Future Manufacturing, Markets, and Logistics Needs

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In 1962 Peter Drucker discussed the logistics-distribution area in an article entitled "The Economy's Dark Continent," referring to it as the last frontier for significant cost reduction. In describing the situation then, Drucker made the following observations:

> Distribution is one of the most sadly neglected but most promising areas of American Business. . . . We know little more about distribution today than Napoleon's contemporaries knew about the interior of Africa. We know it's there, and we know it's big; and that's about all. . . . Most of our present concepts focus on production or on the stream of money and credit, rather than on the flow of physical goods and its economic characteristics. . . . To get control of distribution, therefore, requires seeing—and managing—it as a distinct dimension of business and as a property of product and process rather than as a collection of technical jobs.
>
> The industrial purchaser has to know his own business . . . he has to know what the product or supply he buys is supposed to contribute to his company's end results. . . . My purpose is to point to distribution as an area where intelligence and hard work can produce substantial results for American business. Above all, there is a need for a new orientation—one that gives distribution the importance in business design, business planning and business policy its costs warrant. (1,p.103)

Reflecting on the developments in logistics and transportation since 1962, one may be tempted to use the line of a popular advertisement: "We've come a long way." Logistics and transportation have indeed come a long way, and there are many signs of successful achievement. For example, the number of major manufacturing and service companies represented by individuals with titles of vice president or director of logistics, distribution, materials management, or transportation has increased dramatically, as have the responsibilities and salaries of such individuals (2,pp.120–130). The membership of one of the best known logistics organizations, the Council of Logistics Management, has swelled to more than 7,000 active members and another 40,000 members who periodically attend the annual meetings of the organization.

Despite the significant developments that have occurred in logistics and distribution since World War II, logistics and transportation are still in a period of growth and development, as depicted in Figure 1 (2,pp.124–125). For many companies, 15 to 25 percent of the cost of their manufactured products goes to cover the expenses incurred before an item gets to or after it leaves the production line: transportation, inventory, warehousing, packaging, and materials

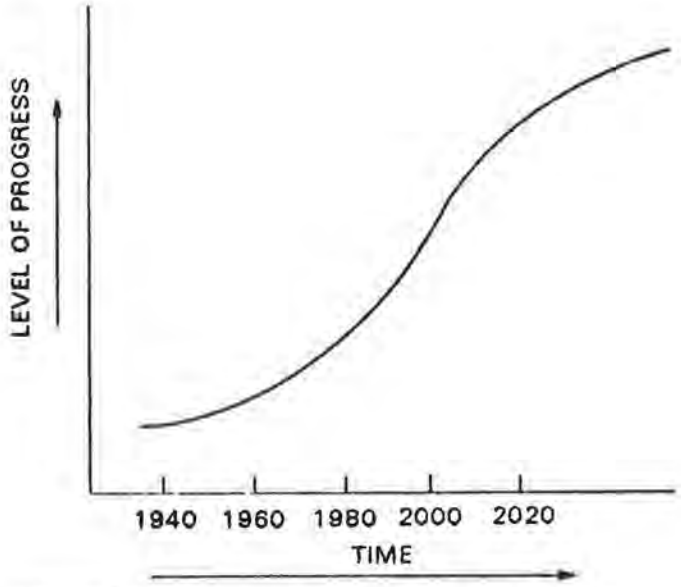

FIGURE 1 Development of importance of logistics and distribution in U.S. companies (*34*,p.2).

handling. For service companies, the costs are often higher (*3*,pp.8–12). One U.S. automobile producer, for example, spent more than $3 billion on transportation alone in 1990 (see Table 1).

The 1970s could be classified as the decade for products and markets, and the 1980s as the decade for finance. Many individuals believe that the 1990s will be the decade for transportation and logistics because gaining and maintaining access to a customer base and significant market share are the focus of strategic thinking and planning in big and small organizations (*3*,pp.10–14). Logistics and transportation can play an important role in helping achieve such strategic objectives (*4*,pp.21–24).

The 1980s was a decade of prosperity and growth, but it was also a period of turbulence and upheaval that resulted in a transformation in the ways in which materials, products, and services moved through the supply chain from vendors to manufacturers to customers. Of particular note has been the shifts in relationships among distribution channel members, especially the increased economic leverage of large retailers such as Wal-Mart and Toys-R-Us, and the growth in importance of the entire service sector. Increasing sophistication of all buyers, industrial and consumer, with their insistence and quality and value has also contributed to the transformation (*4*,pp.38–39). But the 1990s will be even more significant in terms of change in the U.S. economy and the distribution system that will be needed to support it (*5*).

In the next section, the logistics concept will be examined to provide additional insight into understanding the needs of shippers in the 1990s and the general nature of the demand for transportation services. The impact of the logistics concept will be illustrated by research done on the use of larger equipment size by shippers. The section on the logistics concept will be followed by a discussion of the major change agents (drivers) that continue to dictate distribution system requirements in the 1990s. Next will follow an examination of some macro data that will underscore the impact of the logistics changes of the 1980s. Following the examination of the macro data will be a discussion of critical factors for shipper success in the 1990s. The final section will summarize the transportation strategies of shippers and their impact on freight movements in the United States.

Logistics Concept

History

The origins of the modern logistics concept in businesses can be traced to developments in military logistics during World War II (*6*,pp.2–6.) The recent Persian Gulf War again demon-

TABLE 1 Major Transportation Purchasers, 1991 (*35*,p.15)

Rank	Company	'90 Tab ($)
1	General Motors	3,450,000,000
2	Ford	3,000,000,000
3	Chrysler	1,000,000,000
4	International Paper	1,000,000,000
5	U.S. Steel	734,200,000
6	General Electric	700,000,000
7	Dow Chemical	670,000,000
8	PPG	478,000,000
9	Shell	382,000,000
10	Bethlehem Steel	374,000,000
11	LTV Steel	352,300,000
12	Union Carbide	340,000,000
13	Alcoa	300,000,000
14	FMC	263,000,000
15	J.I. Case	220,000,000

strated the importance of logistics to a successful military effort. In fact, the Persian Gulf effort has been referred to as the "logistics war," and the importance of the integrated logistics pipeline supporting the fighting effort was acknowledged repeatedly by the military and civilian leadership. The integrated logistics concept was obviously critical to the military's success in the Gulf War. That same concept, while not new, has also been receiving increased attention in the private sector in the 1990s (*3*,pp.28–30).

One of the most widely used and cited definitions of logistics is as follows:

> Logistics is the process of planning, implementing and controlling the efficient, effective flow and storage of raw materials, in-process inventory, finished goods, services and related information from point of origin to point of consumption (including inbound, outbound, internal, and external movements) for the purpose of conforming to customer requirements. (6)

Implied in the definition is that the logistics process provides a systems framework for decision making that integrates transportation, inventory levels, warehousing space, materials handling systems, packaging, and other related activities and encompasses appropriate trade-offs involving cost and service. Another definition suggests that logistics involves the efficient and effective management of inventory whether in motion or at rest to satisfy customer requirements and organizational objectives (6,p.10). The important aspect of the latter definition is that transportation service is recognized as inventory in motion; therefore, the true transport cost is more than the actual rate charged by the transportation company.

To gain some additional perspective on the importance of the integrated logistics concept and how it has affected business organizations, the Dow Chemical Company will be used as an illustrative example (7,pp.173–176). The Dow Chemical Company is a diversified manufacturer of basic chemicals, plastics, specialty products, and services and produces and sells more than 1,800 products that can be categorized into four major groups: basic chemicals, basic plastics, industrial specialties, and consumer specialties. Many different formulations of these products are packaged in many different containers at 28 manufacturing locations in the United States. These products can be distributed through any one or a combination of 350 stocking points.

Since Dow is highly integrated, the supplier for raw materials for one manufacturing process is often another Dow plant. Managing work-in-process inventories is not difficult, but manag-

ing finished goods inventories is complex and challenging. Many of the finished products must be in inventory when customer orders are received. Just the size and complexity of the logistics network makes managing it extremely difficult, but other factors add to the problem (7,p.177). Traditionally, for example, the product supply chain of manufacturer, distributor, and supplier worked independently of one another trying to anticipate demand, but without real visibility into the future demand from the other links in the chain. Inventory was used to buffer uncertainty at each step, which resulted in large inventories at plant and field warehouses (7,p.175).

Computer systems are now being used to substitute information for inventory all along the supply chain. Each link works with the same demand information properly offset by time and rounding quantities. The result is that each link in the supply chain provides a time-phased schedule of the demand that it expects to place on the next link.

Demand forecasting is used to anticipate customer demand. Some customers may provide estimates of demand, leaving forecasting to anticipate the rest. Distribution requirements planning (DRP) considers inventory position, translates forecasts into realistic shipping quantities and schedules, and then consolidates that demand at each shipping point in the distribution network, ultimately to the plants. Master production scheduling (MPS) systems are used to translate schedules of DRP demand into feasible master schedules of when finished goods will be produced. The master schedule puts demands on raw materials. So materials requirements planning (MRP) translates master schedules into a schedule of when raw materials need to arrive from the suppliers.

Computer systems also support the flow of materials and products along the supply chain. Purchasing and transportation systems supported by electronic data interchange (EDI) manage the flow of material from vendors. Technologies such as computer-aided design and manufacturing and automatic materials handling systems support the manufacturing process. Deployment planning, vehicle load management, and vehicle routing and scheduling systems plan the movement of products from plants to warehouses to customers. The benefits from using an integrated systems approach to supply and demand have allowed Dow to reduce its logistics costs on a relative basis and improve its customer service.

Much more could be added about the results of integrated logistics at companies such as Dow, but hopefully enough perspective has been provided to show that companies want to attain high levels of customer service yet reduce inventory levels and transportation costs at the same time. The improvement of customer service and the reduction of logistics costs would have been described as contradictory 10 years ago, but not today. Logistics and transportation systems in the leading organizations are achieving these apparently contradictory goals by strategic management of their logistics systems (7,p.178).

As indicated, modes are being chosen using a selection framework based on an integrated set of logistics-related factors. Decisions are no longer based simply on transportation cost (rates). Other factors can influence the decision. As part of the research effort for this paper, an examination was made of how a logistics framework would influence a shipper's decision to take advantage of lower rates with larger shipment tenders made possible by larger equipment sizes of motor carriers (8).

Application

The purpose of the research was to assess the opportunity cost associated with the additional inventory resulting from shipping and receiving larger order sizes. Given the current trend toward lowering inventory levels, the impact of longer combination vehicles (LCVs) on inventory was considered to be a relevant issue for analysis. The research used combinations of actual product values, shipment weights, densities, and distances that were examined to determine if inventory costs increased to the point that they offset the savings in transportation costs. Higher product values and larger shipment sizes usually increase average inventory levels and carrying costs.

Given the inventory-transportation trade-off, the question is whether the increased capacity will be used if carriers do offer larger vehicle capacities to shippers at lower rates. The trade-off approach necessitated by this systems perspective necessitates analyzing the impact of inventory on the total cost of logistics.

The first step was to test various shipment alternatives and their inventory-transportation cost trade-offs, which was done by running many hypothetical shipping scenarios using a simulation model developed at Pennsylvania State University to test the sensitivity to an assortment of variables: product value, freight rate level, demand volumes, carrying cost rates, and so on. For each variable, a range of values was run through the model to help identify which commodity and traffic lane characteristics most influenced the inventory carrying costs associated with larger vehicles (shipments).

The next step was to select a variety of shipper commodity groups to include in the survey. The commodity groups selected reflect a wide spectrum of shipping characteristics (Table 2). The commodity groups possessed a diversity of weights, densities, and product values. Moreover, 1987 Census of Transportation data showed that these 12 groups represented a significant percentage of total U.S. commodity flows.

Each shipper selected received a questionnaire that requested information pertaining to its specific transportation and logistics characteristics, and the shippers were asked to include data for high-volume products currently moving by full truckload (TL). The information requested included product values, inventory carrying costs, freight rates, line-haul distances, annual volumes, and order costs. The range of each of these six variables for the shippers surveyed is summarized in Table 3, showing product variables. As can be seen, there was a wide range with most of the variables.

- *Product value* is based on a company's price charged to its best customer ordering in full TL quantities. In many industries the terminology for this price structure is "bracket pricing." It reflects the best price to the best customer using the most economical shipping vehicle of the shipper. From an accounting standpoint, it represents the cost at the end of the manufacturing line plus a percentage markup.
- *Shipment size* incorporates two factors. The first is the size of the shipping vehicle. The larger the vehicle, the more freight it can carry (if not restricted by weight). The second factor is the physical characteristics of each commodity. Compare a packaged cereal shipment to a chemical shipment: the cereal is light and bulky and, because the physical dimensions of the trailer, will reach the cubic capacity before it reaches the weight capacity of the trailer;

TABLE 2 Industry Presentation of Survey Participants

SIC	Description
(01)	Agricultural Products
(20)	Food & Kindred Products
(21)	Tobacco
(22)	Textile Mill Products
(25)	Furniture & Fixtures
(26)	Paper & Allied Products
(28)	Chemicals & Allied Products
(32)	Stone, Clay & Glass Products
(33)	Primary Metal Industries
(34)	Fabricated Metal Products
(35)	Industrial Machinery & Equipment
(50)	Wholesale-Durable Goods

SIC: Standard Industrial Code Representation

TABLE 3 Product Variables Range of Values

Variable	Hi/Lo Values
Product Value	$0.18 - $52.00 per lb.
Inventory Carrying Cost	10% - 30%
Fixed Order Cost	$13.00 - $63.71
Freight Rate	$0.99 - $3.86
Shipping Distance	75 - 2,716 miles
Annual Volume	12 - 1,740 tklds.

conversely, the chemical product is usually packaged in drums and has a weight density (pounds per cubic foot) that creates shipments that "weigh out" before they "cube out" in standard dry van equipment.

- *Shipping distance* reflects the distance from the point of origin to the point of destination. The origin and destination for all products are from a plant to another plant or distribution center. One important reason for this selection is because moves from plant to plant/distribution center are typically done in single-commodity TL shipments.
- *Product weight density* is expressed on the basis of weight per shipping unit (sacks, drums, or cases). This variable affects the total amount of a product that a company can legally load and transport in a trailer. The maximum TL quantity also depends on the interior physical dimensions (cubic carrying capacity or volume) and weight limitations of the shipping vehicle. A product with low weight density makes more efficient use of the added cubic capacity afforded by the LCVs.
- *Inventory carrying cost* reflects the corporate cost of holding inventory at origin and destination. Total inventory carrying costs will vary depending on the value of the product in inventory and the rate calculated for carrying inventory (current interest, property tax, and insurance rates).
- *Freight rate* expresses the flat charge of the shipment based on shipment distance or shipment weight and is usually expressed by dollar per mile or hundredweight. Freight costs, along with inventory carrying costs, typically make up the major share of total logistics costs. Most of the shippers surveyed used carriers that quote rates on a per-mile basis. For ease of analysis and consistency, rates were converted and expressed in the per-mile format.
- *Annual lane volume* in units and hundredweight was furnished by each company. This permitted the entering of various demand levels into the simulation model to analyze the impact of annual demand on the total logistics cost for each vehicle type.
- *Fixed order cost per shipment* reflects the cost of processing an order at the origin. It reflects the cost of the paperwork and information transfer to the shipper. Total order costs will vary by vehicle type. A standard 48-ft trailer would have to make twice as many trips as a double 48-ft trailer combination to meet the same annual lane volume, which would mean twice as many orders.

To illustrate the impact of the variables, four case studies based on data obtained from shippers were developed (Table 4, Figures 2 through 9). For each scenario, three shipment configurations were used: 48-ft TL, 48-ft/28-ft LCV, and 48-ft/48-ft LCV. The last two represent LCV movements, which are larger shipment sizes than currently being used and would provide lower rates because of carrier productivity. The 48-ft TL shipment was considered standard. For each case, total logistics costs (freight, inventory carrying cost, and order costs) associated with the three shipment configurations are shown, followed by a presentation of what has been labeled the break-even rate. The break-even rate is the rate that could be charged by each configuration to equalize the total logistics cost of all three.

In Case 1, the variables are mostly in the middle range for each category but the product value is relatively low. The simulation model shows that the twin 48-ft LCV would provide

TABLE 4 Values for Cases 1–4

CASE	PRODUCT VALUE ($/lb)	INVENTORY CARRYING COST (%)	FIXED ORDER COST ($)	FREIGHT RATE ($/mi)	SHIPPING DISTANCE (mi)	ANNUAL VOLUME (48-ft TLs)
1	2.70	20.25	37.74	1.30	300	100
2	4.03	18.00	35.00	1.10	734	12
3	1.47	20.00	25.00	1.75	617	52
4	12.76	20.25	25.00	1.80	300	55

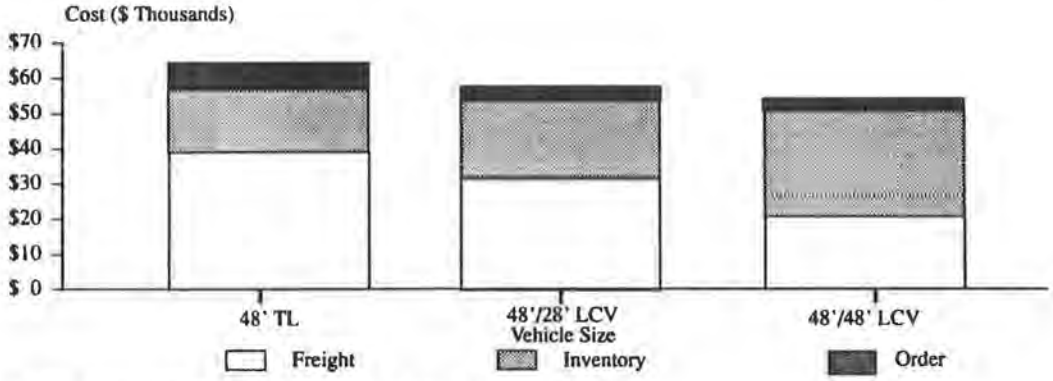

FIGURE 2 Comparison of costs by vehicle size, Case 1.

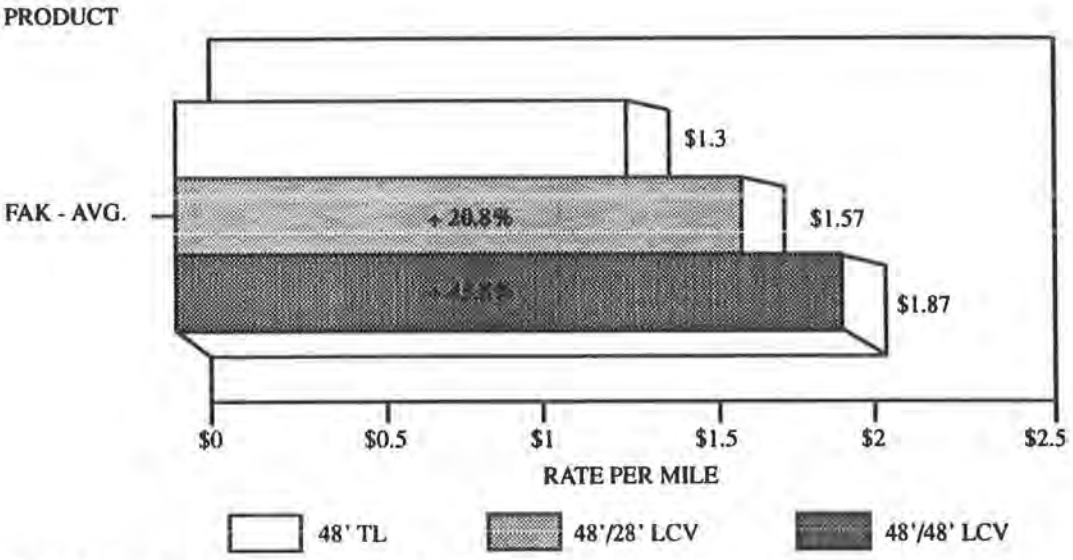

FIGURE 3 Break-even freight rates, Case 1.

the lowest total logistics costs and that the transportation rate on this configuration could increase by 43.8 percent over the single 48-ft trailer before total logistics costs would be equal.

Case 2 represents a shipment situation with higher product value, longer distance, and less volume. In this case, the 48-ft standard trailer would provide the lowest total logistics cost because the inventory carrying costs are so high relatively. Interestingly, the twin 48-ft could offer a zero transportation rate, and total logistics costs would still be lower for the 48-ft trailer paying $1.10/mi.

Case 3 has low product value and relatively long shipment distance. Here, the twin 48-ft LCV again provides the lowest total cost, and there could be an 88.6 percent increase in the

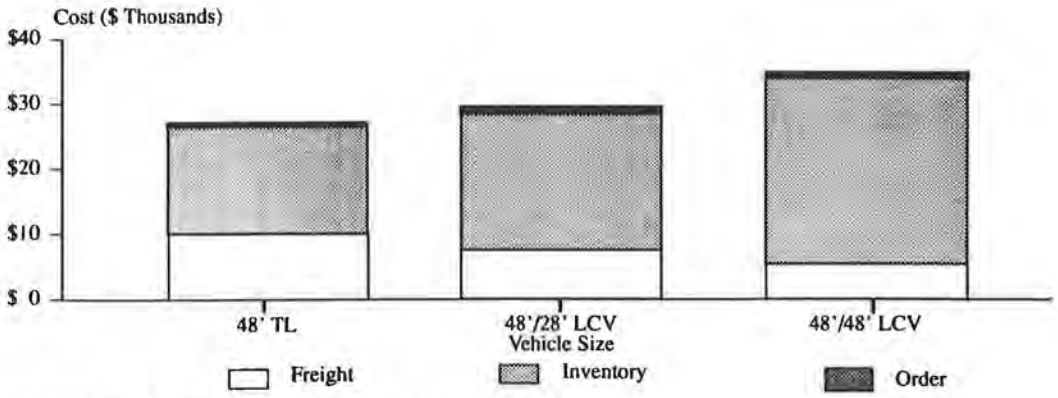

FIGURE 4 Comparison of costs by vehicle size, Case 2.

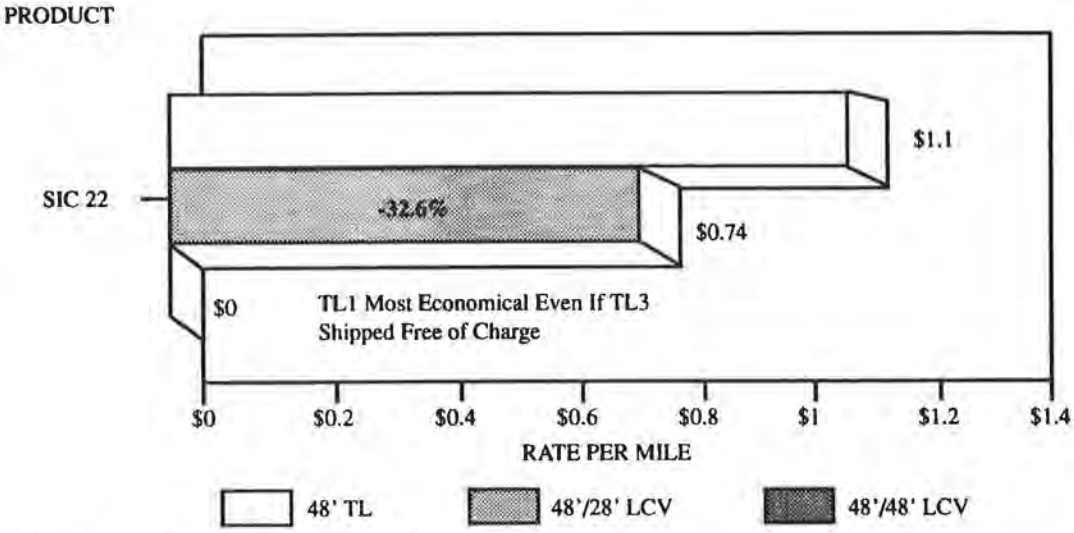

FIGURE 5 Break-even freight rates, Case 2.

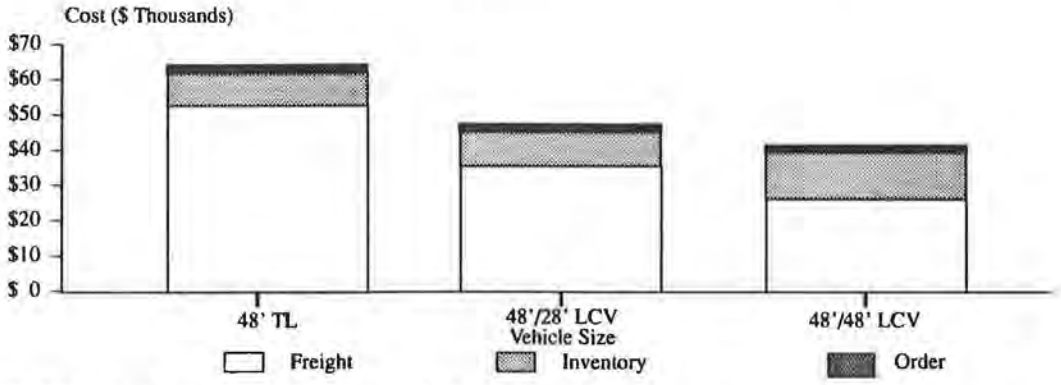

FIGURE 6 Comparison of costs by vehicle size, Case 3.

rate, from $1.75 to $3.30/mi, before total logistics costs would be equalized with the single 48-ft configuration.

Case 4 illustrates a situation with high product value and lower shipment distance. Consequently, the single 48-ft configuration provides the lowest total cost. Again, even if transportation were free, the double 48-ft LCV would give a higher total logistics cost.

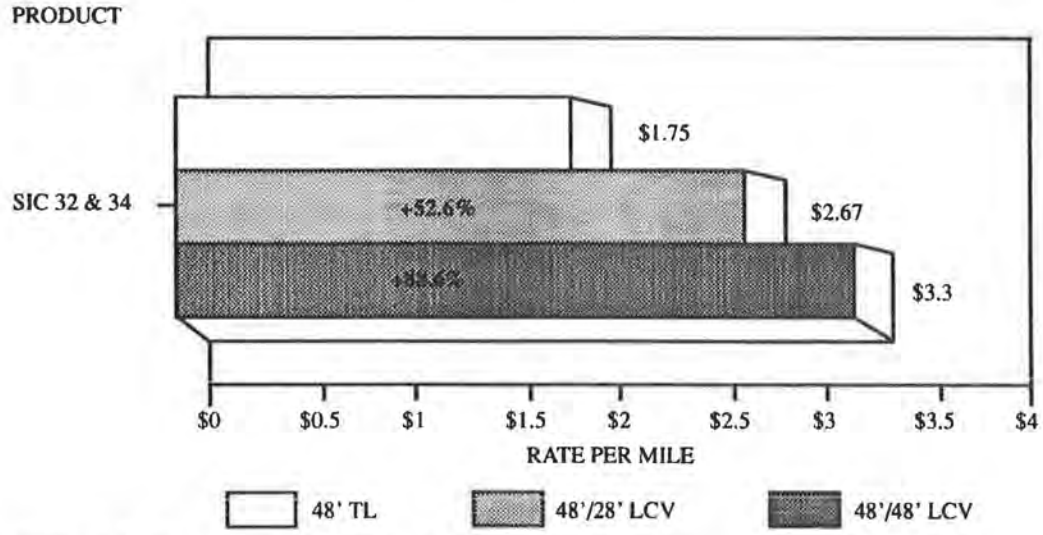

FIGURE 7 Break-even freight rates, Case 3.

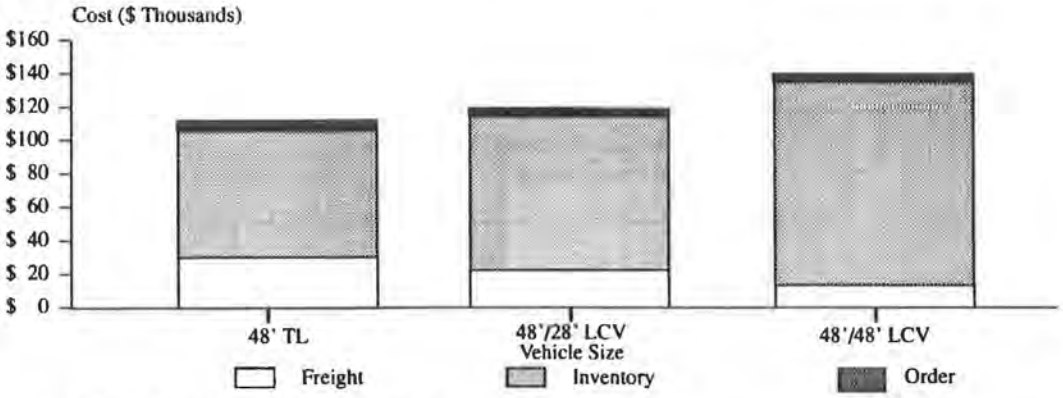

FIGURE 8 Comparison of costs by vehicle size, Case 4.

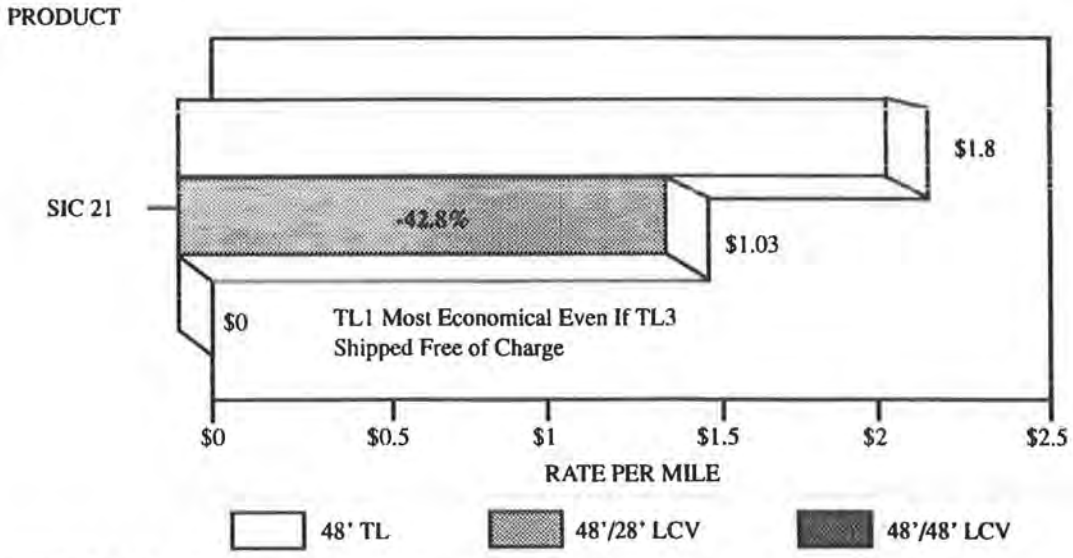

FIGURE 9 Break-even freight rates, Case 4.

As illustrated by these four cases, even with free transportation it is possible to have higher total logistics costs because of the impact of inventory carrying cost when product value is high. Besides inventory carrying costs, other logistics costs can influence the transportation decision because of their impact total cost. Even though the cost (rate) of transportation services is an important variable affecting almost all transportation decisions (maybe the most important factor in some decisions), other costs can offset the effect of lower transportation costs, as we have seen. Shippers are now in a position, as illustrated by the Dow example, to evaluate the logistics impact of varying shipment sizes.

The trends in this society definitely point toward the movement of higher-valued, time-sensitive commodities, which will mean increasing focus on a systems perspective in making transportation decisions (*9*). The next section of this paper will explore some of the most important drivers of change in the U.S. economy that will affect logistics and transportation and the flow of goods and services in the future.

The possibility of increasing customer service while decreasing logistics costs would have appeared impossible in the 1970s, but some major forces were at work during the 1980s that pressured many business organizations to perform more efficiently and effectively and revealed the potential contribution of an underleveraged distribution system.

Drivers of Change

Globalization of Economy and Markets

The internationalization of U.S. companies and the competitive pressure of foreign competition in both domestic and global markets has affected large and small companies. This globalization of U.S. business has been a double-edged sword, providing both a threat and an opportunity. There is no doubt, however, that it is no longer business as usual, and companies have responded in part by copying some foreign business practices, such as just-in-time (JIT) inventory control and flexible manufacturing systems, as well as instituting other changes in their organization structures to remain competitive (*10*).

Globalization runs the gamut from foreign purchasing (sourcing) of raw materials and supplies and selective sales in international markets with extensive use of intermediaries to multifaceted international manufacturing and marketing strategies encompassing international production sites, multistaging inventory, and counter trading product sales. The growing international dimension of both the inbound and outbound logistics channels has had and will continue to have a major impact on the logistics and transportation requirements of companies. The complexity of logistics and transportation will increase because of the length (distance and time) of the distribution pipelines inbound and outbound. The domestic transportation system will have to respond in a coordinated fashion with international transportation companies.

Much of the attention has been directed at the countries of the European Economic Community (EEC) and the Pacific Rim, but the recent signing of the North American Free Trade Agreement (NAFTA) will dramatically change trade relationships with Canada and Mexico (*11*). In fact, much has happened already in terms of trade with Canada and especially Mexico.

Mexico: A Case Study

The trade situation in Mexico provides a convenient example to illustrate the importance and the complexity of global operations for U.S. companies and the transportation service that will be required. The first question to be answered is why Mexico has become important. A few economic variables will answer that question. With about 88 million people, Mexico's population is more than three times that of Canada, but more important, by 1995 more than half of that population will be under 20 years of age—a marked contrast to the U.S. population

(*11*,p.44). This youthful citizenry represents a low-cost labor pool ($12 less per hour than the United States) and a growing consumer market. Mexico's gross national product (GNP) has been growing at 4 percent annually over the past 3 years, and its hyperinflation problem appears to be over. All this combined with a government that has been proactive in attracting foreign investment has made Mexico a very attractive country for foreign producers (*12*).

The most well-known aspect of the proactive governmental policy in Mexico has probably been its Maquiladoras program, which allows companies to set up production and assembly operations and pay duties only on the value added by the additional processing in Mexico. Seventy-five percent of the Fortune 200 companies in the United States have Maquiladoras operations (*13*,pp.32–24). Although Maquiladoras programs tend to be located in border communities, there has been a growth in such operations in interior communities because of the larger population base.

Essentially, the Maquiladoras operation necessitates a transportation movement into and out of Mexico. The international dimension complicates the logistical transportation situation, as indicated by the depiction in Figure 10 of a typical border crossing just into Mexico. The left side of the illustration shows that the number of parties expands to five from the usual one-party operation of a domestic movement. The border clearance charges add between $200 and $400 of additional cost per trailer that does not include the cost of the interior transportation movement. But the labor, utility, and other cost savings offset the additional costs of transportation and logistics (*13*,p.38).

U.S. motor carriers are precluded by Mexican law from operating directly in Mexico—in contrast to Canada. U.S. carriers have responded to the great growth in the flow of products to and from Mexico by establishing alliances with Mexican carriers. J.B. Hunt, Roadway, ABF, United Parcel Service (UPS), Yellow Freight, and others have been aggressive in this area; for instance, the Roadway subsidiary Roadway Bodegas y Consolidacion offers second-day service between Nuevo Laredo and Mexico City and overnight service between Nuevo Laredo and Monterrey. Other examples of such relationships are as follows:

- J. B. Hunt
  - –Established partnership with Santa Fe to move trailers and containers to El Paso,
  - –Moves trailers to border, and
  - –Teamed with Fletes Sotelo, a Mexican TL carrier, to launch Hunt de Mexico to transport within Mexico.
- Contract Freighters Inc.
  - –Signed operating agreements with more than 20 Mexican trucking companies;
  - –Shares customer service, maintenance, and management standards with Mexican partners;
  - –Has terminals in Laredo, El Paso, and Dallas with full-service maintenance, driver residence, and 24-hr dispatch office; and
  - –Averages 900 border crossings a day using more than 3,500 air ride trailers.
- UPS
  - –Runs international express business out of Mexico,
  - –Tests transporter ground business between Mexico and United States, and
  - –Flies own aircraft in and out of Mexico.
- Mexican Express
  - –Is based in Texas;
  - –Introduced less-than-truckload (LTL) capabilities to Mexican partners;
  - –Offers in-bond shipments between Texas and Mexico City, Guadalajara, and Monterrey through subsidiary Transportacion Mexico Express SA de CV; and
  - –Possesses special permit from Mexican government to bring consolidated loads in-bond for customs clearance at destination.

NAFTA also includes tight restrictions on U.S. carriers operating directly into Mexico. This has been a sore point for many U.S. carriers, but change is on the horizon. Alliances with

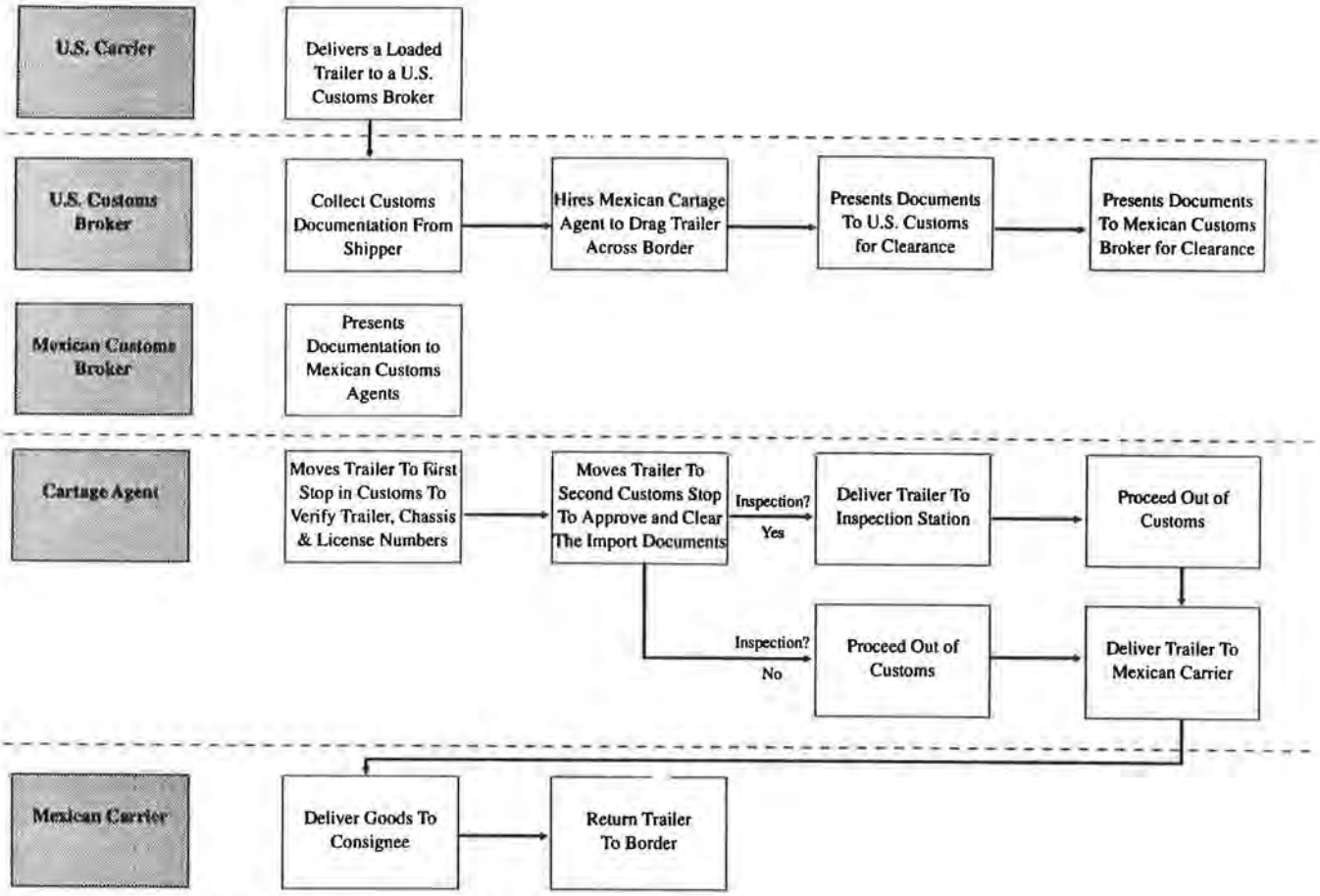

FIGURE 10 Typical border crossing into Mexico.

Mexican carriers have been the only alternative to allow participation in this growing flow of products into Mexico from the United States and back out again. NAFTA will in all likelihood make Mexico even more attractive for manufacturing and processing operations of U.S. companies and necessitate increased alliances, but ownership of Mexican carriers will be possible in several years.

Other Examples

Canada passed a deregulation act in 1988, the National Transportation Act. The act attempted to deregulate transportation, but it required the concurrence of each Canadian province. Ontario deregulated its transportation system in 1989, but Quebec did not. However, Quebec allows progressive market entry procedures. Heavy traffic moves between Canada and the United States via motor carriers. U.S. carriers are allowed to deliver up to 150 mi into Canada, and U.S. motor carriers have a cost advantage over Canadian motor carriers because of the U.S. tax code, which allows investment write-offs not allowed in Canada.

The final economic and financial integration of the Western European countries will establish the largest single market area in the world. The combined gross domestic product will be larger than that of the United States. There will be new distribution patterns internal to the integrated countries and the necessity for international transportation alliances. In fact, many U.S. trucking companies have already moved aggressively to establish partnerships to penetrate the European market.

The EEC's goal of completely eliminating barriers affecting manufacturing and trade will have a significant impact on these countries. The elimination of barriers will increase produc-

tivity by an estimated 5 to 7 percent and could create 2 million to 5 million new jobs. The removal of these barriers will also affect distribution and transportation patterns in Western Europe. Companies currently operating in the EEC need to have plants and warehouses in each of the countries in which they wish to market their goods. With the elimination of trade barriers and tariffs among the various countries, a more regionalized approach, similar to that used in the United States, will be possible. In other words, because countries are very small, a company could have a warehouse in one country from which it will distribute to several countries, using longer, more efficient transportation hauls and larger, more efficient warehouses instead of the current practice of having a warehouse in each country. The regionalized approach is likely to have a dramatic impact in Western Europe and may produce logistics savings not unlike those experienced in the United States during the 1980s (*14*). The potential of Western Europe has also attracted motor carrier companies to form alliances with European carriers.

Globalization has increased the pace of change and will continue to do so throughout the 1990s. Decisions involving sourcing of supplies, manufacturing, assembly, packaging, and warehousing will have a global perspective, and the transportation system will play an important role in linking this all together. Partnerships or alliances of domestic and international carriers will play an increasing role. Intermodal partnerships offer special promise both on a global and domestic basis. Shippers will expect reliable and timely shipments even with the complexity of the global operations. One factor that could help resolve some of the problems of global operations is technology.

Technology

Nowhere in day-to-day business operations is the force of technological change more apparent than in data processing and information systems. Major price breakthroughs in hardware and low-cost, user-friendly software have brought enormously powerful, low-cost computing support to the logistics integration process and to transportation providers.

The impact of changing computer technology on logistical practices has been far reaching. Complex tasks such as truck routing and scheduling are now much more routine when using desktop computers. Simulations of entire logistical systems can be developed to determine the optimal approach to achieving desired customer service performance. It is possible to simulate the knowledge of logistics experts and combine it with current data to develop new strategic alternatives. Such systems offer the promise of linking status and control information from material procurement to delivery of the finished product. The development and management of such a huge data base would not have been possible a few short years ago (*15*).

Currently available systems such as bar coding are being improved and combined with data communication transmission to improve logistical control and manage inventory more effectively. With the advent of satellite transmission, a shipper or carrier can pinpoint the location and schedule of an individual package at any time throughout the entire logistical supply chain. Throughout the logistics infrastructure, carriers, warehouses, and special service providers are introducing much better information and control systems (*16*).

The information transmission part of the technological revolution is worthy of special note. EDI and bar coding have played a major role in the more efficient and effective management of the distribution process, but much more can be done to integrate the systems of vendors, customers, and transportation companies (*15*).

The advances in technology have also spread to other parts of the logistics and distribution system. Automation in warehouses and terminals has advanced at a rapid rate with automated storage and retrieval systems as well as other sophisticated storage and conveyor systems. But perhaps the most important aspect has been the software packages combined with the advances in communication technology to form integrated systems (*17*). We are on the threshold of an era that will revolutionize the way in which business is done because of the advances in technology, and the distribution process will probably be the area of business that is affected the most.

Interestingly, the adoption and use of the current technology is far from universal. Even technologies such as EDI have not been completely integrated into the channels of distribution of some major companies (*18*). The same is also true of some carriers that have not taken full advantage of the available technology. It appears likely that carriers that do not move forward with the available technology will be the business failures of tomorrow.

A dimension of technology that is sometimes overlooked is that it has introduced a form of economies of scale not envisioned previously. Large TL carriers such as Schneider and J. B. Hunt have been able to expand in a market that has been viewed as an analog for the pure or perfectly competitive market model. In other words, such a market would usually preclude a company from becoming larger than its many competitors because of the lack of scale economies. J. B. Hunt and Schneider, as well as others, are examples of the power of technology in providing efficiency in operations; they have provided a basis of efficiency and effectiveness from their size and associated leading-edge technology.

Organizational Restructuring

A third driver of change has been structural changes in business and in the economy, particularly in the United States with changes in both the structure of business and the concentration of markets. Businesses have experienced a series of far-reaching changes with mergers, spin-offs, employee stock ownership plans, and leveraged buyouts, which have created a potential synergy for consolidating logistical operations across newly combined business units (*19*).

No industry segment will probably escape the restructuring and consolidation fever that has characterized business in recent years. Economies of scale, market coverage, and specialization in services and product niches will continue to drive competitors in the worldwide market to make appropriate (or even inappropriate) organizational changes.

A key trend in organizational restructuring has been the flattening or leaning of organizations, with layers of middle management being eliminated and the span of control being increased. The logistics and transportation function has frequently been a primary area for economies to be implemented with less staff. With mergers, one company's department of logistics and transportation is often eliminated; in some instances both company's departments are eliminated and the function is outsourced to a third party in whole or in part. In fact, third-party companies have become so important that they deserve special consideration, which will be provided subsequently. Restructuring continues to be an important agent of change as evidenced by recent events at IBM, General Motors, Westinghouse, General Electric, and other companies.

The outsourcing of logistics and transportation has created a niche for transportation companies to add services that will add value for their customers. Some transportation companies have established subsidiaries to offer broad-based logistical services for their customers, including warehousing, inventory control, order processing, delivery, and so forth (*20*).

The net effect is that transportation companies have changed dramatically and will continue to do so. The alliance or partnerships with other transportation companies, especially intermodal and international relationships as discussed previously, coupled with the third-party opportunities for expanded services has created a new type of organization that is vastly different from the transportation company of the 1970s (*21*).

Deregulation

Another driver has been transportation deregulation, which has spurred a virtual revolution in the U.S. transportation system since 1980, resulting in many fundamental changes, some positive and some negative. Overall, it is probably safe to say that the cost and quality of transportation services have improved for many shippers since 1980. Deregulation started in

1977 with air freight and continued in 1978 with air passenger movements. In 1980 railroads and motor carriers were also deregulated, which was a major political accomplishment.

In all four instances, economic regulation was drastically reduced. In other words, transportation companies became much more like other businesses in being able to adjust their prices and services more quickly in response to the marketplace. Before 1980 a very complex, bureaucratic regulatory system required elaborate hearings to make relatively simple changes in transportation prices and services (22,pp.30–33).

On July 1, 1980, President Carter signed the Motor Carrier Act of 1980. The basic legislation established a federal policy designed to promote a competitive and efficient motor carrier industry that would meet the needs of shippers, receivers, and consumers while allowing price flexibility and encouraging greater efficiency of operation. The legislation offered increased opportunities for new carriers to get into the trucking business and for existing carriers to expand their service (22,p.34) (Figure 11).

The act also made some significant changes in rates. Previously, the motor carrier industry collectively set the rates it charged to the public through the rate bureaus. The 1980 act limited the permissible scope of collective rate making. The net effect has been a substantial lessening of the importance of rate bureaus (6,pp.79–80) in the setting of rates and a significant increase in the volume of independent rate changes.

In the pricing reform area, the act allowed motor carriers and freight forwarders greater freedom to set rates in response to market demands and gave them much more pricing flexibility. Carriers and shippers are allowed to negotiate reduced transportation rates in exchange for a limited liability on the property being transported.

In many ways shippers must now build rate and service protection for themselves where in the past the Interstate Commerce Commission (ICC) acted as a consumer protection agency (6,p.85).

Like the Motor Carrier Deregulation Act, the Staggers Act of 1980 was a mechanism for deregulation of the rail industry. The regulatory structure for railroads was developed over a period of more than 90 years, and regulation has not been completely eliminated. However, the Staggers Act made changes that gave the railroads much more freedom and flexibility to respond to changes in the marketplace. With motor carriers and airlines, the most important

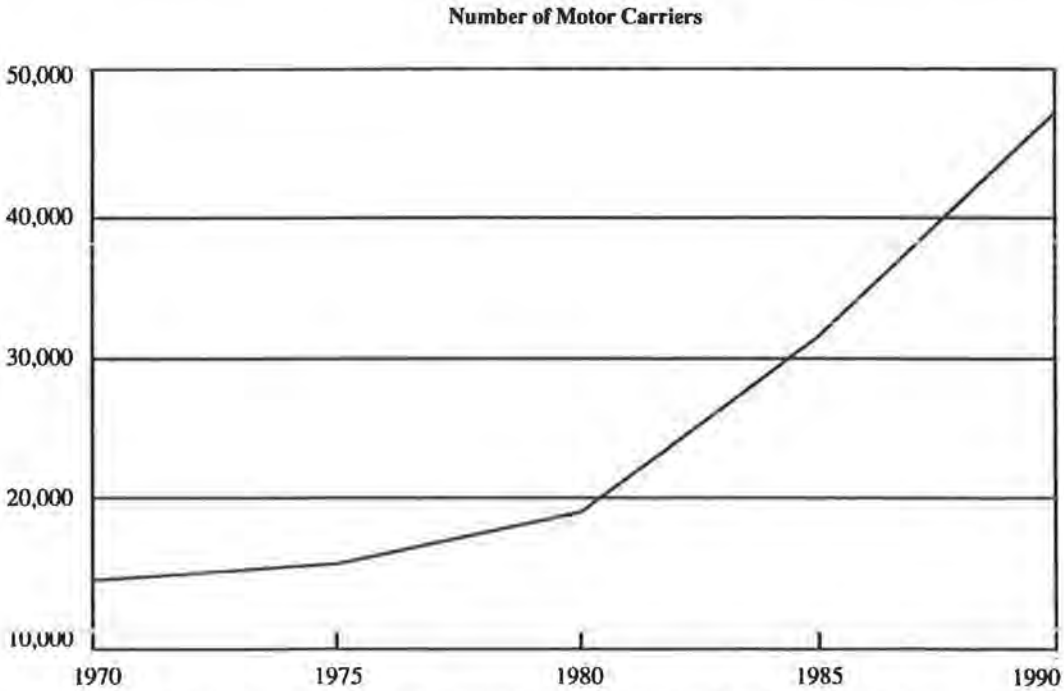

FIGURE 11 ICC-regulated carriers, 1970–1990 (*source: American Trucking Associations and ICC*).

areas of change had to do with entry and exit from service and rate making. For the railroads, rate making was the most important area because the entry and exit issue was so much more complex and long term in nature with the high capital cost associated with entry.

The Staggers Rail Act opened the way for the railroads to start negotiating contract rates with larger shippers, and contract rates have increased dramatically. In 1980, 100 percent of rail traffic was regulated (i.e., the rates were subjected to ICC approval). In 1990, that percentage was below 40—the most dramatic change in any sector of transportation (Figure 12). Railroads and shippers are increasingly cost-conscious in evaluating contract rates. The carriers are looking at the cost of each movement against the revenue gained to eliminate cross subsidization. Some carriers and shippers are putting penalties for delays and premiums for better service into the contracts (23,p.12).

Although there has been a significant reduction in economic regulation, there has been an increase in the amount of regulation, control, and policy in other areas, namely, safety and environment. Federal and state controls related to safety and the environment have increased in scope and complexity. The movement of hazardous materials, for example, has received increased attention.

Concerns with gridlock (congestion) and pollution have lead to increasing analysis of approaches to controlling the flow of traffic in urban areas, including required pooling and tolls. The reduction in waste materials and more recycling have also received more attention. Interest is growing among manufacturers in reverse logistics systems to support recycling and waste management. Overall we should see even more legislation and policy related to safety and environment that will affect the design and operation of logistics systems.

The next section will present an analysis of the impact of these drivers of change as reflected in selected distribution and transportation data on a macro level. It is virtually impossible to summarize all changes driven by deregulation. In some cases, the number of carriers has increased dramatically (motor TL carriers); in other instances the number of carriers has decreased (airlines) or there has been a shift toward more market concentration (rail and motor LTL). The distinctions between common, contract, and private carriers have blurred. Transportation companies offer a greater variety of services with a comprehensive set of service and pricing strategies. Transportation companies are vastly different today than they were in 1980, and the pace of change is accelerating. It should also be noted that deregulation in the communication systems and in the financial area has also affected logistics and transportation.

In summary, the four drivers of change—globalization, technology, organizational restructuring, and deregulation—have changed the market and distribution patterns in the United States and the profile of the companies that serve them.

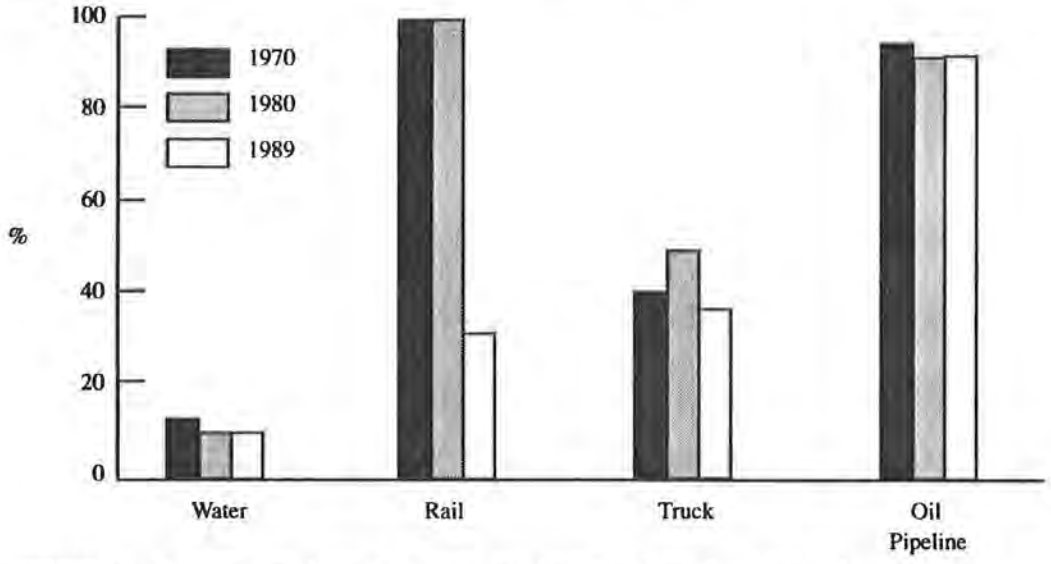

FIGURE 12 Percentage of domestic intercity freight federally regulated by mode.

Discussion and Analysis of Marketplace Changes in Distribution

The logistics-related costs of U.S. businesses should exceed $600 billion/year during the 1990s. Figure 13 summarizes logistics costs from 1980 through 1990, showing logistics costs in billions of dollars and as a percentage of GNP. Aggregate logistics costs have been increasing since about 1983. However, logistics costs as a percentage of GNP declined during the 1980s. The end of the decade showed that logistics costs stabilized at about 11 percent, but this is down from a high near 15 percent in 1981 (*24*).

The projection for the 1990s is that logistics costs as a percentage of GNP will decrease to about 10 percent of GNP. Table 5 presents the components of 1990 logistics costs. As the table indicates, the major categories are inventory costs, transportation costs, shipper-related costs, and administrative costs. The largest, transportation costs, accounted for $277 billion out of $600 billion (*25*). Inventory carrying cost was a close second at $221 billion. Factors that accounted for the relative decline in logistics costs will be discussed subsequently.

Figure 14 compares overall logistics costs, transportation costs, and inventory carrying costs as a percentage of GNP from 1971 through 1989. The top line, which indicates overall cost, shows the previously mentioned logistics costs figure of approximately 11 percent for 1990. The second line shows transportation costs, which during the 1980s declined to about 6.3 percent of GNP from a high of about 8 percent. The third line, which shows inventory cost, also indicates a decline: costs fell to approximately 4 percent from a high of about 6 percent in the early 1980s.

These trends in inventory and transportation costs are quite interesting on a macro basis. Many factors have helped to reduce transportation costs, but one important factor was the deregulation of transportation. That transportation deregulation provided shippers more opportunities to negotiate rates, which led to reduced transportation rates. In addition, increased competition in many sectors of the transportation marketplace also led transportation companies to lower prices. Better transportation service and better inventory management techniques, such as JIT, reduced inventory costs. Overall business logistics costs declined by approximately $65 billion during the 1980s, with about $30 billion in savings from the inventory area and $35 billion in savings from transportation (*25*).

Figure 15 shows the ratio of business inventories to final sales from 1980 through 1989. This is a more dramatic perspective on the relative decrease in inventory. The ratio of inventories to sales was more than 26 percent in 1980, but it declined to less than 20 percent in 1990. This dramatic decrease of inventory levels accounted for $30 billion in savings.

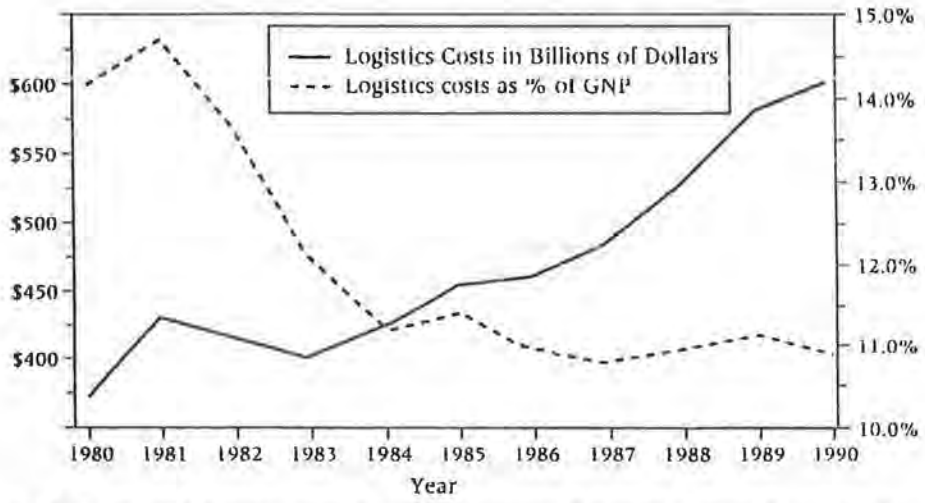

FIGURE 13 U.S. logistics costs, 1980–1990 (*source: Robert D. Delaney, Cass Logistics, Inc.; reprinted with permission*).

TABLE 5 Components of 1990 Logistics Cost

COMPONENT	COST ($ billions)
Inventory Carrying Costs	
Interest	76
Taxes, obsolescence, depreciation	84
Warehousing	61
	221
Transportation Costs	
Motor Carriers	
Public and for hire	77
Private and for own account	87
Local freight services	113
	277
Other Carriers	
Railroads	32
Water carriers	21
Oil pipelines	9
Air carriers	13
	75
Shipper-Related Costs	4
Distribution Administration	23
Total	600

A recent in-depth study of four major industries (chemical, electronics, foods, and pharmaceuticals) shows that they experienced a significant decline in the ratio of inventories to sales ranging from improvements of 23 percent in foods to 37 percent in chemicals, which substantiates the overall data of the Federal Reserve Board (26). The data for these four industries are summarized in Figures 16 through 19. These data lend credibility to the macro data in Figure 15. U.S. companies have made a commitment to reduce inventories in the distribution pipeline to gain efficiency. This is true not only in high-valued product industries such as pharmaceuticals but also in such industries as chemicals. The lowering of pipeline inventories as indicated in

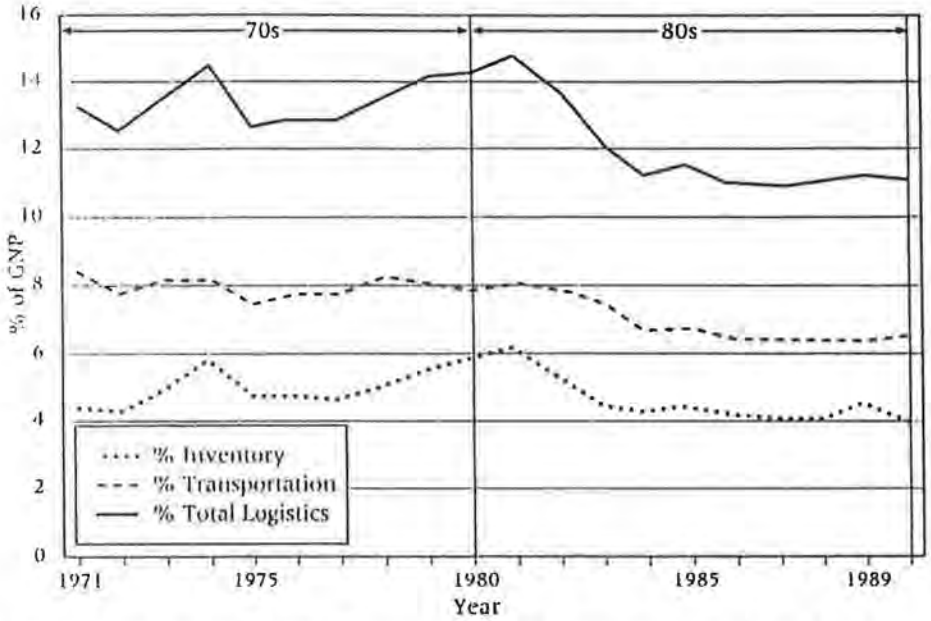

FIGURE 14 Business logistics, transportation, and inventory carrying costs as a percentage of GNP (*source: Robert D. Delaney, Cass Logistics, Inc.; reprinted with permission*).

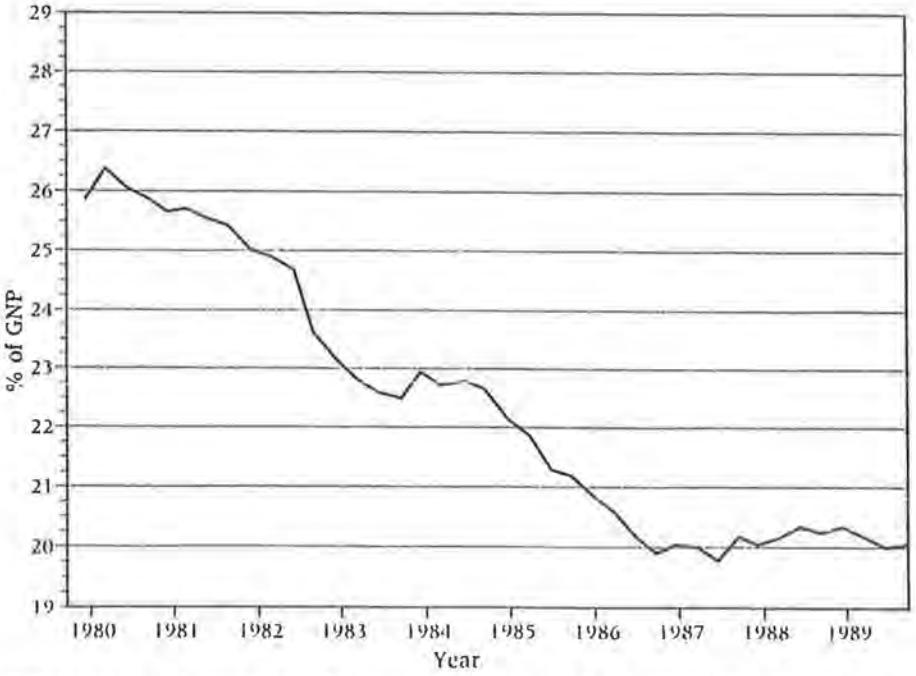

FIGURE 15 Nominal ratio of business inventories to final sales, 1980–1989 (*source: Federal Reserve Board*).

the Dow Chemical example represents a focus point for additional logistics savings during the 1980s. A critical element in the success of such a strategy is a highly dependable, reasonably fast carrier. The motor carrier industry can play an important role in this area, but their service requirements will be particularly sensitive.

Figures 20 and 21 address the transportation costs discussed previously. Figure 20 shows trucking costs during the 1970s and the 1980s using the 1977 constant dollars. This table presents information for both TL and LTL costs, showing that both costs have declined significantly in the post-deregulation era since 1980. The same general conclusion is apparent for railroad costs in Figure 21, which shows costs from 1968 through 1988. Rail costs have been declining since 1980. The reductions in motor carrier costs are more significant than those of railroad. Of the $35 billion combined total mentioned previously, trucking savings accounted for the larger share: $30 billion (27).

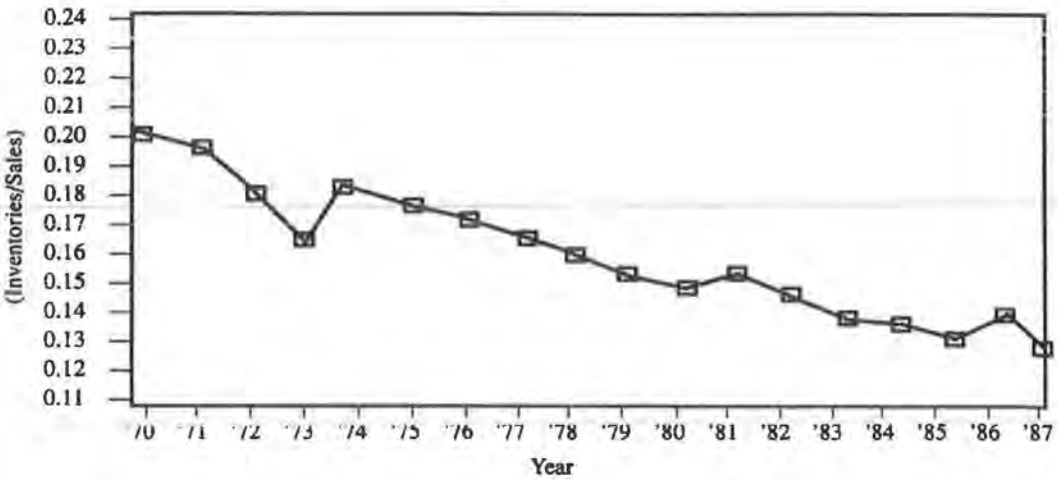

FIGURE 16 Chemical industry, inventories and sales (36,p.75).

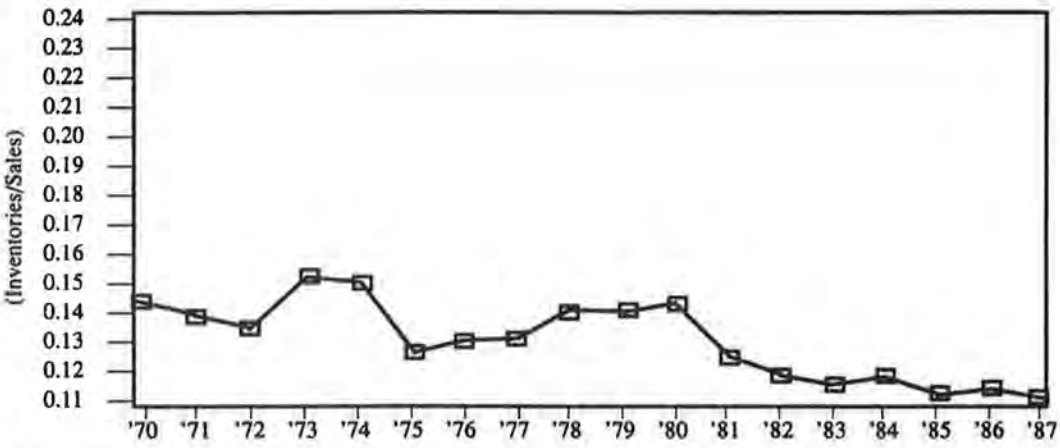

FIGURE 17 Food industry, inventories and sales (*36*,p.80).

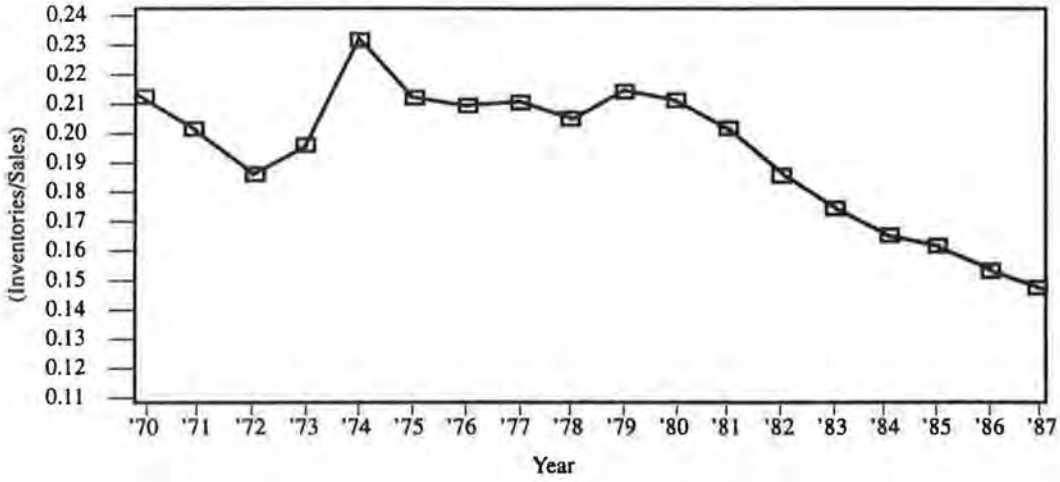

FIGURE 18 Pharmaceutical industry, inventories and sales (*36*,p.81).

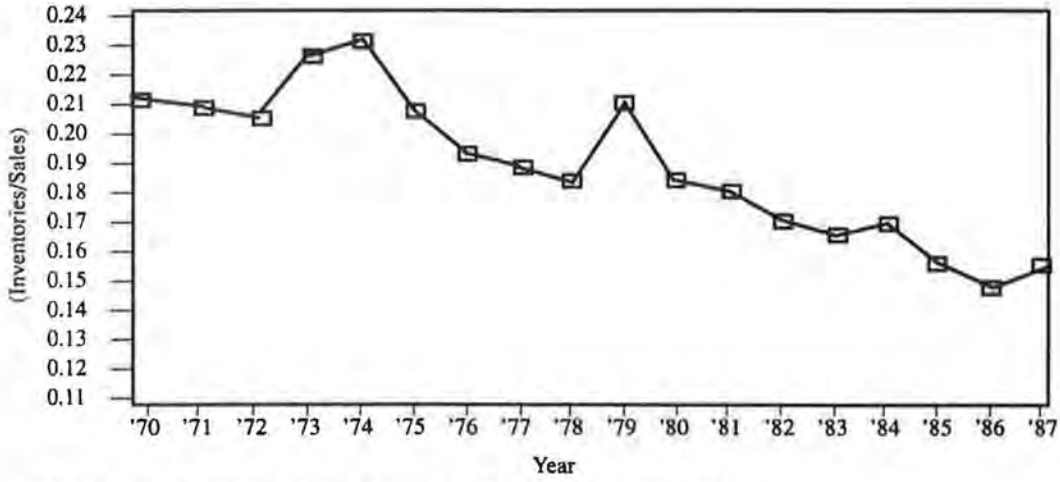

FIGURE 19 Electronics industry, biggest and smallest sales (*36*,p.84).

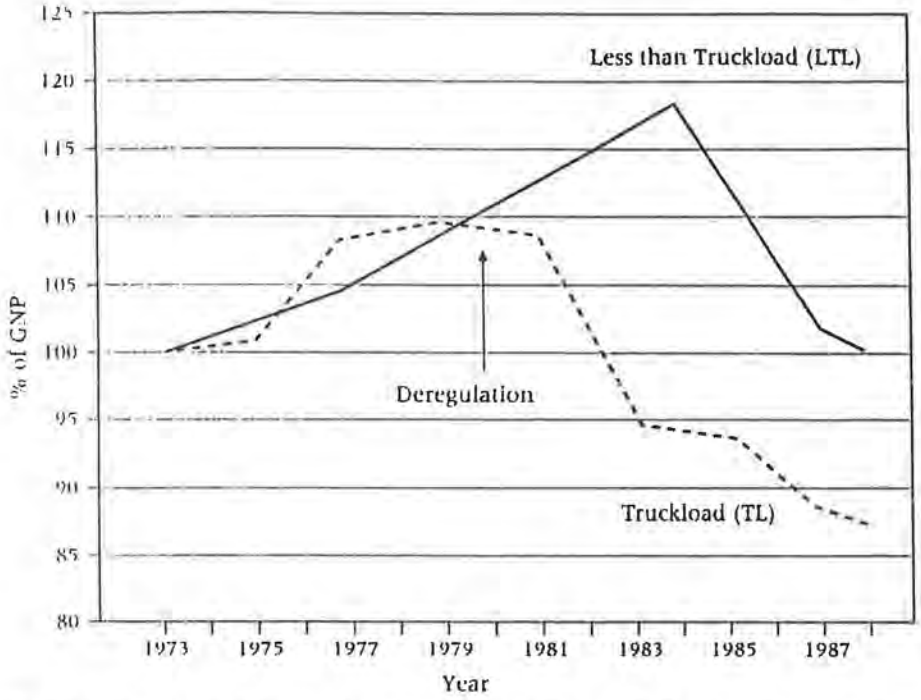

FIGURE 20 Trucking costs, 1973–1987 (*source: Robert D. Delaney, Cass Logistics, Inc.; reprinted with permission*).

The 1990s will see additional savings on a macro basis, and carriers will be under continuing pressure to work with shippers to reduce direct transportation costs or overall logistics costs. One area of particular interest is deregulation of transportation at the state level, which could be a source of important savings. But there are other opportunities to reduce logistics costs, especially pipeline inventories.

On a macro basis, U.S. companies have made significant strides in reducing logistics-related costs during the 1980s, particularly transportation and inventory costs. Deregulation of

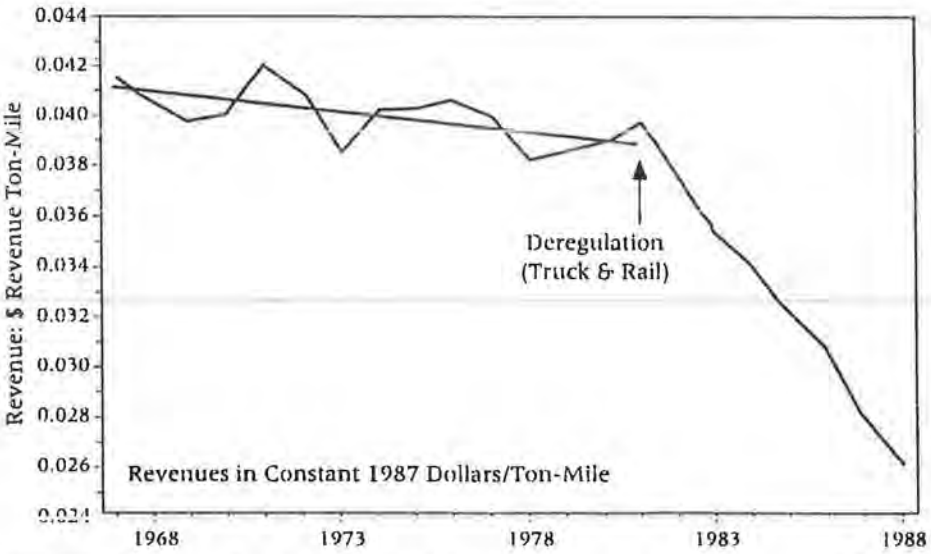

FIGURE 21 Railroad costs, 1968–1988, in 1987 dollars per ton mile (*source: Robert D. Delaney, Cass Logistics, Inc.; reprinted with permission*).

transportation played a major role in providing an opportunity to negotiate rates and service levels which allowed shippers to experience these savings. In addition, improved inventory control approaches such as JIT, DRP, and MRP also allowed more efficiency to be introduced with associated improvements in effectiveness. Better technology, computerization, and automation were also important elements.

Factors Affecting Nature of Demand for Transportation Services in 1990s

In the previous sections, a case has been made for the dynamic marketplace that has significantly affected both carriers and shippers. In many ways, the decade of the 1980s was the decade of greatest change in the history of U.S. transportation. The 1990s will continue the accelerated pace of the 1980s. In fact, the 1990s will probably be a period of even faster change than the 1980s.

Since most of the demand for transportation services (excluding passenger service) is not a primary demand but a derived demand, it is important to understand the factors affecting U.S. business that will in turn influence the nature of the demand for transportation services. The successful carriers in the 1990s will be those that are responsive to the needs and special requirements of U.S. industry. As indicated previously, companies will be affected by global strategies, technology, and regulation. In other words, these factors and others will shape the demand for transportation.

Speed

Most companies have recognized that time is a strategic variable that influences competitive success in the marketplace (*28*). Initially, the focus was on product design and manufacturing to shorten the lead time for the introduction of new models of existing product lines and completely new products. For example, in the automotive industry, the Japanese demonstrated the advantages of shorter, more flexible design and manufacturing strategies that reduced by more than 50 percent the lead time to introduce a new model. Part of Ford Motor Company's resurgence has been based on this same factor.

The emphasis on time compression has spread to other areas, especially the distribution pipeline. Given the current emphasis on reducing inventory levels and JIT, MRP, and DRP inventory practices, transportation will continue to play an increasingly important role in the ability of distribution pipelines to meet the needs of "quick-response" logistics systems. Motor carriers often have an inherent advantage over other surface modes in the area of speed of service, but factors such as congestion and the deteriorating infrastructure will have negative influences. Lower inventories and very short lead times will provide opportunity for airlines to compete with motor carriers for certain products. Federal Express has already demonstrated its competitiveness in selected product markets. Speed will be an area in which companies will seek to lower costs, add value, or both.

Quality

Concurrent with the pressure for reduced lead times has been a significant trend to emphasize quality not only in the production of products but also throughout all areas in a company. The distribution pipeline has again become a major focal point of total quality management (TQM) programs because in the final analysis it is the customer's perceived receipt of quality that is most important. The service areas that interface with the customer, such as transportation, have received increased attention with the recognition of their importance in this area. The expectations of purchasers of transportation services have become increasingly higher in terms of consistent service levels (*23*,pp.10–14).

The synergistic impact of the time compression factor and quality expectations have encouraged carriers to provide service deliveries and pickups to meet increasingly narrow windows—30 to 60 min, for example. The rise in importance of companies such as Federal Express, UPS, Roadway Package Service (RPS), Customized Transportation (CTI), and others is a reflection of this combined trend. But all transportation companies are feeling the impact of this pressure for timely, high-quality, and responsive service (*29*).

The motor carrier has traditionally been viewed as providing the highest overall level of service. It is not the fastest service provider (except for distances under 300 mi), but because of its operating characteristics the motor carrier has usually been able to provide more timely, consistent, and secure service levels than its competitors. The technology advances discussed previously have helped sustain the competitive position of motor carriers, but shippers have emphasized not only sustaining service performance but also continuous improvements (i.e., increasingly better service). The motor carrier industry is in position to respond to the increasingly demanding service levels, but competition from other carriers (rail and air) will intensify (*29*). Motor carriers should investigate how participating in intermodal operations can enable them to lower cost yet sustain quality.

Asset Productivity

Another factor that will shape the demand for transportation service during the 1990s is an increasing concern among shippers about asset productivity. Reducing inventory levels and improving inventory turnover received most of the initial focus of the drive to improve asset productivity as indicated by discussion in a previous section.

Investment in fixed facilities such as warehousing also has been coming under scrutiny, with a definite trend to decrease private warehousing requirements through inventory reductions and increased use of public warehousing. This same focus led to a more stringent evaluation of private motor carrier fleets and a subsequent decrease in the use of private motor carrier operations by many larger companies, especially for intercity movements (*30*).

The drive to improve asset productivity has focused on reducing not only internal inventories but also pipeline or supply chain inventories. Vendors and buyers have been cooperating and sharing data in an attempt to reduce inventories in the entire distribution pipeline. Procter and Gamble (P&G) and Wal-Mart have received much attention in the business press for their efforts in this area, but there are many other examples (*31*). Again, fast, responsive and flexible transportation becomes a critical part of this vendor-customer relationship.

Organizational Reengineering

Another trend among U.S. corporations is the reexamination and evaluation of the internal processes to minimize transactional activities and emphasize value-adding activities. A manifestation of the reengineering has been the reduction of middle management in many companies (*15*,pp.10–13). An outcome of the thinning of middle management ranks has been a trend toward outsourcing of distribution activities to focus more on core activities that add value. The development of third-party companies that provide a range of distribution and logistics services on a contract basis to companies has been a response to such changes. A growing number of transportation companies, including motor carriers, have established third-party logistics companies that offer a range of logistics services including transportation (intercity and cartage), inventory management, warehousing, order processing, billing, and more. Some trucking companies have established third-party organizations that offer services to a broad base of users; others have emphasized a particular niche such as the automotive industry (e.g., CTI of Jacksonville, Florida).

Another dimension of the changing organizational relationships that is important to transportation demand is the practice adopted by shippers of reducing the number of carriers from which they buy transportation service to leverage their buying power (*32*). This practice is an

outgrowth of deregulation and is also associated with the JIT philosophy of operations that stresses "win-win" buyer-seller relations based on long-term, high-volume, quality-based vendor commitments. The decrease in the number of carriers used by individual shippers has been dramatic: some have gone from more than 1,000 to fewer than 100 carriers. Such relationships are viewed as partnerships not unlike the relationship between P&G and Wal-Mart, in which shippers and carriers share information that allows a win-win opportunity: lower rates and improved carrier efficiency.

Customer Satisfaction

Another trend among shippers that is affecting the demand for transportation is the customer service—customer satisfaction emphasis, which is particularly important to logistics and transportation (*33*,pp.257–272). It has long been recognized that measures of service levels are important to evaluate performance. Traditional measures included the length of the order-delivery cycle, order shipment time, and orders shipped complete. Now measures are aimed directly at the customer side. For example, the very best companies use measures such as on-time delivery, orders received complete (no loss and damage), and orders billed accurately. One result of the customer service focus is that transportation services receive more attention and transportation companies are frequently viewed as partners in providing the higher levels of customer service (*33*,pp.258–260). This has often necessitated data sharing between shippers and carriers to develop the win-win type of relationship mentioned earlier.

Another aspect of the customer satisfaction focus is the levels of customer service delineated by the very best companies. Reliability is viewed as the basic requirement with the added level of flexibility to meet special needs of customers. The icing on the cake is the addition of creativity to add value that will affect the customer's bottom line. Again, transportation can and will play an important role in this new era of customer service. Perhaps a better way to state the case is that the successful carriers will be those that can offer customized and tailored services to be responsive to needs of shippers who will be required to offer excellent service to maintain a competitive position in today's marketplace (*33*,pp.265–270).

In summary, the nature of the demand for transportation services in the 1990s will be different and will be shaped by the marketplace factors discussed in this section. The view of transportation as the simple movement of goods through space from origin to destination is not enough. Transportation companies must be much more sophisticated in developing services to meet the needs of shippers. The logistics perspective outlined previously is a necessary concept for carriers to understand. But the demand for this better service will not soften the pressure to provide such service at a low cost.

By using a much smaller carrier base from which to purchase transportation service, large shippers will change the demand for services dramatically. Low cost (efficiency) will be an expectation, but the ability to provide high-quality service (effectiveness) will become the critical factor. Projections based completely on historical data will therefore have reduced significance in the 1990s environment. Shippers will expect a seamless pipeline that is responsive and flexible.

Summary and Conclusions

The evidence continues to grow indicating dramatic improvement in productivity associated with the logistics costs, including transportation, of U.S. businesses. In fact, 1991 was a year in which overall logistics costs were lower absolutely and relatively (see Figure 22). The savings in 1991 can again be attributed to lower investment in inventory, lower interest costs, and continued control of warehousing and inventory cost (*6*,p.7).

The lower inventory costs can be attributed to better logistics management along with better transportation service. The increased reliability and flexibility of carriers has enabled man-

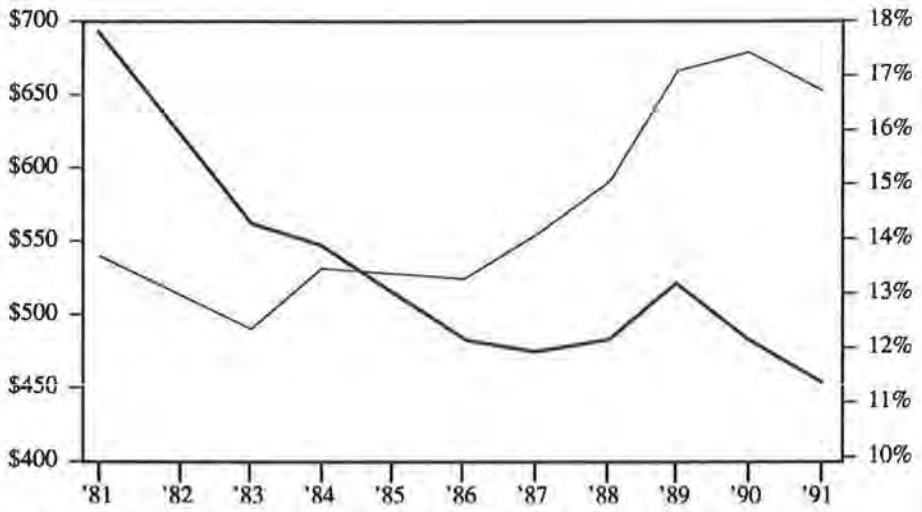

FIGURE 22 Logistics cost in relation to gross domestic product (*source: U.S. Department of Commerce*).

agers to reduce safety stock levels and to reduce the number of inventory stocking points.

In the 1980s, savings of more than $65 billion associated with logistics contributed to overall productivity improvements in many companies and helped to make U.S. business more competitive on an international basis. Manufacturers and other companies are shipping heavier loads, using lighter packaging materials, and reducing empty vehicle miles.

Motor carrier transportation continues to play a major role in our economy, and by two measures—total tonnage and freight revenue—is the most important mode of transportation. In fact, motor carriers have improved their position by both measures during the 1980s, when their revenue went from 74 percent of total transportation revenue to 78 percent and tonnage went from 36 percent to 41 percent. Only in the area of ton miles carried, which reflects both tons and miles, were railroads larger. But interestingly, rail ton miles stayed basically constant during the 1980s (37.5 to 37.6 percent), and motor carrier ton miles grew from about 22 to 25.6 percent of total (27).

Motor carriers have fared reasonably well with the increased emphasis on the integrated logistics approach in which efficiency and effectiveness are important. Motor carriers will need to continue their aggressive response to shipper requirements to be successful in the 1990s. We will see more value-added services and intermodal cooperation to achieve these goals. The infrastructure, environment, increased fuel taxes, safety, and other issues will challenge the motor carrier industry and influence the demand for and supply of transportation.

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