventually, the network can oscillate in very large swings as each organization in the supply chain seeks to solve the problem from its own perspective.

ownership. The range of possible relationship styles between the buyer and supplier varies from a pure arm's length relation to vertical integration as illustrated in Figure 4.1.

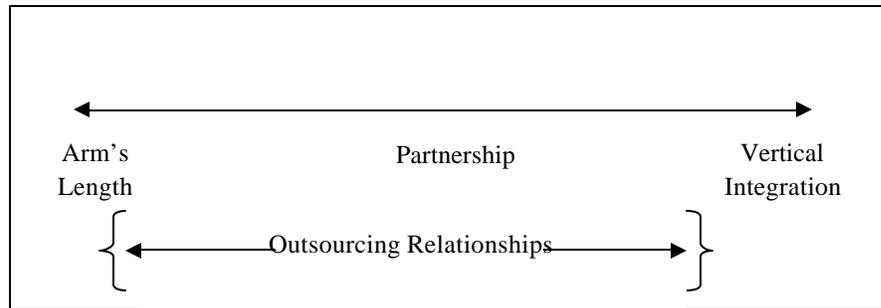


Figure 5.1 Range of Governance Structures

This next chapter discusses the different types of relationships that firms can be involved in, with special attention given to third party logistics including arm's length and partnership interactions in comparison to ownership governance structures and develops the alternative hypothesis underlying each governance structure.

### **Production versus Transaction Economies**

Neoclassical economics defines any business organization as a “production function” motivated by profit-maximization.<sup>22</sup> Organizations provide goods and services to markets where they have comparative cost advantages and rely on the marketplace for goods and services in which they have comparative cost disadvantages. Neoclassical economics predicts that firms justify sourcing based on production costs. In terms of production economies, acquiring transportation services is treated as an economic ‘make-or-buy’ decision- a decision that compares the opportunity cost of internal operations versus the opportunity cost offered in the marketplace.<sup>23</sup> When a firm buys activities or inputs from the marketplace, we say that the firm is outsourcing to market firms; when a

<sup>22</sup> Williamson, 1981

<sup>23</sup> Ford and Farmer, 1986

firm provides the activity or makes the input itself, we define the decision as insourcing or vertically integrating that activity or input.<sup>24</sup> Neoclassical economics predicts that a firm will choose to outsource or insource based on the costs of internalizing versus the price it has to pay vendors for the same services.<sup>25</sup> Accordingly:

Hypothesis 1: The higher the comparative production cost advantage offered through outsourcing, the greater is the degree of outsourcing.

Transaction cost economies extends the neoclassical economic perspective of the firm by recognizing the time and costs incurred in searching, creating, negotiating, monitoring, and enforcing a service contract between buyers and suppliers.<sup>26</sup> Transaction costs can erode comparative advantages in production costs of vendors. When a firm has to incur substantial effort and costs in supervising, coordinating, and monitoring the activities of the vendor, it may decide that external market firms are too costly. Accordingly, firms may opt for internal sourcing when transaction costs override any production cost advantages in market exchanges.<sup>27</sup>

Hypothesis 2: The less the transaction costs involved in hiring an outsourcing firm, the greater the degree of outsourcing.

### **Third Party Logistics Structures**

Very few arguments would be made by any organization that transportation is not important to its success. Organizations that decide to let a more experienced company provide the transportation rely on third party providers. The definition of a third party provider is defined as a “company that supplies or coordinates logistics functions across multiple links in the logistics supply chain.”

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<sup>24</sup> Besanko

<sup>25</sup> Saarinen and Vepsalainen, 1994

<sup>26</sup> Mahoney, 1992

<sup>27</sup> Bako and Brynjolfsson, 1993

An obvious reason for shippers to enter into a relationship with a third party is simply the large number of third parties that already exist. In many instances, no reason exists for a shipper to operate its own fleet of transportation vehicles. Little incentive exists for a shipper to duplicate assets or expertise when they already exist in the marketplace.

Hypothesis 3: 3PLs who provide their own equipment, which then reduces the need for a firm to invest in specialized equipment, will attract more firms.

With the ownership of these assets come some economies of scale and economies of scope.<sup>28</sup> The fixed costs associated with these assets can be allocated across various shippers, reducing fully allocated costs per unit. Shippers who own assets to provide logistics service cannot generate similar economies. Accordingly:

Hypothesis 4: 3PLs who have larger networks tend to have larger economies of scale, which lower unit costs relative to private fleets.

Outsourcing also allows firms to focus their resources on core activities, thereby increasing firm-specific experience and skills, which in turn may lead to an increase of production efficiency advantage.<sup>29</sup> In this same regard, third party logistics firms bring a tremendous amount of expertise to a shipper from having done business with other shippers in similar industries. This expertise produces better decisions on utilization of equipment and personnel leading to increased specialization in the provision of transportation activities and increased production efficiency.

Hypothesis 5: Increased demand for third party transportation firms increases specialization and the capability for 3PLs to better exploit scale economies.

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<sup>28</sup> Economies of scale occur as cost per unit of output (average cost) declines the more output is produced. Economies of scope exist if the firm achieves savings as it increases the variety of goods it produces.

<sup>29</sup> Williamson, 1975

The market also disciplines third party logistic performance through stronger incentives to hold down costs and to innovate than a division performing the same activity within a vertically integrated firm. While a division within a hierarchical firm may hide its inefficiencies behind complex monitoring and reward systems, independent firms must survive the discipline of market competition. With the absence of market competition, vertically integrated firms try to replicate market incentives with administrative controls designed to deter slack effort (agency costs) but must incur the transaction costs associated with this strategy.<sup>30</sup>

Hypothesis 6: 3PLs have stronger incentives to innovate because there are lower agency costs relative to private fleets.

#### Arm's Length Governance Structures

Arm's length or spot market relationships are often defined as agreements that last for a single transaction between the buyer and the seller and no commitments are made for future transactions. This relationship is mediated by contractual agreements on price and performance and often does not persist beyond a small number of clearly defined transactions. The seller typically is not dedicated to the needs of the particular buyer, and the customer base of a particular supplier is usually large. The basic scope of activities in an arm's length relationship entail reliability services based and measured on low transport price, on-time delivery, zero damage, and accurate invoicing.<sup>31</sup> These are called reliability services because the only measure of success is 100% accurate performance. This focus on 100% performance by a shipper indicates that these services are evaluated based on quality.

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<sup>30</sup> Besanko, 1996

<sup>31</sup> Transportation, 2000.

The standard reliability service is the shipment of freight between two points where the single deciding factor is transport price. The lower transport price is a reflection of the economies of scale the market firm is able to generate. If the shipment is time sensitive and flexibility is important, a different type of relationship between the shipper and the carrier might be necessary. The main characteristic of an arm's length governance structure is that the relationship is very short term in nature, minimizing the risk to both the carrier and the shipper because neither has to commit volume or capacity. Because of the length of the agreement, transaction costs associated with negotiating, monitoring, and enforcing the contract are limited. However, because no commitment exists on the part of the shipper or the carrier to continue to do business together no opportunity exists for either to leverage volume and decrease their transaction costs.

In the logistics arena, these services are commodities and the relationship a shipper will have with a third party providing only these services will typically involve an arm's length relationship. A third party cannot gain market share by performing these services well, but can lose market share by doing them poorly. If a third party provider cannot provide basic on-time delivery on a consistent basis, another third party will. Consistently meeting shipper expectations for these services, however, will allow the third party an opportunity to elevate to the next level with the shipper.

#### Partnership Governance Structures

Ellram and Hendrick (1990) define a partnership as an “ongoing relationship between two firms that involves a commitment over an extended time period and a mutual sharing of information and the risks and rewards of the relationship.” This broad definition can encompass either a short-term contractual relationship that requires little

investment from either party and has a limited scope of activities to a longer contractual relationship that requires significant investment from both parties with a larger scope of activities. The definitions of partnership usually stress co-operation and trust.

A short-term partnership is similar to an arm's length governance structure in general. The primary difference might be increased reliability through guaranteed delivery times, a minimum dedicated fleet on the part of the carrier, or a guaranteed minimum volume on the part of the shipper in order to decrease the overall line haul rate. Because suppliers see themselves entering a longer-term relationship rather than a one-time, arm's length contract, they can typically bid a lower cost than the prevailing market price because of the potential gain of future business, a strategy known as the "buy-in."

Hypothesis 7: The longer the contract with the 3PL, the lower the price the 3PL can offer due to the potential gain of future business.

In contrast, a longer-term partnership typically involves carriers who are guaranteed annual volume or dedicated freight lanes, given incentives for cost-reduction efforts, and perform more than basic transportation services. This type of partnership takes longer to develop simply because of the trust and commitment that are necessary for the relationship to work and emphasizes responsiveness services of a third party logistics provider. Responsiveness services are evaluated by shippers as value adding. A value-adding service can increase market share if done well and lose market share if done poorly. Examples of value-adding services would be transporting management, custom-tailored delivery systems, bar coding, electronic data exchange, warehouse management, and so on. They all build on basic transportation service but provide more value to the shipper because they integrate more logistics activities.

Because of the longer-term nature of the relationship and the existence of a contract, this type of governance structure can also increase the risk because of the potential loss of investment by either the carrier or shipper. However, the rewards of success can be substantial. The success of this type of relationship can create a significant competitive advantage for both firms, the type of competitive advantage that neither firm could generate on its own leading to the following hypothesis:

Hypothesis 8: Longer-term contracts generate more opportunities for developing a trusting relationship which creates greater incentives to share information that generates competitive advantages for both firms.

### **Vertically Integrated Governance Structures**

If the decision is made to provide transportation internally, then the firm is vertically integrating its transportation activities. The most common form of vertical integration in transportation is the use of private fleets. Private trucking is defined as the transportation of raw material and a finished product owned by the firm who also owns or leases and operates the transportation equipment.

Key to the successful exploitation of economies of scale is the coordination of production flows throughout the vertical chain, from raw materials acquisition, through production, to finished goods distribution. For coordination to be successful, a number of players must make decisions that depend, in part, on the decisions of others. Suppliers must plan for and produce adequate supplies and distributors must be able to transport and warehouse the goods. Without good coordination, bottlenecks may arise undermining a company's sales and market share. The failure of one supplier to deliver parts on schedule can shut down a factory.

While coordination problems can arise between in-house departments of vertically integrated firms, they are often more serious when independent firms contract with each other in the market. The reason is that when an activity is carried out within a vertically integrated firm, coordination can be achieved through centralized administrative control. Such control is absent when independent firms contract with each other in the market. As a result, it often makes sense to integrate all critical upstream and downstream activities and rely on administrative control to achieve the appropriate coordination, rather than rely on independent firms and hope that coordination emerges automatically through the market mechanism. Avoided shipment coordination problems potentially lead to improved levels of service, which allows the firm to differentiate its product and increase its sales and profits through reduced transaction costs.

Hypothesis 9: Vertical integration is preferred to market firms when there exist shipment coordination problems with 3PLs relative to private fleets.

The private truck fleet also permits the firm to have greater control and flexibility in its transportation system so it can respond to customer needs, both for finished goods and for raw materials. This increased responsiveness is a result of the private carrier's direct control over the dispatching, routing, and delivery schedules of the fleet. Such control means the private carrier can lower transit times to the customer and improve reliability therefore lowering inventory levels and possible stock outs. Greater control and flexibility over transportation and the resultant lower lead-time enable the private carrier to reduce the inventory levels of the firm and its customers.

Hypothesis 10: Vertical integration is relatively more attractive when flexibility and responsiveness to customer needs are important.

And finally, the option of private trucking can be a negotiation tool for seeking lower rates from for-hire carriers. The freight that moves via the private fleet is lost revenue to the for-hire carrier. Firms with a private fleet can threaten to divert traffic to the private fleet if the for-hire carrier does not provide a lower rate. Accordingly:

Hypothesis 11: Vertical integration changes the pattern of asset ownership and control, and thus helps alter the bargaining power between parties.

Private trucking does have disadvantages as well. Probably the most significant cause of higher cost is the empty backhaul. The cost of returning empty must be included in the outbound (inbound) loaded movement. Therefore, the cost of moving freight is higher than the cost of the one-way move. Capital availability is also a problem for the paper industry because the money tied up in trucks, trailers, and maintenance facilities is money that is not available for use in equipment upgrades and manufacturing expansions. Newly formed private carriers may also be hampered by a lack of trucking background to effectively operate the fleet. Because of a lack of in-house talent, the firm must hire outside managers for the specific purpose of managing the fleet which then increases management costs.

## **VI. TEMPLATE FOR CASE STUDIES**

### **General Information**

Several separate questionnaires were developed to interview and survey corrugated container manufacturers. The final survey took the form of written and electronic questionnaires, telephone interviews, and on-site personal interviews. The interviews and surveys were developed to recognize and document the unique issues facing each manufacturer as they approached transportation governance structure

decisions and implementation. The survey instrument was constructed after referencing current industry literature and annual reports. A variety of question formats were used including multiple choice, required ranking attributes, and open-ended questions. Questions were intentionally designed to be broad enough to be applicable to different manufacturing processes, yet specific enough to capture varying governance structure activities in a uniform and consistent format.

The companies targeted for this study were chosen for specific reasons. The corrugated container producers were selected to represent a mixture of integrated and non-integrated producers, although each company shared similarities in market power. Although the governance structures for each manufacturer was unknown before the interview, each producer engaged in some sort of outsourcing activity typically mixed with some type of vertical integration.

Prior to the interviews, information about each individual company was collected. Sources of information included: the Internet, current periodicals, and trade industry data. During the interview process, time was allowed for open-ended discussions about specific issues surrounding each company's transportation governance structure.

### **Manufacturer Survey**

The three corrugated container manufacturers surveyed included two integrated producers and one non-integrated producer. The questions in the first section of the survey were developed to identify the basic logistics function carried out at the particular company. In addition, a brief history of the organization was researched and recorded to assist in placing the responses in context. The second section targeted a more detailed record of the specific inbound and outbound logistics operations occurring at the

company's plants and well as identifying the company's main preferences such as transport price, in-time delivery of goods, and frequency of service that directly affect decision in the supply chain management strategy. The third section pertained to the buyer-supplier relationship and the different governance structures used for inbound and outbound shipments. The final section comprised questions intended to gather information on benchmarking best practices in the corrugated container industry. A sample of the survey questions is provided in Appendix A.

## **VII. CASE STUDIES**

Improved trucking logistics operations can save costs (from transportation, material handling and storage, loss from waste, etc.), shorten lead time and enhance service quality for various firms in the pulp and paper industry. Conducting profiling studies, based on case studies of a few box plants for understanding their current logistics practices, is helpful in understanding how to improve the trucking logistics operational performance. The companies targeted for this study were chosen for specific reasons. The corrugated container producers were a mixture of integrated and non-integrated producers, although each company shared similarities in market share. For proprietary reasons, the identity of the companies is withheld.

### **Company Background: Company A**

Company A is one of the largest non-integrated corrugated packaging companies in terms of both production and market share in the United States. Company A manufactures semichemical corrugating medium, primary, secondary, and die cut corrugated boxes, point-of-purchase displays, interior packaging, corrugated sheets, and

roll stock. It has national market coverage with a strong presence in the food, beverage and general industrial segments and last year had revenues of more than \$550 million while employing over 2,000 workers. The company consumes over 600,000 tpy of containerboard, while owning shares in various high producing semichemical corrugated medium mills.

Boxes are engineered for durability and coated with this company's proprietary “label life” coatings to prevent scuffing and abrasion. The company's boxes are engineered for durability, are made in a wide range of shapes and sizes, and can be fitted with E flute corrugated interior partitions.<sup>32</sup> These die-cut partitions do not generate dust or scrap materials and can be printed upon without difficulty.

Raw material operations are mainly located in the Midwest although some manufacturing facilities are situated in the Southwest and the West coast. Although Company A does produce corrugated boxes at plants on the West coast, the majority of activity occurs in the Midwest and East coast.

### **Company A’s Governance Structures**

At the box plant in Southeast, Company A employees two different governance structures for their inbound and outbound transportation. Because all the vendors for the inbound production materials provide the transportation for their products, shipment schedules and the associated quantities for inbound production material such as linerboard, corrugated medium, paper sheets, semifinished boxes, chemical glue, and ink are coordinated at the corporate level. The inbound governance structure incorporates both arm’s length contracts and long-term partnerships, while the outbound governance

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<sup>32</sup> E flute lightweight corrugated interior partitions minimize shipping damages caused by concussions or other sudden forces, while remaining flexible.

structure solely relies on the outsourcing of their trucking logistics in an arm's length relationship.

#### Company A's Inbound Governance Structure

All the linerboard shipments and 50% of the corrugated medium shipments reach the plant by rail. The price structure and the heavy load capability makes rail an ideal mode for carrying the large, heavy, low-value, high density products. One rail car alone typically carries 7 to 8 rolls of paper, where two rolls alone produce one full truck load of boxes.<sup>33</sup> Because the paper sheets and the semi-finished boxes weigh significantly less than the rolls of linerboard, trucks are the only mode used to deliver these inputs to the box plant. The minimum truckload (TL) weight for a truck is around 20,000 to 30,000 pounds in comparison to the rail carload minimum weight of 40,000 to 60,000.<sup>34</sup>

In late 2002, Company A acquired a substantial stake in a high corrugating medium mill from a large integrated producer. Included in the terms of the purchase agreement, Company A agreed to buy a percentage of output from that mill. Subsequently from that agreement, further purchasing transactions emerged between Company A and the integrated producer.

This long-term partnership between the integrated producer and Company A has translated into the integrated producer supplying the majority of linerboard and corrugated medium to the Georgia box plant, although 35% to 40% of the plant's linerboard and corrugated medium purchases come from competitive bids from different integrated producers. At the corporate level, Company A has lowered its transaction costs

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<sup>33</sup> This estimate is based off an interview with David Blythers, the logistics coordinator for Weyerhaeuser IMPAK Center for Graphics packaging.

<sup>34</sup> Transportation. John J. Coyle, Edward J. Bardi, Robert A. Novak, 1999.

through its negotiated long-term partnership as well as its arm's length purchasing transactions. The inbound governance structure of this company tends to reinforce the hypothesis that transaction costs are a main factor in buying decisions. Corporate handling of inbound traffic flows also highlights the importance of coordinating input shipments from the various contracts with individual vendors.

#### Company A's Outbound Governance Structure

The outbound governance structure employed by Company A recently changed in late 2003 from a leased private fleet to a third party logistics provider (3PL) who manages Company A's dedicated fleet. Initially instigated by a simplistic cost/benefit analysis at the corporate level and further fueled by concerns over the high fixed cost associated with their trucking fleet and the liability of their drivers, the company opened up bidding from 3PLs providers based on the cost structure of the plants' hauls, stops, and destinations. As implied in hypothesis 3, Company A felt there was little incentive to continue to duplicate assets or expertise in transportation when those assets and expertise already existed in the marketplace.

In trying to resolve the issues of high capital expenditures and excessive labor costs, financial considerations were the primary factor influencing the company's decision to outsource. Outside experts were not involved in the decision to outsource. In addition, the company indicated that the perceived major risks to outsourcing were delivery performance and flexibility. Concerned with reliability services such as low transport prices and on-time delivery, Company A's corporate headquarters outsourced all of their outbound shipments in a 5-year contract that included provisions for price guarantees with a 3PL trucking logistics supplier. Because flexibility and responsiveness

to its customer's needs was important, the current shipping supervisor maintained control over the dispatching, routing, and delivery schedules of the fleet. Control over these aspects were considered necessary due to the continually changing shipments that have forced the plant to inventory safety stock for short notices on just-in-time delivery.

Five months into the new governance structure, the box plant has been unable to exploit their 3PLs scale due to the escalating transaction costs of coordinating their shipments, informing the 3PL of particular customer service needs, and transferring industry "know-how." The main factor in the inability to exploit the economies of scale has been the difficulty in shipment coordination. Although Company A has remained in control of the scheduling, the 3PL's limited and inflexible driver pool has forced the Georgia box plant to outsource 10% of their outbound product shipments to other trucking firms in order to maintain customer responsiveness. Because these outsourced shipments are typically shipping less-than-truckload (LTL) averaging distances of 50 to 60 miles with a couple of trips at 200 miles, less-than-truckload and empty backhaul are an additional expenses.

Because boxes are cheap commodities, the source believes the best practice in the industry is to achieve would be better utilization of the trailers with improved cube loads.<sup>35</sup> Through improved 3PL communications and working with customers to consolidate the load, the shipping supervisor believes the box plant could achieve a 10% to 20% cost savings if best practices are achieved.

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<sup>35</sup> "Cubing" out is defined as commodities that fill the trailer before reaching the legal weight limit. "Weighing" out is defined as commodities that cause the vehicle to reach its axle and gross weight limits before it fills the trailer.

## **Company Background: Company B**

Company B is a highly integrated paper company that operates through four main segments: Bleached Pulp and Paper, Packaging, Consumer Products, and Building Products. At the close of 2003, Company B had net sales over \$20 billion with a workforce greater than 50,000 employees.

Company B participates in the US corrugated and paperboard box industry through the Packaging, Bleached Pulp and Paper, and Consumer Products segments. Through these segments, the company produces unbleached and bleached containerboard, corrugating medium, corrugated boxes, feeder and standard corrugated sheet, specialty and litho-laminated corrugated packaging, bleached paperboard and folding cartons. In 2002, Company B was one of the largest US producer of corrugated and paperboard boxes, with a share of the market a little under 10 percent.

Company B's packaging segment had 2002 sales a little under \$3 billion, of which exports accounted for over \$110 million. Through this segment, the company produces and sells containerboard, corrugating medium, kraft paper and corrugated packaging. The company makes containerboard at mills primarily in the Southeast combined annual production capacity exceeds 2.0 million tons.

Company B's corrugated packaging products include corrugated boxes and feeder sheets, as well as point-of-purchase displays. Corrugated boxes made by the Company include single-, double- and triple-wall types, bulk bins, and moisture-resistant boxes.

In 2003 the company manufactured corrugated boxes at plants all along the East and West coast as well as a couple of plants throughout the Midwest with a combined annual production capacity well over 2 million tons.

Company B is also active in the US corrugated and paperboard box industry through the market of litho-laminated corrugated packaging for the food and beverage, warehouse store, electronics, toys, automotive aftermarket, home and garden products, and process manufacturing industries. Litho-laminated packaging enhances point-of-display containers because it can be foil-embossed, coated with aqueous or ultraviolet light-resistant compounds, windowed and printed upon in up to seven colors with or without varnishes.

### **Company B's Governance Structures**

Similar to Company A, Company B incorporates two different governance structures for their inbound and outbound supply chain transportation systems. Unlike Company A which is an independent, non-integrated company, Company B produces linerboard and corrugated medium through their bleached pulp and paper segments. Therefore, all inbound logistics are performed at the corporate level. The inbound governance structure is vertically integrated while the outbound governance structure outsources their trucking logistics through several third party logistic providers in a short-term partnership relationship.

#### Company B's Inbound Governance Structure

Internally deciding and coordinating the transportation from the paperboard mills to the box plant, Company B bases its logistics scheduling on a linear program (LP). With the typical company box plant holding 5 to 6 weeks of inventory, the LP models shapes the decision for inbound transportation with constraint factors such as lead time, mode variability, delivery time, and location. The optimal mode is based on cost per ton-mile, with reliability and service quality given less weight.

That cost is the main driver is exemplified in the 60 to 70% rail usage for linerboard, corrugated medium, and paper sheets. Again, for chemical glue, ink and semi-finished boxes trucks are the preferred mode due to their smaller shipping size allowing for lower minimum truckload weight which allows lower inventory carrying costs. Vertical integration for the inbound shipments is particularly attractive to company B because of the large asymmetries and potential proprietary information involved in the transaction from the mill to the corrugated container plant. Coordination of shipments and the associated high transaction cost of using an outside provider for the inbound shipments is a dominant factor in the transportation governance structure.

#### Outbound Governance Structure

With the same emphasis on transport cost, Company B recently switched from a private fleet to outsourcing a dedicated fleet with a 3PL. Unable in most regions to generate large economies of scale in order to compensate for empty backhaul and driver liability, the company entered into an 18 month short term partnership that highlighted price guarantees for the trucking logistics service provided. With the primary goal of cost reduction and improved efficiency in outbound shipments, both a company shipping scheduler and a dedicated fleet manager coordinated outbound shipping schedules. The expertise in transportation of the 3PL allowed for better management of the costs associated with utilizing equipment, while the company shipping supervisor adds industry and customer needs knowledge.

Flexibility to customers as illustrated through additional inventory storage and just-in-time delivery is not a primary concern for Company B. In fact, Company B does not keep finished products in inventory, unlike Company A, plant shipments typically

leave between 4 to 9 am illustrating the importance of prompt delivery time rather than customer flexibility. Company B carrying smaller inventories than Company A is consistent with the queuing theory, however, since Company B does not carry *any* inventory it is more realistic to assume that flexibility is not as vital a concern as cost.

Company B's outbound governance structure tends to validate the hypotheses regarding economies of scale and core competency as seen through the utilization and interaction of its 3PL provider. With cost as a primary determinant of its supply chain management strategy, one can easily understand the decision for a vertically integrated inbound governance structure and a limited, short-term partnership for the outbound governance structure.

The company defines best practices as better utilization of driver & tractor/trailer utilization. Again, lowering overall supply chain costs by increasing volume and scheduling that permits greater decreased in empty backhaul costs. If this company's inbound box plant operations obtained "best practices" by optimizing distance and trailer utilization, predicted cost could drop by 33%.

### **Company Background: Company C**

Company C is one of the top forest products firms in North America, with major positions in containerboard and packaging, white papers, softwood lumber, and engineered wood products. The company owns large amounts of softwood timber and is one of the largest producers of market pulp and containerboard. Company C produces over 6 million short tons of containerboard per year from 13 mills in the United States, Canada, and Mexico. Through a flurry of joint ventures and major acquisition in the past few years, Company C has increased its global market, and subsequently, its market

power. At the end of 2003, Company C reported net sale well over \$15 billion and net earnings slightly under \$300 million with a workforce well over 55,000.

### **Company C's Governance Structures**

Company C, like Company B, is an integrated company that utilizes almost every ton of containerboard manufactured at its 13 mills and 40 plus corrugated packaging plants. Similar to both Company A and Company B, Company C employs two different governance structures for their inbound and outbound supply chain transportation systems. The inbound governance structure is a mixture of private transportation for the production inputs in combination with a 3PL scheduling the inbound traffic flow, while the outbound governance structure is completely outsourced to one 3PL provider in a long-term partnership relationship.

#### Inbound Governance Structure

Internally providing the transportation from the paperboard mills to the box plant, Company C bases its logistics scheduling on its outside 3PL provider. The largest problem the company was attempting to resolve was improved control over a large transportation and logistics network. Since the largest risks of outsourcing the inbound shipments were on-time or just-in-time delivery of goods, Company C decided to outsource inbound traffic flows while providing the transportation internally. This inbound governance structure integrates varying hypotheses by combining the proposition that vertical integration is relatively more attractive when flexibility and responsiveness are important along with the supposition that division of labor and core competency creates specialized skills in 3PL providers. It is interesting to note here two distinct differences between the integrated producers of Company B and Company C.

While Company C particularly emphasizes reliability and flexibility of inbound shipments, Company B was not concerned with these attributes and focused more on cost per ton-mile. Also, one of the primary reasons Company B did not use a 3PL for inbound shipments was the associated transaction cost, however, Company C found these transaction costs negligible and used a 3PL to coordinate the inbound traffic.

#### Outbound Governance Structure

In addition to outsourcing their inbound traffic control, Company C outsourced outbound traffic control, transportation planning and management, freight consolidation, and order fulfillment and/or product returns. Because of the company's immense size, partly because of the recent mergers, decision makers felt measuring performance and properly utilizing private fleets was extremely difficult. Deciding that it was easier to develop specific measures in a 3PL contract along with the added belief that the 3PLs larger scale would be better to handle their vast logistic network, Company C decided to outsource all their outbound shipments. Trying to address outbound shipment problems of cost per-ton mile, performance inefficiencies coupled with concerns over flexibility and quick customer responsiveness, Company C contracted a three-year partnership with a single 3PL provider that emphasized price guarantees and minimum on-time delivery percentages.

The primary focus of the outsourcing governance structure was to minimize total cost, fully utilize the scale of the 3PL, and improve flexibility and customer responsiveness. Although both Company A and Company C placed substantial weight on just-in-time service and customer responsiveness, Company C did not retain control over the dispatching, routing, and delivery schedules. Because of the global scope of its

logistic networks, Company C felt that the core competency and the associated expertise in transportation of its 3PL allowed for better management of all outbound shipment decisions. This decision also shows the trust component of the company's long-term partnership with its 3PL provider. Through increased coordination, cooperation, and information sharing, Company C's strategy was to combine both parties scale and scope advantages into a substantial competitive advantage.

Relative to its current trucking logistics practices, Company C would extend customer receiving hours, create more cross synergy opportunities with other 3PL providers, and reduce deadhead and total transportation costs in order to achieve best practices in the industry. Again, all of these actions place an emphasis on cost, efficient utilization of its vast logistic network, and customer responsiveness. Company C's outbound governance structure tends to highlight the hypothesis that longer-term partnerships create greater competitive advantages from economies of scale and scope through each partner's specialization or core competency.

## **VIII. POLICY IMPLICATIONS**

In a perfectly competitive environment: (1) all firms have identical cost structures and the same set of technology available; (2) all firms produce a homogenous transportation service; (3) no firm produces a large enough output to have any appreciable effect on market price; and (4) firms can freely enter or exit the market.

The truckload sector used in coordination with outbound governance structures of box plants is assumed to operate under constant return of scale. Why should we expect the TL sector to have constant returns to scale? This sector comprises a relatively large

number of small firms in which owner-operators play a significant role. Also, because capital requirements are relatively small, there is ease of entry and exit. Further, although output for a motor carrier is heterogeneous, once inter-firm differences are accounted for by the operating characteristics, the freight service provided in transported a particular commodity between a given origin-destination pair is homogeneous. Thus, the TL sector appears to approximate the basic requirements of a competitive industry- a large number of small firms providing a homogeneous service with relatively easy entry/exit- which implies that an incumbent firm operates at the minimum point on its long-run average cost curve, its minimum efficient scale. This point characterizes constant returns to scale.<sup>36</sup>

Oum, Waters, and Yong's (1992) compiled a major survey of academic papers that calculated own price elasticity estimates of freight demand. Table 7.1 report, respectively, elasticity estimates of demand for truck freight by commodity groups and the functional forms used to calculate the estimates.<sup>37</sup> A notable feature is the translog flexible cost model for paper products gives the elasticity of 1.05.

Since the truckload motor carrier firms providing specialized services for paper products approximate a competitive industry, as assumed, then we would expect to observe constant returns to scale, which is equivalent to translog output elasticity equaling one. From table 8.1, we see that our estimate of  $a_1$  is 1.05, which says that, at the sample mean and holding all else constant, a 1% increase in output leads to a 1%

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<sup>36</sup> McCarthy, 2000

<sup>37</sup> Sources of this chart are Friedlaender and Spady (1980); Lewis and Widup (1982); Oum (1979b); Oum 91989); Wilson, Wilson, and Koo (1988); and Winston (1981).

Table 8.1 Elasticity Estimates of Demand for Truck Freight

COMMODITIES	AGGREGATE LOGIT	TRANSLOG
AGGREGATE COMMODITIES	0.93	0.69
CHEMICALS	0.98	2.31
FOOD PRODUCTS	0.52, 0.65, 1.00	0.99
PAPER, PLASTIC, & RUBBER PRODUCTS	1.05	0.29
STONE, CLAY, & GLASS PRODUCTS	1.03	2.04
WOOD & WOOD PRODUCTS	0.56, 1.55	0.14

Source: Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates: An Interpretative Survey”

increase in long-run total costs. Therefore, at the sample mean, firms are operating under constant returns to scale.

### Implications of the Perfectly Competitive Market

In the very short run, shippers and carriers have few degrees of freedom in responding to transportation network changes; delivery schedules and routings can be changes, but origins and destinations are fixed. In a somewhat longer run, truck-fleet characteristics can be changed while, in a still longer run, sizes and locations of factories and warehouses can all be changes.

Suppose that one of the box plants achieves best practices. Once best practices are achieved, the relevant demand schedule is the vertical line shown in Figure 8.1.

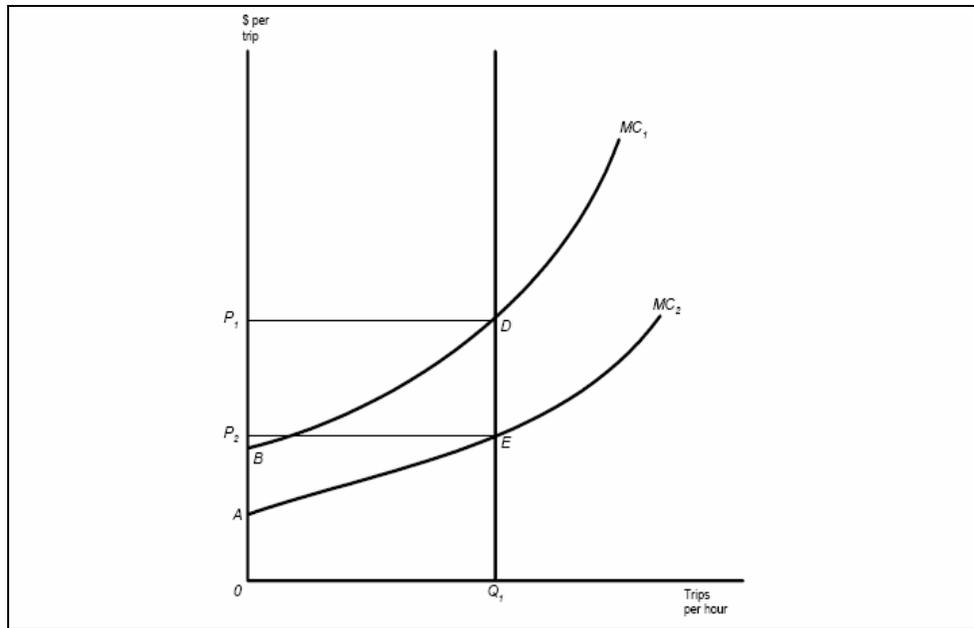


Figure 8.1 Changes in a Perfectly Competitive Environment in the Short Run

As a result of best practices, empty backhaul diminishes, customers become more flexible with extended receiving hours, and full utilization of the trucks occurs, full prices of trips will fall from  $OP_1$  to  $OP_2$ . However, too little time will elapse for them to adjust their travel behavior to take advantage of this change.

As the impact of the box plants best practices affect price, ripple effects influence a number of related markets. Most obviously, increased speeds and reduced prices on corrugated containers induce additional use that results in increased quantity demanded. Again, as quantity demanded decreasing the delivered price of the corrugated containers, cost saving throughout the supply chain such as production, distribution, and inventory practices occurs. In addition, the increased accessibility improvement may increase the values of complementary goods such as corrugated interior partitions.

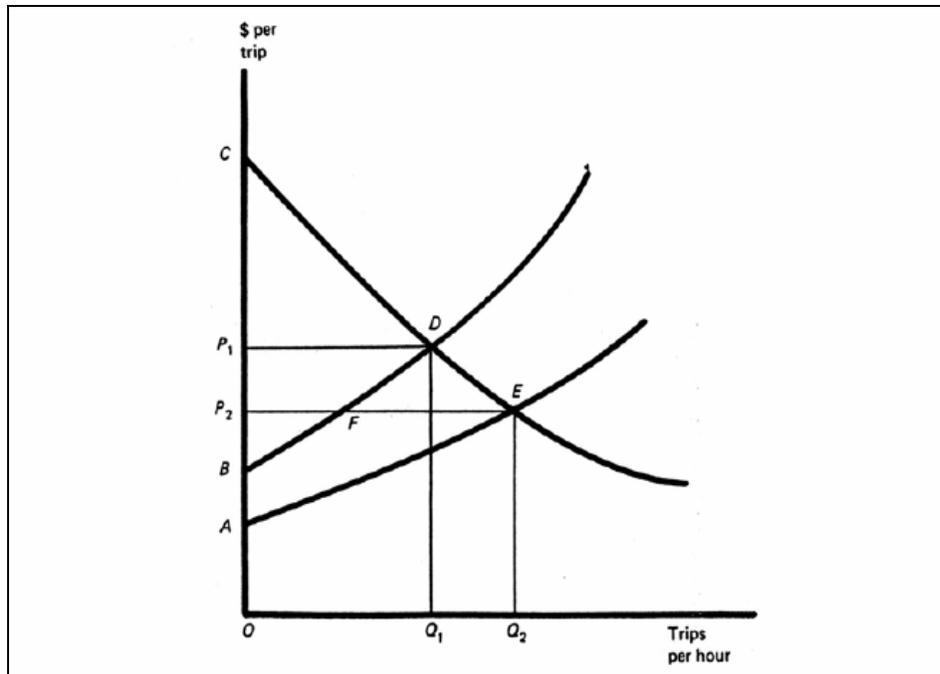


Figure 8.2 Changes in a Perfectly Competitive Environment in the Long Run

A longer-run equilibrium is pictured in Figure 8.2, where optimal price has lowered from  $P_1$  to  $P_2$  and optimal quantity for the overall industry has increased from  $Q_1$  to  $Q_2$ .

### Applications of Elasticity

The basic concept of elasticity and its application to demand are well known. An elasticity gives the percentage change in one variable in response to a percent change in another. In the case of demand, the own-price elasticity of demand is the percentage change in quantity demanded in response to a one percent change in price. The own-price elasticity of demand is expected to be negative, indicating that a price increase decreases the quantity demanded.

In regards to freight transport, a change in the price of an input to a production process, such as transport cost, has a substitution effect as well as a scale or output effect. The substitution effect is the change in input use in response to a price change holding output constant. But a reduced price of an input increases the profit maximizing scale of

output for the industry (and firms in the industry) which, in turn, increases demands for all inputs including the one experiencing the price change, as seen in the above graphs.

It is important to recognize that for measuring the ordinary price elasticity for freight demand, the freight demand system must be estimated simultaneously with the shippers' output decisions, i.e. treating output as endogenous. Ignoring the endogeneity of shippers' output decisions is equivalent to assuming that freight rates do not affect output levels. This, in turn, is equivalent to ignoring the secondary effect of a freight rate change on input demand caused by the induced change in the level or scale of output.

Because the calculation of elasticity uses proportionate changes, the result is a unit less number that does not depend on the units in which the price and quantity is expressed. Individually, if Company A were to achieve best practices and fully realize cost reductions of 33%, one could observe an estimated increase of 34.65% in quantity demanded. Along the same reasoning, Company B would realize a 21% increase in quantity demanded if it obtained best practices and Company C could obtain a 9.5% increase in quantity demand.

## **IX. CONCLUSION**

The main finding of the study is that the corrugated container sector can achieve significant cost economies by taking advantage of the opportunities made possible through strategic strategy in trucking logistics. All of the companies interviewed in the case studies could substantially increase their quantity demanded by 9 to 35%.

More interestingly, this report was able to identify revealed preferences in regards to cost, coordination, contracts, and asset between the various companies interviewed.

The policy implications of this study are illustrated in Table 9.1.

Table 9.1 Policy Implications

	<b>ARM'S LENGTH</b>	<b>PARTNERSHIP</b>	<b>VERTICAL INTEGRATION</b>
<b>COST</b>	<b>High Emphasis</b>	<b>High Emphasis</b>	<b>Lower Emphasis</b>
<b>COORDINATION</b>	<b>Low Emphasis</b>	<b>Emphasis</b>	<b>High Emphasis</b>
<b>CONTRACTS</b>	<b>High Emphasis</b>	<b>High Emphasis</b>	<b>Low Emphasis</b>
<b>ASSETS</b>	<b>Low Emphasis</b>	<b>Emphasis</b>	<b>High Emphasis</b>

For companies driven by minimizing cost with relatively smaller concerns with coordination, arm's length governance structures tend to be the best logistics strategy. However, if coordination is a relatively substantial strategy in addition to minimizing transaction cost, vertical integration is a suggested structure.

In regards to inbound shipments, all three companies placed a substantial emphasis on coordination; however, the governance structure employed to manage the coordination varied. Concerned with the efficient allocation of inputs, Company C outsourced the input coordination. Company B was mainly driven by cost and therefore opted to handle the coordination internally, and Company A focused on customer responsiveness and flexibility and subsequently decided to let the corporate handle all shipments to avoid stock outs.

In regards to cost and contracts for outbound shipments, Company A had the longest contract although its governance structure had more of an arm's length characteristic. The only outsourced function Company A allocated was point-to-point shipments in order to lower cost. Company B also focused on cost but chose to outsource several of its outbound logistic functions to several 3PL providers in short term

partnerships. This strategy was chosen in order to utilize each 3PLs scale and specialized skills. Company C outsourced all of its outbound logistic functions to only one 3PL provider revealing their preference to gain a competitive advantage by exploiting both parties economies of scale through a trusting relationship.

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**APPENDIX A**  
**PILOT SURVEY**

TRUCKING LOGISTICS 'BEST PRACTICES'

A SURVEY OF BOX-PLANTS

A box-plant may use its own resources to meet all of its logistics needs. Alternatively, it may outsource some or all of these logistics functions to third party logistics (3PL) providers, also referred to as contract logistics. This survey will ask you about various aspects of your mill's inbound and outbound logistics functions - particularly those related to your mill's transportation logistics arrangements - for the purpose of gaining insight into 'best practices' that currently exist in box-plant transportation logistics activities.

Press any key when you are ready to proceed.

I. BOX-PLANT LOGISTICS FUNCTIONS

In this section, we are interested in learning about your mill's total logistics operations as well as those associated with inbound and outbound transport logistics activities.

A box-plant's logistics functions typically include

Materials Management	Route and Network Optimization
Product Distribution	Freight Brokering/Forwarding
Inbound/Outbound Traffic Control	Freight Consolidation
Carrier Negotiation and Contracting	Freight Bill Payment
Transportation Planning and Management	Inventory Management
Order Fulfillment	Customs Brokering
Electronic Data Interchange Capability	Product Returns

Press any key when you are ready to proceed.

Below are listed 10 different logistics functions. For each logistics function, please select the number that best describes how your mill meets this function.

Each logistics function I am asking about will be highlighted. In making your selection, use the guide at the bottom of the screen.

Outbound Traffic Control  
Inbound Traffic Control  
Carrier Negotiations and Contracting  
Transportation Planning and Management  
Freight Consolidation  
Freight Bill Payment  
Freight Forwarding and/or Brokering  
Inventory Management  
Order Fulfillment and/or Product Returns  
EDI Capability

- 1 Your mill/company meets the function using its own resources
- 2 Your mill/company outsources the logistics function
- 3 Not applicable

#### Inbound Logistics Functions

I would now like to ask you a few questions about your inbound logistics functions.

Below are listed 6 different inputs that are used to produce boxes. For each input, please select the number that best describes the transport mode(s) used to ship each input into your mill.

Each logistics function I am asking about will be highlighted. In making your selection, use the guide at the bottom of the screen.

Paper Sheets  
Chemical Glue  
Chemical Ink  
Semi-Finished Boxes  
Linerboard  
Corrugating Medium

- |                |                    |
|----------------|--------------------|
| 1 - Truck Only | 3 - Truck and Rail |
| 2 - Rail Only  | 4 - Other Mode(s)  |

Approximately what percentage of your plant's inbound transportation logistics costs are associated with trucking logistics?

- 1 < 10%
- 2 10% - 25%
- 3 26% - 50%
- 4 51% - 75%
- 5 > 75%

Please select the appropriate number.

In arranging your plant's trucking logistics for inbound shipments, please rate the importance of each of the following factors.

Each logistics function I am asking about will be highlighted. In making your selection, use the guide at the bottom of the screen.

- Transport price (\$ per ton-mile, door-to-door service)
- Scheduled travel time from origin to destination
- On-time delivery of goods
- Frequency of service
- Just-in-time delivery service
- Reputation of transport provider
- Integrating trucking logistics with other logistics functions
- Coordination with other modes

- 1 - Not important
- 2 - Somewhat important
- 3 - Important
- 4 - Very important
- 5 - Extremely important

Outbound Logistics Functions

I would now like to ask you a few questions about your outbound logistics functions.

Below are listed 4 different product categories for distribution. For each output, please select the number that best describes the transport mode(s) used to distribute each output out of your mill.

Each logistics function I am asking about will be highlighted. In making your selection, use the guide at the bottom of the screen.

Sheets

Non-printed corrugated containers

Printed corrugated containers

Color/graphic corrugated containers

- |                |                    |
|----------------|--------------------|
| 1 - Truck Only | 3 - Truck and Rail |
| 2 - Rail Only  | 4 - Other Mode(s)  |

Approximately what percentage of your plant's outbound transportation logistics costs are associated with trucking logistics?

- |   |           |
|---|-----------|
| 1 | < 10%     |
| 2 | 10% - 25% |
| 3 | 26% - 50% |
| 4 | 51% - 75% |
| 5 | > 75%     |

Please select the appropriate number.

In arranging your plant's trucking logistics for outbound shipments, please rate the importance of each of the following factors.

Each attribute I am asking about will be highlighted. In making your selection, use the guide at the bottom of the screen.

Transport price (\$ per ton-mile, door-to-door service)

Scheduled travel time from origin to destination

On-time delivery of goods

Frequency of service

Just-in-time delivery service

Reputation of transport provider

Integrating trucking logistics with other logistics functions

Coordination with other modes

- |                        |                         |
|------------------------|-------------------------|
| 1 - not important      | 4 - very important      |
| 2 - somewhat important | 5 - extremely important |
| 3 - important          |                         |

II. TRUCKING LOGISTICS BUYER-SUPPLIER  
RELATIONSHIPS

In this section, we are specifically interested in your mill's trucking logistics functions and the types of buyer-supplier arrangements you have made in order to meet your mill's inbound and outbound trucking logistics needs.

Do you outsource any of your mill's trucking logistics functions?

- 1 - Yes
- 2 - No

Please select the appropriate number.

How many different trucking logistics providers do you use in a typical month in order to satisfy your plant's shipping needs for your INBOUND shipments?

- 0 - no logistics providers for inbound shipments
- 1 - one logistics provider for inbound shipments
- 2 - two logistics providers for inbound shipments
- 3 - three logistics providers for inbound shipments
- 4 - four or more logistics providers for inbound shipments

Please type in the appropriate number.

How many different trucking logistics providers do you use in a typical month in order to satisfy your plant's shipping needs for your OUTBOUND shipments?

- 0 no logistics providers for outbound shipments
- 1 one logistics provider for outbound shipments
- 2 two logistics providers for outbound shipments
- 3 three logistics providers for outbound shipments
- 4 four or more logistics providers for outbound shipments

Please type in the appropriate number.

Which of the following trucking logistics functions do you perform using mill or company resources? Please select all that apply.

Use the arrow keys to move the highlight bar to a logistics function you perform, then press the SPACE BAR to select that function. To change a selection, move the highlight bar to the position again and press the SPACE BAR. When you have chosen all the functions you perform, highlight "No More" and press SPACE BAR or press ENTER.

Truck Fleet Negotiations and Contracting  
Truck Route Planning  
Truck Fleet Consolidation  
Bill Payment for Truck Fleet Shipments  
Truck Freight Forwarding and/or Brokering  
Inventory Management using Truck Fleets  
EDI Capability  
No More

Below are definitions for four types of buyer-supplier relationships that are commonly used by mills to satisfy their trucking logistics needs.

1 - Spot Market

Truck logistics services are provided for a single transaction and no commitments are made for future transactions.

2 - Arm's Length

Trucking logistics services are purchased from 3PL providers and no commitments are made for future transactions.

3 - Coordination

Trucking logistics needs are coordinated with the services provided by 3PLs with a short-term contractual relationship that requires little investment and involves a limited scope of activities.

4 - Strategic Alliance

A mill's logistics activities, operationally and strategically, are integrated into the functions provided by 3PLs. This arrangement has a long term focus and normally involves many logistics activities.

Press any key when you are ready to proceed.

Select the number of the buyer-supplier relationship that best describes the form of INBOUND trucking logistics arrangements that you have with your PREDOMINANT 3PL supplier.

1 Spot Market  
2 Arm's Length  
3 Coordination  
4 Strategic Alliance

Select the number of the buyer-supplier relationship that best describes the form of OUTBOUND trucking logistics arrangements that you have with your PREDOMINANT 3PL supplier.

- 1 Spot Market
- 2 Arm's Length
- 3 Coordination
- 4 Strategic Alliance

Let's now focus upon your OUTBOUND trucking logistics arrangements. I would now like to ask you a couple of questions about your current contract with this 3PL trucking logistics provider.

Please type in the total number of months of your current contract with your predominant 3PL trucking logistics supplier.

Which of the following types of provisions are included in your contract with your predominant outbound trucking logistics supplier?  
(Check all that apply)

- Minimum annual traffic volume guarantee
- Price guarantee for the trucking logistics services provided
- Minimum on-time delivery percentage
- Penalties for late deliveries
- No More

I would now like to ask your opinion related to various characteristics and activities of trucking logistics providers. These questions fall into four broad categories: Cost, Coordination, Contracts, and Assets

Let start with costs.

Relative to meeting ALL of your trucking logistics functions using mill or company resources, please tell me how much you agree or disagree with the following statements.

- 3PLs offer cost advantages because they operate on a large scale
- 3PLs offer cost advantages because they must innovate to stay competitive
- 3PLs offer greater cost advantages the larger the inbound/outbound shipment
- 3PLs do not offer cost advantages if a mill's primary customers are local
- 3PLs are always cost competitive

- 1 - strongly disagree
- 2 - somewhat disagree
- 3 - somewhat agree
- 4 - agree
- 5 - strongly agree

Let's now move on to Coordination

Relative to meeting ALL of your trucking logistics functions using mill or company resources, please tell me how much you agree or disagree with the following statements.

Coordination of input flows is more difficult with 3PLs  
Coordination of product distribution is more difficult with 3PLs  
Measuring the quality of 3PLs trucking logistics services is more difficult  
Developing a trusting relationship with a 3PL provider is essential

- |                       |                    |
|-----------------------|--------------------|
| 1 - strongly disagree | 4 - agree          |
| 2 - somewhat disagree | 5 - strongly agree |
| 3 - somewhat agree    |                    |

We would also like your opinion on trucking logistics contracts.

Relative to meeting ALL of your trucking logistics functions using mill or company resources, please tell me how much you agree or disagree with the following statements.

The cost of negotiating & enforcing contracts with 3PLs are major concerns  
Long term contracts with 3PLs reduce trucking logistics costs  
It is important to include specific performance measures in 3PL contracts  
Contracting with more than one 3PL prevents 3PL opportunistic behavior  
Information sharing with 3PLs is more prevalent in longer term contracts

- |                       |                    |
|-----------------------|--------------------|
| 1 - strongly disagree | 4 - agree          |
| 2 - somewhat disagree | 5 - strongly agree |
| 3 - somewhat agree    |                    |

Finally, let's move to Assets.

Relative to meeting ALL of your trucking logistics functions using mill or company resources, please tell me how much you agree or disagree with the following statements.

3PLs reduce the need for purchasing specialized equipment  
Mill location is less important with 3PLs  
Just-in-time delivery increases your incentive to use a 3PL

- |                       |                    |
|-----------------------|--------------------|
| 1 - strongly disagree | 4 - agree          |
| 2 - somewhat disagree | 5 - strongly agree |
| 3 - somewhat agree    |                    |

Please wait a moment ...

I would like to ask you a couple of questions on Trucking Logistics Best Practices at your mill/company.

Relative to your current trucking logistics practices, what percentage improvement is needed for you to achieve 'best practices' in meeting your mill or company's trucking logistics needs?

1. 0% - 10% improvement
2. 11% - 20% improvement
3. 20% - 40% improvement
4. 40% - 60% improvement
5. > 60% improvement

Relative to your current trucking logisitics practices, what three actions would you take in order to achieve 'best practices' in meeting your trucking logistics needs?

We are now at the end of the survey and I just have a few more questions.

Box-plants differ along various dimensions, including personnel, size, number of mills, location, and level of integration. Below are a few demographic questions that will enable the research team to control for these differences in our analysis.

What is your title at the box-plant?

How long (in months) have have you been in this position?

Approximately how many employees work on transportation logistics operations at your mill?

Geographically, where are the majority of your customers located?

1. Locally (< 100 miles)
2. Regionally (< 750)
3. Nationally
4. Globally

THANK YOU!