Appendix A

Factors Influencing Freight Demand

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This appendix discusses a variety of factors that influence freight demand. These factors are presented in two groups. The first group consists of factors that affect demand relatively directly. The second group consists of factors whose direct effects are on the costs of one or more transport modes and, in some cases, on the services offered; these factors affect demand indirectly as a result of changes in transport costs and rates and in the services offered.

The discussions focus on the influence that each factor currently is having on freight demand and how the factor could change future demand. Where appropriate, historical context is provided (usually for a 10 to 15 year period). Influences on supply are also discussed, particularly when changes in supply (e.g., services offered) can affect demand. However, supply issues that have little effect on demand (e.g., competition between U.S. and foreign carriers) are treated much more briefly, if at all. Where appropriate, the discussions include measures for each factor, sources of data for the measures, and any relevant comments on the usefulness of the data sources.

■ A.1 Factors that Affect Demand Directly

The Influence of the Economy

The demand for freight transportation is commonly referred to as a "derived demand"; that is, it derives from a more basic demand – in this case a location-specific demand for a product that results in a need to ship the product to that location. As a derived demand, the most basic influence on total freight demand is the volume of goods produced and consumed. Expansion in the national economy, or the economy of any region, results in increases in overall freight demand, while economic contractions result in reductions in freight demand.

At the national level, the size of the economy is most frequently measured in dollar terms as gross national product (GNP) or gross domestic product (GDP). However, freight demand is more closely related to the goods-production component of GNP or GDP.

- The Bureau of Economic Analysis' Regional Projections[2] of population, employment, earnings and personal income by 57 sectors by state and region (formerly called the "OBERS" projections). These forecasts are issued at approximately five year intervals and extend approximately 50 years into the future. They are based, in part, on the BLS 15-year forecasts. They have the advantage of a longer forecast period, and they also provide 14-sector forecasts for 183 economic areas and for 336 metropolitan areas and aggregates of metropolitan areas. However, they do *not* forecast output; thus their use requires an extra adjustment for growth in output per worker or per dollar of earnings.

- Commercial services, such as Data Resources, Inc., (of Lexington, Massachusetts), Wharton Econometric Forecasting Associates (of Bala Cynwyd, Pennsylvania) and INFORUM (of the University of Maryland), that forecast a variety of economic measures for various time periods.

- A variety of sources of region-specific forecasts (e.g., the Center for the Continuing Study of the California Economy) and commodity-specific forecasts (e.g., fuel-demand forecasts produced by the U.S. Department of Energy).

Industrial Location Patterns

Just as the economy determines the amount of goods transported, the spatial distribution of economic activities determines the distances they are transported. Thus, industrial location patterns are an essential factor in determining transport demand when it is measured in ton-miles or in any similar units that reflect length of haul. This influence of spatial distribution can best be measured through its actual effect on demand: as average length of haul by commodity or total ton-miles transported. Ideally, such a measure would be applied in mode-neutral form as great-circle miles, though reducing actual origin-to-destination distances to great-circle miles usually entails more effort than is warranted.

The U.S. Departments of Energy and Agriculture publish data on the production of coal, natural gas, and many agricultural products by state; and many corresponding state agencies publish more extensive and/or more detailed data on shipments of these commodities, frequently by county. Most states also publish industrial guides containing the location of manufacturing facilities, etc. The distribution of an industry's production across counties frequently is inferred from employment data by industry and county published annually by the U.S. Department of

[2] E.g., see U.S. Department of Commerce, Bureau of Economic Analysis, *BEA Regional Projects to 2040*, Three Volumes, U.S. Government Printing Office, October 1990.

Goods production has tended to grow somewhat more slowly than the overall economy. Goods production represented about 43 percent of total GDP in 1980 and had declined to about 39 percent of GDP in 1991. Goods production, and particularly durable-goods production, also tends to fluctuate with the business cycle more than total GDP does. (The production of services has smaller fluctuations, while the remaining major component, the production of structures, has greater fluctuations.) The relationship between changes in freight demand since 1980 (as measured in ton-miles) and in the real value of goods production can be seen in Exhibit A.1. This exhibit also shows corresponding changes in real GDP, which has grown faster and somewhat more smoothly than freight demand and goods production.

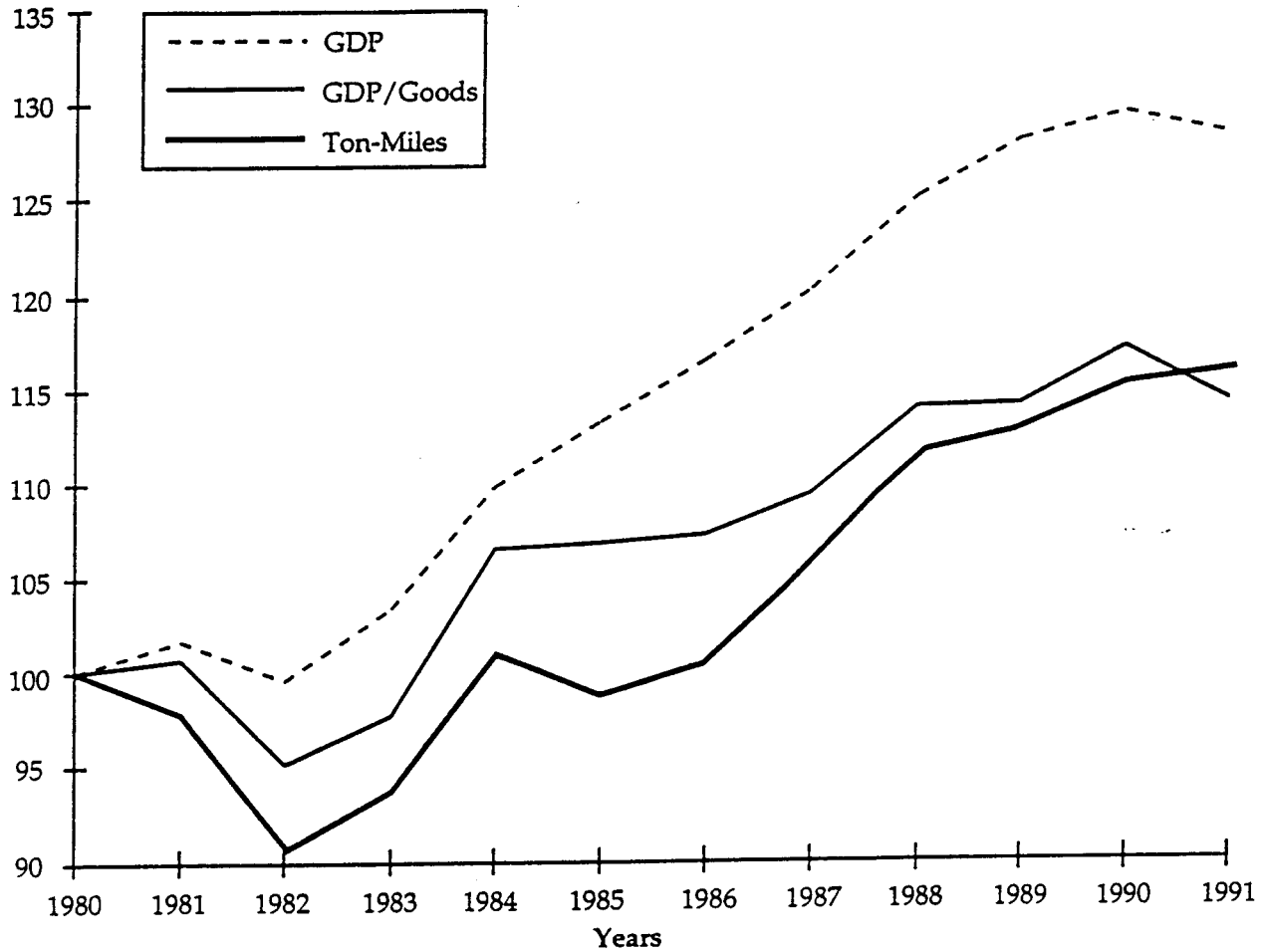
Although real GDP of goods is a reasonable overall measure of the influence of the economy on freight demand, it measures goods production in dollars rather than in tons or volume. The production of low value (dollars per ton) commodities, such as coal and agricultural products, generates a much larger share of total freight demand than their total value would indicate. Commodity value and perishability are also important influences on mode choice, with most low-value commodities commonly transported by the slower, less costly modes (pipeline, barge, and rail) and higher-value and perishable products usually transported by truck and sometimes air. For these reasons, careful forecasts of freight demand usually incorporate forecasts of production (and/or consumption) that distinguish several different commodities. For raw materials, forecasts of production and consumption in physical units (tons, bushels, etc.) usually are available and can be used in generating forecasts of freight demand. However, for manufactured products, production forecasts usually are expressed only in dollars – a somewhat less desirable measure for freight-demand forecasting, since changing technology, packaging, and product mix can result in corresponding changes in the ratios of value to weight or volume.

Some potential sources of economic forecasts are:

- The U.S. Department of Labor, Bureau of Labor Statistics (BLS), which produces low, moderate, and high forecasts of real domestic output, exports and imports by detailed industrial sector for periods extending 10 to 15 years into the future.[1] These forecasts are issued at approximately 2.5 year intervals.

[1] E.g., see *Monthly Labor Review*, November 1991; or *Outlook: 1990-2005*, Bureau of Labor Statistics Bulletin 2402, May 1992.

Exhibit A.1 The Relationship Between Freight Demand, GDP, and Goods Production



Sources: **Ton-Miles** – Eno Transportation Foundation, Transportation in America, Tenth Edition, Vienna, Virginia, 1992.

GDP and Goods Production – U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States*, Various Editions.

Commerce in *County Business Patterns;* however, these inferences frequently are misleading, especially for mines, since employment usually is reported by office location rather than by actual place of employment.

The spatial distribution of economic activity also is a major influence on the modes that are used. Many commodities are likely to be shipped by one mode (e.g., truck) when distances are relatively short and by another (e.g., rail or air) when distances are longer. Water transport is competitive for many low-valued commodities being shipped domestically between points at or near appropriate ports, but it is rarely competitive for transport between points that are not located near ports. Plants located on rail lines are likely to use rail for an appreciably greater share of their transport needs than similar plants that are not so located. (Indeed, expected rail usage is usually, but not always, the most important factor affecting the decision as to whether or not to locate on a rail line, and accessibility to the Interstate Highway System is a major influence on locational decisions of many plants that expect to make significant use of trucks.)

Globalization of Business

In recent years, the U.S. economy has become increasingly integrated into the global economy. Today, many companies, both domestic and foreign, are managing worldwide production and distribution systems. In personal computers, a company may source chips, subassemblies such as motherboards, disk drives and monitors in several different countries in Asia, assemble the computers in Asia, Europe, or the U.S., and warehouse and distribute to retail stores and through direct mail on each continent. In automobiles, Ford and General Motors use parts and subassemblies produced in Europe and Latin America for their domestic production. The Asian and European automobile firms with assembly plants in the U.S. use parts and subassemblies produced both here and abroad. Ford and GM have both announced plans to build certain models in a single plant in Europe for worldwide distribution.

These patterns of domestic and foreign production and distribution vary significantly by industry and by product type. To understand these important determinants of freight demand, it is necessary to understand each specific type of product and its production, distribution, and marketing characteristics. These characteristics are different across products within a single company. For example, Philips is a Dutch electronics company with major operations in North America, Europe, and the rest of the world. The production and distribution patterns for its lightbulbs are different from those for televisions, for VCRs, and for new products such as CD players.

Furthermore, distribution patterns are dynamic, not static. For some products, relatively minor changes in currency exchange rates and market

conditions can rapidly change freight patterns; for others, the effects are slower but still can be significant. The U.S. decision two years ago on tariffs on certain types of computer screens forced U.S. computer manufacturers to move computer assembly operations offshore. A reversal of this decision is expected soon, which will then cause a shift of production back to the U.S. Similarly, 15 years ago electronics production in Japan, Taiwan, and Korea was causing declines in major U.S. production of computers and consumer electronics. Today, Japan, Taiwan, and Korea have become relatively high-cost producing areas and much production has shifted to Indonesia, Malaysia, and China.

Changing patterns of world trade not only affect transport flows, they affect modes used. Products that are received by truck from domestic suppliers may be obtained by containership and doublestack train from overseas suppliers or, if their value is relatively high or delivery speed important, by air freight. Garments may move in the early part of the season by ocean and then by rail or truck; but later in the season, as time to market becomes more critical, significant shipments may move by air and truck.

For some very long distance movements, for example from Asia to the East Coast or to Europe, the basic choices of air vs. ocean are augmented by mixed choices. For example, some commodities may move by sea to the West Coast of the U.S., by truck across the U.S., and then by air to Europe. Movements such as this one, entailing a domestic haul of a shipment that both originates and terminates abroad, are classified as "in-transit". Combination moves of this type provide levels of trip time and cost that are intermediate between the extremes of all-air and all-sea, and are attractive to some shippers under some conditions.

Measures of world trade include value and volume of imports, exports, and in-transit shipments, by foreign country (or region) of origin or destination. Total volume of imports and exports by foreign country is from the Bureau of the Census on CD-ROM. Total volume is also available, by commodity, in commodity-specific units (tons of coal, pairs of shoes, etc.), and volume is available in tons for water and air shipments. Value and weight of in-transit shipments entering or leaving the U.S. by water are also available from the Bureau of the Census in other files. Import, export, and in-transit data for all low-value shipments (up to $1,250 for imports, up to $2,500 for exports) are estimated from historic data without commodity detail.

Another source of import and export data is the Journal of Commerce's Port Import/Export Reporting System (PIERS) which provides data on value, weight, commodity, and foreign origin/destination for individual waterborne shipments, and, for containerized shipments, also provides number and size of containers. Other sources include individual ports and airports, United Nations' publications, and trade data from other countries.

International Trade Agreements

Global patterns of production and distribution are affected by our import restrictions and tariffs, those of our trading partners, and by international trade agreements. Quotas not only have the obvious effects on volumes of goods shipped internationally, but, in the case of natural resources on which quotas are frequently adjusted to reflect changing supply conditions, they encourage the use of foreign distribution warehouses that provide capabilities for responding quickly to quota changes. Most countries exporting to the U.S. qualify for "most favored nation" status, and additional arrangements exist with Canada and Mexico.

Duties on goods imported from Mexico's *maquiladora* zones are paid only on non-U.S. components and value added, making these zones attractive places for performing labor-intensive assembly of U.S. components. The result has been an increase U.S. truck and rail traffic to and from the Mexican border. In recent years, truck border crossings with Mexico have been growing at an annual rate of seven percent and those with Canada at an annual rate of 12 percent.

Adoption of the North American Free Trade Agreement (NAFTA) would accelerate this trend and also result in some in-transit truck and rail movements between Canada and Mexico. However, the concern that in-transit movements might result in a significant increase in freight traffic in certain corridors is probably exaggerated; in-transit movements on the I-25 corridor through Denver (which have been mentioned as being of some concern) would be limited by low population densities in Alberta and Saskatchewan and the limited interest to Mexico of the wheat and petroleum produced by these two provinces.

NAFTA would also eventually allow truck hauls to or from Mexico to be handled by a single U.S. or Mexican carrier, improving the efficiency of such movements and opening up a new area of carrier competition. The potential also exists for the development of containerports on Mexico's Pacific Coast and doublestack trains from these ports to the central United States; such services could divert much of the container traffic now moving to or from the South Pacific via Los Angeles and Long Beach.

The emergence of the European Community (EC) is also having a significant effect on trade and on freight distribution patterns. The Single Economic Market (SEM), initially targeted for completion by 1992, was a major element of this. The effects of the SEM are of two kinds: the direct effects on production within and outside the EC, and the indirect effects on global competition. The creation of the SEM is being brought about by the relaxation of internal barriers within the 12 member countries of the EC; and, especially important, by the creation of homogeneous product conditions. Previously, an auto manufacturer within the EC had to meet the different noise and air pollution requirements of the 12 different countries, and so had 4 to 12 different versions of each model to

manufacture and stock. As a result of standardization of product regulations within the EC, auto manufacturers now need produce only one version of each model. This allows significant economies of scale for both production and inventory maintenance, permitting a complete restructuring of production and distribution, and leading to new alliances between manufacturers (e.g., Volvo and Renault).

The effects of international agreements cannot be readily measured separately from those of other factors affecting world trade discussed in the preceding subsection.

Just-in-Time Inventory Practices

Just-in-time (JIT) systems, originated by the Japanese during the 1950s and 1960s, have been embraced by U.S. manufacturers at a rapid pace during the past decade. Industries in which U.S. manufacturers have successfully adopted JIT systems include the metal products, automotive, electronics, food, and beverage industries.[3]

JIT systems focus on keeping inventories at minimum levels through a coordination of input deliveries with production schedules. Adopting a JIT system usually results in increasing the frequency with which inbound shipments are scheduled, decreasing the lead times for these shipments and their size, and increasing the importance of receiving these shipments on time. Firms adopting JIT systems frequently reduce the number of suppliers and transport companies with which they deal, and they require suppliers that are close enough to be able to deliver shipments reliably within the constraints of short lead times.

The effects on freight demand are to increase the number of individual shipments, decrease their length of haul, and, most importantly, increase the importance of on-time delivery. Some shift may occur to modes that are faster or can handle smaller shipment sizes (from rail to truckload, truckload to LTL, or LTL to air freight or parcel). Within modes, a shift is likely to carriers that are capable of delivering highly reliable service, and, as the emphasis on reliability increases, the total number of carriers used generally falls. Total VMT of trucks may rise as a result of diversion from rail and reduced shipment sizes for truckload shipments, but these effects are likely to be partly balanced by reductions in lengths of haul and diversion to air.

Use of JIT systems in this country has been increasing and is likely to continue to increase over the near future. One observer estimates that, by

[3] Douglas M. Lambert and James R. Stock, *Strategic Logistics Management*, Richard D. Irwin, Boston, Massachusetts, 1993, p. 486.

1995, 55 percent of U.S. manufacturers will be making at least some use of JIT systems.[4] However, this trend will not continue indefinitely. Indeed, in Japan, a decline in transport reliability resulting from increasing highway congestion is now causing a shift away from JIT.

Appropriate measures of the use of JIT systems are the number of companies or plants that consider themselves to be using such systems, the total value of the product of plants using these systems, and the total volume (tons) of inbound shipments to these companies. These measures are imperfect (in part, because there is substantial variation in the actual inventory practices of companies that identify themselves as using JIT systems), and they are difficult to quantify. However, changes to or from JIT systems are monitored in the logistics literature.[5]

Centralized Warehousing

As transportation systems have become more efficient and more reliable, there has been a trend toward using fewer warehouses for the distribution of products. Reducing the number of warehouses reduces inventory requirements but increases the lengths of haul for many shipments from warehouses. This trend is in part the result of increasing use by manufacturing firms of third-party logistics operators that specialize in optimizing the distribution process. The trend results in increasing transport demand and associated costs in order to achieve a larger saving in inventory costs.

The extreme of this trend consists of serving a company's entire market from one or two centralized warehouses. The Limited, for example, operates a single warehouse near its Columbus, Ohio headquarters – receiving merchandise from its suppliers around the world, frequently by air, and shipping to its stores throughout the country, predominantly by LTL carriers.

Integrated air carriers have found contract operation of centralized warehouses at their hubs to be a natural extension of their air freight business. These carriers are able to provide distributors of high-value products (such as computers and computer parts) with efficient air freight and express delivery while capturing substantial amounts of business for their transport system.

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[4] Isaac Shafran, Louis Berger International, Inc., *A Review of National Domestic Freight Policy*, prepared for AASHTO Joint Committee on Domestic Freight Policy, 1992.

[5] E.g., *Transportation Distribution*, the *Journal of Business Logistics, Logistics and Transportation Review, Traffic Management, Traffic World*, and the *Journal of Commerce*.

The trend toward centralized warehousing results in increased transport demand (measured in ton-miles, shipment-miles, or value of service) and, in some instances, a shift from truck to air delivery. Appropriate measures of this trend are: the number of companies using one or two warehouses (or otherwise reducing the number of warehouses they use); and the value or volume (tons) of products shipped from these warehouses. These measures, like those for JIT usage, are difficult to quantify; however, changes in warehousing practices are monitored in the logistics literature.

Packaging Materials

The age of plastics has brought with it the use of styrofoam, bubble packs, and other very lightweight materials as protective packaging for many manufactured products. The result has been a reduction in the average density of shipments of these products. Since low-density shipments cause trucks to "cube-out" before they "weight-out," the increase in relatively low-density shipments has created a demand for larger truck trailers (such as the 53-foot trailers that are now allowed in most states, as discussed subsequently under "Truck Size and Weight") and shipping containers that are larger than 40 feet.

Although some historic estimates of shipment density exist,[6] there do not appear to be any data on how the shipment density of manufactured products has been changing (and even the historic estimates tend to focus primarily on the density of natural resource shipments – shipments that usually are quite dense and whose density is likely to vary very little). Prohibitions on the manufacture or use of styrofoam and other laws designed to encourage re-use (rather than disposal) of many plastics will affect which packing materials are used in the future and how they are used; however, the likely effect of such laws on shipment density are not clear at the present time.

Recycling

Increasing use of recycled materials affects the origin/distribution patterns, lengths of haul, and modal usage of several commodities.

Processing plants that use virgin materials are usually located near a major source of supply of these materials, and they commonly ship their products long distances to their markets. Thus, most of the paper

[6] E.g., William S. Kuttner, *A Disaggregate File of Commodity Attributes, Center for Transportation Studies,* Massachusetts Institute of Technology, Cambridge, Massachusetts, August 1979.

products used in the northeast and midwest historically have been shipped from paper mills in the southeast, the Pacific northwest, and Canada, with rail used for much of the long-haul transport.

Recycling plants, on the other hand, usually are located near the markets they serve, which also provide them with substantial volumes of material for recycling. Plants producing products from a combination of raw and recycled materials are likely to be located near sources of supply for their more important inputs and may receive some inputs by rail from more distant sources of supply.

■ A.2 Factors that Affect Demand Through Their Influence on Costs and Service

The factors discussed below have a less direct effect on demand than those discussed in the preceding subsection. In general, the factors discussed in this subsection affect the transportation industry, its costs, and the services it offers, and they affect supply only through their effects on costs and services. Although some of these factors (such as deregulation and intermodal operating agreements) are significant influences on demand, others affect demand to a very limited extent or only in a very narrow way (e.g., through port choice). Factors of the latter type may be important for specific purposes but there are many applications of freight demand forecasts that do not require consideration of all of these factors.

Economic Regulation and Deregulation

The deregulatory movement of the late 1970s, culminating in passage of the Airline Deregulation Act of 1978, the Motor Carrier Act of 1980, and the Staggers Rail Act of 1980, had significant effects on the airline, trucking, and railroad industries, the services they offer, and the uses made of those services by shippers. The effects on each of the modes are discussed below.

Air

All-cargo air services were deregulated in 1977 and the rest of the industry was deregulated by the Airline Deregulation Act of 1978.

Previously, the Civil Aeronautics Board (CAB) maintained strict regulation of nearly all facets of U.S. commercial air cargo services. The 1978 Act allowed free entry and exit from air cargo markets, freedom to select routes and set fares, and permitted integration of aircraft services within multi-modal integrated systems.

The primary impact of deregulation was a dramatic change in the composition of the carrier group providing all-cargo services. The scheduled combination carriers such as American Airlines and United Airlines largely have been replaced by the integrated carriers which provide express and standard door-to-door services, as well as specialized air charter operators. The development of new cargo systems has resulted in exceptionally high market growth rates in traffic and carrier revenues, and a substantial increase in the U.S. freighter fleet. Overnight express air services are now available to all U.S. zip codes, and the level of service now available to manufacturers and retailers has revolutionized the distribution of materials and products, extending market ranges and facilitating fast-response parts replacement and catalogue sales.

Deregulation has resulted in a highly competitive market characterized by advanced customer service, high reliability, pickup and delivery, and a wide array of cost/service options. The huge expansion of air cargo activity in the 1980's resulted in a continuing decline in shipper costs, while service levels continued to increase.

Domestic air cargo operations also are affected by regulations of trucking activity which is used by integrated carriers both for local pickup and delivery and as a substitute for air services in short-haul and deferred shipment markets. The Deregulation Act of 1978 permitted vertical integration by freight forwarders, creating the door-to-door integrated carrier prevalent today. However, a remaining issue is whether these carriers are subject to state regulation (and possible state prohibitions) when they use trucks for short-haul shipments without crossing state lines.

A 1992 ruling by the ninth U.S. Circuit Court of Appeals exempted Federal Express (but, for technical reasons, not its competitors) from such regulation in California and other states in the ninth circuit. A similar case currently is pending in Tennessee. Further deregulation of intrastate trucking operations of integrated carriers could occur as a result of the actions of individual states. On the other hand, the Air Freight Association is concerned that any move to aid the airline industry by increasing regulation not be extended to air freight.

Truck

The most important effect of the Motor Carrier Act of 1980 was a substantial easing of restrictions on the entry of motor carriers into new markets. The burden of proof was shifted from the carrier applying to enter a new market to those opposing the application, and arguments in opposition were limited to showing that the proposed service is inconsistent with the public convenience and necessity. Open competition enabled well-run carriers to enter any market they could serve efficiently and forced many inefficient carriers out of business. To attract customers,

carriers developed a variety of price and service options tailored to the needs of individual shippers.

In the truckload segment of the industry, several carriers developed operating strategies that made them extremely efficient, enabling them to offer low rates and high quality service and to expand rapidly. These so-called "Advanced Truckload" firms hired their own drivers, purchased equipment in bulk at discounts in the 20 percent range, and focused their marketing on corridors with high densities of demand that could provide them with directionally balanced traffic. This marketing strategy enabled them to achieve empty backhaul ratios of six to eight percent instead of the 15 percent that is typical of other truckload carriers of general freight.

In the LTL segment, competition was also enhanced by prohibiting collective ratemaking for single-line rates, a change that became increasingly significant as major LTL carriers expanded their route systems to reduce the amount of interlining required. Mergers and business failures have resulted in an increasingly concentrated industry, with the market share of the eight largest firms rising from 32 percent to 52 percent between 1980 and 1989.[7] This increase in industry concentration, however, does not appear to have resulted in oligopoly pricing; the real decline in LTL operating revenues over the 1977 to 1987 period has slightly exceeded the real decline in operating expenses (28 percent to 27 percent),[8] and profit margins have been low.

The overall effect of motor-carrier deregulation has been an appreciable reduction in transport costs and an improvement in service that has permitted reduction in associated inventory costs and in other logistics costs. In the truckload sector, these effects now have largely run their course, though some further industry consolidation is likely. However, the structure of the LTL sector is still evolving, with the major unionized carriers setting up lower cost nonunionized subsidiaries and the trend toward concentration continuing. Real costs of LTL carriers are continuing to decline; however, increasing concentration in the industry eventually could allow oligopoly pricing in some markets.

Relevant measures of concentration include the number of carriers in the industry and the market share of the largest three, four, six, or eight carriers. Measures of profitability, such as operating ratios (operating expenses divided by operating revenue) can be used as indicators of the existence of monopoly pricing. Data for all measures can be obtained from annual reports filed with the ICC by Class I and II motor carriers and summarized in the ICC's *Transport Statistics in the United States* and in the

[7] Thomas M. Corsi, "Motor Carrier Industry Structure and Operations," International Symposium on Motor Carrier Transportation, Transportation Research Board, Williamsburg, Virginia, June 1993.

[8] *Ibid.*

TTS Blue Book of Trucking Companies (issued annually with occasional supplements by Transportation Technical Services, Inc., of New York City).

The above data are available only for Class I and II carriers. No data are available for Class III carriers (those with annual revenue less than a threshold that is indexed for inflation and is now about $1.2 million) or for carriers that have grown above the Class II threshold but have not volunteered this information to the ICC. Since the elimination of reporting requirements for Class III carriers, no mechanism has existed to require carriers whose revenue grows beyond this threshold to report this change. Accordingly, the number of nonreporting carriers with revenues exceeding this threshold has undoubtedly grown over time, resulting in slowly increasing underestimates of total revenue of Class I and II carriers and of industry concentration and in exaggerated estimates of the decline in the numbers of Class I and II carriers.

Rail

While airline and truck deregulation were intended to promote competition, the primary goal of rail deregulation was to improve the profitability of a financially ailing industry. The Staggers Rail Act: streamlined the process for abandoning unprofitable branch lines; relaxed the regulation of railroad mergers; and, most importantly, substantially relaxed ICC oversight of railroad rates, eliminating regulation entirely for movements on which a railroad does not have "market dominance" and for movements covered by contract rates negotiated with the shipper.

In the years following passage of the Staggers Act, several major railroad mergers occurred. Class I railroads continued to abandon low-density lines or to sell them to smaller (frequently newly formed) railroads that could operate them more economically (sometimes with public subsidies). Between 1980 and 1991, the number of Class I railroads fell from 40 to 13, primarily as a result of mergers, and the miles of rail line operated by these railroads declined from 165,000 to 117,000. During the same period, miles operated by local and regional railroads rose to 44,000 and the number of such railroads rose to 522.[9] The increased pricing flexibility enabled the railroads to tailor their rates to competitive conditions, to make extensive use of negotiated contract rates, and to develop new services. Although overall rates rose, their average annual increase during the first five years following deregulation, despite high inflation, was only

[9] Association of American Railroads, *Railroad Facts*, 1981 and 1992 Editions, Washington, D.C.

4.1 percent, appreciably below the 10.9 percent rate of increase in the preceding five year period.[10]

Water

Economic regulation was never as significant a factor for international shipping as it was for air, truck, and rail transport, and so deregulation of international shipping has been less important. Nonetheless, the Shipping Act of 1984 did have some effect on services offered by international shipping companies. One of the more important changes instituted by this Act was the elimination of restrictions on the offering of through rates for transport involving intermodal pickup or delivery, a change that led to the intermodal operating agreements discussed subsequently. The Act also eased restrictions on changing rates and allowed the use of volume-based contracts. The widespread use of such contracts and the restricted availability of information about contract rates makes any rate analysis based on published tariffs highly speculative.

Aside from cabotage laws, which exclude foreign carriers from domestic service, economic regulation of domestic shipping was largely limited to movements of nonbulk commodities – commodities which, for domestic water transport, are significant only for movements to or from domestic noncontiguous locations (Alaska, Hawaii, Puerto Rico, etc.). These movements were originally subject to regulation by the Federal Maritime Commission (FMC), but FMC's regulatory authority was sharply curtailed in 1978 when carriers were allowed to "file annual increases of 5 percent or less with 60 days notice without being subject to suspension."

International Transportation Agreements

Air

Traditionally, international air service has been regulated by bilateral agreements with all countries served. These agreements control the routes that can be served, the number of carriers from each country that can serve them, level of service, fares, and the size of aircraft that can be operated. Historically, these agreements have concentrated international traffic through three major gateways: New York (JFK), Miami, and Los Angeles. In the last several years, several bilateral agreements have been modified to allow additional international service through a score of additional U.S. airports; and service between the U.S. and the Netherlands has been completely deregulated. These changes have slowed the rate of traffic

[10] Frank N. Wilner, *Railroads and the Marketplace*, Association of American Railroads, Washington, D.C., 1986.

growth at JFK and enabled Anchorage to pass Los Angeles as the third largest gateway.[11]

The percentage of air freight moving through the major gateways is likely to continue to decline gradually as bilateral agreements are modified to allow additional routing options. However, complete deregulation of air service to and from additional countries is considered unlikely because of the concerns of foreign carriers about their ability to compete effectively with U.S. carriers in a deregulated environment.

Changes in the share of international freight traffic moving through the major U.S. gateways (or any other set of airports) can be derived from freight traffic data by airport in the North American Airport Traffic Report, published annually by the Airports Council International – North America (see Appendix C). However, the shares indicated for individual airports or sets of airports may be affected by inconsistencies in reporting conventions used by different airports (e.g., treatment of transshipments).

An appropriate measure of the extent of complete deregulation is the volume of air freight transported to/from countries with which air service has been completely deregulated. Export/import data for applying this measure are available in various forms from the U.S. Bureau of the Census (see Appendix C).

Water

International water transport is generally free of the route restrictions that affect air traffic. Accordingly, ports and routes served are determined by market forces rather than by international agreements. However, U.S. carriers do receive preference for carrying military and foreign-aid cargo; and the U.S. does have bilateral agreements with Brazil, Argentina, and China that may limit service to and from those countries.

Several steamship conferences do exert some influence on services of and rates charged by liners (containerships and other vessels providing scheduled service on regular routes). However, the influence of these conferences on services to/from the U.S. is somewhat limited by Federal Maritime Commission (FMC) regulations that prohibit rebating and market-share agreements and require the conferences to be open, to allow free withdrawal, and to provide mechanisms for handling shipper complaints. Last summer, the FMC approved the Trans-Atlantic Agreement (TAA) which provides for a common tariff, open exchange of capacity and equipment, and a capacity management plan for westbound trade. The TAA covers twelve carriers (both conference and independent carriers) that carry about 80 percent of North Atlantic liner traffic.

[11] Airports Association Council International, 1991 data for international air cargo.

Truck

Current law allows both U.S. and Canadian motor carriers to operate across the U.S.-Canada border, subject to the laws of the states and provinces in which they operate. Mexican trucks, however, are allowed to operate in the U.S. only within 30 miles of the border, and U.S. trucks are not allowed into Mexico at all.

Over a six year period, the North American Free Trade Agreement (NAFTA) would phase out all prohibitions on the operations of both U.S. and Mexican trucks carrying international traffic, though both U.S. and Mexican companies continue to be barred from carrying domestic cargo in the other country. Safety standards would be harmonized over the first three years of this period. Size and weight regulations are not affected by the agreement, though some U.S. carriers are hopeful that NAFTA will provide leverage for increasing U.S. weight limits. Mexican carriers would be allowed to hold non-controlling interests in U.S. carriers, but U.S. carriers would not be allowed to have any ownership interest in carriers providing domestic service in Mexico.

The principal effects of NAFTA on motor carrier service would be: improved efficiency in transborder trucking operations resulting from the elimination of the interlining that currently is required on many international movements; and additional downward pressure on rates for hauls that cross the Mexican border due to the ability of low-wage Mexican companies to compete for this traffic.

Rail

Analogous to the developments on North American international trade, rail carriers in Canada and the U.S. are becoming more integrated and better able to serve shippers beyond their home countries. For example, both major Canadian railroads have reached trackage rights agreements with U.S. carriers to move traffic in the U.S. CP, in addition, to its purchase of the Soo Line and Delaware and Hudson, has acquired trackage rights from CSX and Norfolk Southern to serve Chicago and link Chicago with Boston for intermodal traffic. CN, in addition to owning Grand Trunk Western, has reached similar haulage agreements with Burlington Northern and Conrail. These developments will increase rail competition in the U.S., potentially providing lower rates and additional shipments moving by rail.

Intermodal Operating Agreements

Following passage of maritime deregulation, American President Lines (APL) determined that the most efficient means of serving many inland origins and destinations was by doublestack train, and that, under

deregulation, it could contract for doublestack services that were specifically tailored to meet its needs. During the next several years, all major containership companies arranged for such service, operated by the railroads but with marketing handled by the shipping companies. To balance the number of loaded containers moving from the Far East to the central and eastern parts of this country, the shipping companies began soliciting domestic business, offering to transport containers at appropriately low backhaul rates and successfully diverting a share of truck traffic to the Pacific Coast.

More recently, several of the major truckload carriers, led by J.B. Hunt, have determined that such intermodal operating agreements can also be structured to meet their needs for efficient longhaul transport of trailers or containers. J.B. Hunt now has intermodal agreements with six railroads. In 1991, intermodal traffic accounted for six percent of Hunt's loads and 10.5 percent of total revenue, with revenue from such traffic expected to more than double in 1992.[12]

Intermodal agreements have played a major role in the growth of rail intermodal services over the past several years (84 percent growth in loadings between 1982 and 1991[13]); and truck/rail agreements are likely to contribute to continued growth of such services over the next several years as well. Most new domestic intermodal traffic was previously being shipped entirely by truck, though a small but unknown portion was previously moving by conventional rail. Intermodal agreements with the shipping companies also have resulted in the diversion of truck traffic to doublestack trains, though an appreciable portion of traffic moving under these agreements may have been already moving by container trains, and some was moving by ship through the Panama Canal. The agreements with shipping companies also affect port usage, since the intermodal services to or from any area that are offered by any shipping company are usually operated via a single port.

Measures of the role of intermodal agreements are the number of such agreements (reported periodically in the trade press) and the volume of intermodal traffic. The volume of intermodal loadings (trailers and containers, combined) is published by the Association of American Railroads on both a weekly and annual basis for all Class I railroads and selected other railroads.[14] Since all or virtually all intermodal rail movements involve Class I railroads, data on intermodal loadings is essentially complete.

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[12] Business and Market Planning, Fleet Management Department, TTX Corp., "The Truckload Carrier and Intermodal," October 15, 1992.

[13] Association of American Railroads, *Railroad Facts*, 1992 Edition, Washington, D.C., p. 26.

[14] Association of American Railroads, *Weekly Railroad Traffic*, and *Railroad Facts* (annual), Washington, D.C.

Single-Source Delivery of International LTL Shipments

A variant of the door-to-door service provided by the major containership operators has been offered by LTL carriers since the early 1980s. These carriers have established separate units, known as non-vessel operating common carriers (NVOCCs), to arrange for the international transport of LTL shipments. Domestic transport of each shipment is handled by the LTL firm, ocean transport of containers filled with LTL shipments is provided by containership operators from whom the NVOCC purchases space, and transport in Europe and Asia is handled by trucking companies and freight agents with whom the U.S. carrier has partnership agreements. U.S. LTL carriers that provide such single-sources delivery of international LTL shipments include ABF, A-P-A Worldwide, Carolina Freight, the Con-Way Intermodal subsidiary of Consolidated Freightways, Roadway, and Yellow.[15]

Carrier-Shipper Alliances

In recent years, stimulated in part by the demands of JIT inventory-control systems, and made possible by deregulation, a number of industrial firms have found that they can obtain more reliable transport service and reduce other logistics costs by reducing the number of carriers they use and by working more closely with the selected carriers to maximize the overall efficiency of the logistics process. Major industrial companies that have formed such alliances or "partnershipping" arrangements with the carriers that serve them include Black and Decker, Ford, General Motors, GTE, Procter and Gamble, McKesson, 3M, and Xerox.[16]

These carrier-shipper alliances generally result in improvements in on-time delivery and reductions in overall logistics costs for both inbound and outbound shipments. Computerized tracking of shipments usually is an important component of the services provided by the selected carriers, and automation of other services (billing, collections, etc.) is common. The development of these alliances has little effect on the overall demand for freight transport, but it does represent an increase in the quality of service expected of transport companies and does affect competition among carriers.

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[15] Mitchell E. McDonald, "LTL-to-Europe Services Put Accent on Simplicity," *Traffic Management*, September 1992, pp. 51-53, and Mark Soloman, "Roadway Express Enters Race to Capture U.S.-to-Asia Business," *Journal of Commerce*, May 22, 1992, p. 1.

[16] Lambert and Stock, *Strategic Logistics Management*, Richard D. Irwin, Boston, Massachusetts, 1993, p. 239; and Donald J. Bowersox, "The Strategic Benefits of Logistics Alliances," *Harvard Business Review*, July 1990, pp. 36-45.

Fuel Prices

Fuel constitutes a moderately significant and relatively volatile component of costs for all freight modes. Fuel consumption and fuel costs are highest for air freight and generally are lower for the slower, lower quality-of-service modes. Fuel accounts for 7.1 percent of total operating expenses for Class I railroads;[17] fuel, oil, lubricants, and coolants account for about 13.5 percent of operating expenses for 410 truckload carriers of general freight and about six percent of operating expenses for 306 LTL carriers;[18] and fuel represents 30 to 40 percent of operating expenses for air carriers. A significant increase in real fuel prices is likely to result in greater rate increases for the faster modes than for the slower ones and some corresponding shift of demand across modes.

In evaluating the effect of fuel price changes on modal demand, it is necessary to consider fuel requirements for competing services rather than modal averages. Typical rail-competitive intercity truckload operators require less fuel per ton-mile than much other truck transport, while rail doublestack and other intermodal services (which have relatively high tare weights, high speed, and poor aerodynamics) require more fuel than much other rail transport. Thus, a significant increase in fuel prices is likely to result in less diversion from truck to rail intermodal service than a simple comparison of overall fuel efficiency for truck and rail operations would suggest. This can be seen from the estimates of fuel and energy intensity of selected modes and submodes shown in Exhibit A-2 – though the reader is cautioned that these estimates are more than ten years old. Most modes have become somewhat more energy efficient in the last several years, and current rail intermodal services are appreciably more energy efficient than trailer-on-flatcar (TOFC) service.

Information on fuel prices is available from a variety of sources. Data on the average retail self-service price of highway diesel fuel is collected weekly by the Interstate Commerce Commission and published in *Traffic World* and other periodicals. Average diesel fuel prices paid by railroads are published annually by the Association of American Railroads (in *Railroad Facts*) and monthly trends can be estimated from Energy Information Administration (EIA) data on average refiner prices of diesel fuel (and other fuels) sold to end users; the latter data are available in two EIA publications: *Petroleum Marketing Monthly* and *Monthly Energy Review*. The EIA data can also be used as an indicator of diesel fuel costs

[17] Interstate Commerce Commission, *Transport Statistics in the United States* for the Year Ended December 31, 1991.

[18] The figures shown include taxes. Exclusive of taxes, the percentages are 9.4 and 4.1 percent, respectively (Transportation Technical Services, *TTS Blue Book of Trucking Companies*, Supplement, New York City, 1992). The figures shown in the text incorporate a 44 percent adjustment for taxes.

Exhibit A.2 Fuel and Energy Requirements for Selected Intercity Modes and Submodes – 1977-1980

Mode	Route Ton-Miles per Gallon	Circuity Factor	Great-Circle Ton-Miles per Gallon	BTU pre Great-Circle Ton-Mile
Truck				
Overall	60	1.22	49	2,800
Typical rail-competitive	80	1.15	70	2,000
Rail				
Overall	223	1.56	143	970
TOFC	105	1.44	73	1,900
Unit Train	415	1.41	294	470
Water				
Coastwise				
Tanker	535	1.30	410	365
Tug/Barge	385	1.30	296	470
Inland Waterways	290	1.83	158	880
Air				
Cargo Plane	5.3	1.05	5.0	27,000
Belly Freight[a]	45	1.05	43	3,100
Overall	12	1.05	11.4	11,800
Pipeline				
Crude Oil	–	1.10	–	275
Petroleum Products	–	1.10	–	330
Coal Slurry	–	1.10	–	1,000

[a] Estimates for belly freight reflect only the incremental energy required for transporting the freight. Since availability of belly freight is now an important influence on the number and size of aircraft flown on some routes, true energy requirements for belly freight are higher than those shown.

Source: Jack Faucett Associates, *Freight Transport Fuel Efficiency and Commodity Flows*, Bethesda, Maryland, 1983, Exhibit 1.3.

to barge operators, though users should be aware that the prices exclude the Inland Waterway Fuel Tax (currently 17 cents per gallon).

Wholesale prices of jet fuel in the United States and Europe, exclusive of taxes, are published daily in *Platt's Oilgram* and mid-month prices are reprinted in *The Avmark Aviation Economist;* and *Petroleum Marketing Monthly* and *Monthly Energy Review* print EIA data on average monthly refiner prices of jet fuel sold to end users (also exclusive of taxes). Daily New York City, Houston, and New Orleans prices of bunker C fuel, used by maritime carriers, are published (in dollars per metric ton) by the *Journal of Commerce.*

Publicly Provided Infrastructure

Air, water, and truck carriers are all dependent on publicly provided infrastructure.

The FAA is responsible for building, operating, and improving the nation's air traffic control system, for building and expanding airport runways and related infrastructure, and for certifying airport designs; while individual airports and other local authorities exercise primary control over terminal and land-access development. Actual terminal facilities may be developed by the airports and leased to the carriers or developed by the carriers, usually on land leased from the airport.

The U.S. Army Corps of Engineers maintains waterway channels, operates locks and dams, constructs and maintains anchorages, and monitors the status of ports and harbors; and the Coast Guard provides aids to navigation and has developed and operates Vessel Traffic Services navigational assistance systems in several major ports. Most ports on the inland waterway system are privately owned; but coastal ports generally are the responsibility of a public port authority which owns and operates piers and wharves, intraport roads and rail lines, storage facilities, and major handling equipment, often leasing berths or terminals to carriers or stevedore firms. Private companies also construct, own, and operate port facilities, particularly those dedicated to a specialized use (e.g., refrigerated terminals or bulk loaders).

The Federal Highway Administration (FHWA) is responsible for administering the Federal aid highway program, which provides funds for development of the National Highway System (including the Interstate System) and other highways on a matching formula basis. Most major highways are constructed, operated, and maintained by state highway agencies or state toll authorities, although some major highways are the responsibility of local governments and most minor roads and streets are the responsibility of local governments. Direct Federal responsibility for highways occurs only on federally owned land, such as national parks and forests. In a few cases, highways, bridges, and tunnels are owned by

interstate compact agencies, such as port authorities, and in a few cases, private organizations own, operate, and maintain toll facilities or private-access roads open to the public.

The public air, water, and roadway infrastructure is supported by a system of user charges, discussed in the following subsection.

All three systems of infrastructure tend to be expanded somewhat more slowly than the users would like, resulting in congestion that: increases travel times and operating costs; can make delivery times less reliable (a particular problem when JIT service is required); and constrains air-carrier schedules. The quality of local infrastructure and the degree of congestion also affect carrier choices of ports and airports.

Public infrastructure can be measured in terms of physical characteristics (lane-miles of road, channel depths, lengths of runways, etc.) or capital, operating, and maintenance expenditures. Measures of condition also exist for some forms of infrastructure (present serviceability ratings for road pavements and sufficiency ratings for bridges). Sources of data and information include the Corps of Engineers,[19] the Maritime Administration,[20] the American Association of Port Authorities,[21] and the Federal Highway Administration.[22]

User Charges

Most publicly provided transportation infrastructure is funded primarily through user charges. The major exception is the inland waterway system. Half the costs of inland waterway construction projects authorized since 1986 are funded with revenue from the Inland Waterway Fuel Tax, while operating and maintenance costs and all other construction costs are funded from general revenue.

Forty percent of construction operations and maintenance costs for coastal harbors is funded with revenue from a Harbor Maintenance Fee, with the remainder funded by general revenue of the federal government and by local sources. The Harbor Maintenance Fee, established by the 1986 Water

[19] U.S. Army Corps of Engineers, Institute for Water Resources, *The Inland Waterway Review* and the *Great Lakes Review*, Fort Belvoir, Virginia, annual.

[20] U.S. Department of Transportation, Maritime Administration, *United States Port Development Expenditure Report*, annual, and *A Report to the Congress on the Status of the Public Ports of the United States*, biennial.

[21] American Association of Port Authorities, *Finance Survey*, Alexandrai, Virginia, annual.

[22] *The Status of the Nation's Highways: Conditions and Performance*, Report of the Secretary of Transportation to the United States Congress, U.S. Government Printing Office, biennial.

Resources Act, is levied at a rate of 0.125 percent on the value of all cargo loaded or unloaded at a port for which federal funds were used since 1977 for construction, maintenance, or operation. Maritime carriers also pay a number of other fees to the Coast Guard, the Customs Service, the Federal Maritime Commission, the Maritime Administration, and eight other federal agencies for a variety of services provided. Extensive information about these fees is contained in a recent General Accounting Office Report.[23]

The operations of coastal ports are financed by a variety of user charges. These include wharfage charges (per container or per ton of cargo), dockage charges, lease revenue, equipment rental fees, gate fees (for trucks and rail cars), and franchise fees (for stevedore firms and other vendors). Facility construction is financed primarily by a combination of revenue bonds, general obligation bonds, and federal aid. The inclusion of general obligation bonds in the mix suggests that some port facilities are not fully supported by user charges but may require some financial support from state or local governments.

Federal spending on airports and airways is supported by a 10 percent tax on airline passenger tickets, a 6.25 percent air cargo waybill tax, a 15 to 17.5 cents per gallon tax on fuel used in general aviation, and a $6 per person charge for international departures. Revenues from these taxes are deposited in the Airport and Airway Trust Fund, which is used to finance the air traffic control system, to provide federal assistance for airport development, and to support related FAA activities. Increases in the two taxes were passed in 1990, enabling the Trust Fund to run an annual surplus that could be used for deficit reduction purposes.

The construction and operation of individual airports usually are financed through a combination of federal assistance (from the Airport and Airway Trust Fund), revenue bonds (for facility construction), revenue from leasing the facilities to the carriers, landing fees, and fees for landing slots. Landing fee schedules are regulated by the FAA to reflect the effects of operations and aircraft weight on costs. Massport (the operator of Boston's Logan Airport) has proposed incorporating capacity considerations into its fee schedules, though FAA has not allowed such considerations in the past. If adopted, the Massport proposal would allow market forces to produce more efficient use of peak-hour capacity, though the effect on air freight transport is likely to be negligible.

Federal highway programs are supported by the Highway Trust Fund which receives dedicated highway user taxes including 11.5 cents from the 14.1 cent Federal tax on gasoline, 17.5 cents from the 20.1 cent Federal tax on diesel, an annual Heavy Vehicle Use Tax of from $100 to $550 per

[23] General Accounting Office, *Federal Assessments Levied on Commercial Vessels*, March 1993.

heavy truck per year depending on registered weight, an excise tax of 12 percent on the retail price of heavy trucks and tractors, and an excise tax of from 15 to 50 cents per pound on new heavy truck tires, depending on the weight of the tire. For many years, federal Highway Trust Fund receipts could only be used for highway capital improvements. However, over the last few years Congress has gradually reduced restrictions on the use of these funds and, under ISTEA, a high proportion of the receipts can be used for transit and other transportation programs.

Most of the states also have highway or transportation trust funds or special accounts in which highway user taxes and fees are deposited. In about half the states, there are constitutional restrictions on the use of dedicated highway user revenues for non-highway purposes.

Data on state and Federal highway receipts and expenditures are reported annually in *FHWA's Highway Statistics.*

User charges also are used to fund a variety of other activity relating to transportation companies, their suppliers, and international transport. Such user charges include:

- The Leaking Underground Storage Tank (L.U.S.T.) tax of 0.1 cents per gallon which is assessed on fuel dispensed from underground tanks and used to pay for remedial actions required to address leaks from such tanks.

- The Oil Spill Liability Tax and Hazardous Substance Superfund Tax on imports, exports, and production of crude oil and petroleum products, which is used to pay for clean up and related costs resulting from oil spills.

- A Merchandise Processing Fee on imported cargo.

Other Taxes

In addition to user charges (discussed above), transportation companies pay the usual business, sales, and property taxes (though railroads, the only mode that owns its own right-of-way, are exempt from property taxes on their right-of-way in a few states). Most revenue from these taxes is used for the general operations of federal, state, and local governments, though some is used for specified non-user purposes, frequently with a transportation application. The last category includes the use of federal Highway Trust Fund revenue for supporting mass transit.

The transportation industry has a particular concern about the use of fuel taxes for non-transportation purposes. This concern is due to the relatively large amounts of fuel used by the industry and the important role that fuel taxes play in the user-charge system. Currently, 2.5 cents per

gallon of the federal tax on gasoline and highway diesel fuel (and 3.1 cents of the tax on gasohol) is deposited in the federal General Fund (and referred to as a "deficit reduction tax").

It now appears likely that the deficit reduction legislation currently before Congress will include a new or increased tax of several cents per gallon on transportation fuels with the proceeds to be used for deficit reduction. The national airline commission has indicated its intention to recommend that the airlines be exempted from this tax because of their poor financial condition, but there may be some resistance to opening up the process to what could then become a series of exemptions. New or increased taxes on transportation fuels would result in small increases in transport costs. As discussed previously (under "Fuel Costs"), such increased costs would affect the faster modes (especially airlines, if they are not exempted) somewhat more than the slower modes, and they would produce some relatively small amounts of traffic diversion.

Government Subsidization of Carriers

Government subsidization of carriers reduces the cost of transport and, because of unevenness in the way classes of carriers are subsidized, it affects competition between these classes. In particular, subsidization affects competition between domestic modes and, internationally, it affects competition between operators of vessels registered in different countries.

Among domestic carriers, subsidization of motor carriers and barges has long been of concern to the railroad industry. Railroads own and maintain their right-of-way, and, in many states, they also pay property taxes on right-of-way. Except for public subsidies of operations on a few otherwise unprofitable branch lines, railroads do not currently receive any government subsidies. (However, they were the beneficiaries of very significant historic subsidies: the granting of right-of-way land, and, in several cases, substantial amounts of adjoining land that eventually became quite valuable.) On the other hand, trucks operate on public roads and barges operate on waterways that are operated and maintained by the Corps of Engineers.

Barges pay only a small portion of the cost of constructing, operating, and maintaining the waterways. Efforts to increase the share paid by barges are likely to continue. Any significant increase in the share of costs paid would increase barge costs appreciably and cause some diversion of traffic to rail. Total elimination of the subsidy to barge operators would increase average costs for barge transport by about 25 percent and would result in significant diversion of traffic to rail.

The subsidies to trucks are appreciably smaller, and there are several states that have highway tax structures that yield appropriate amounts of revenue from trucks. However, the 1982 federal highway cost-allocation

report indicated that heavy trucks pay less than their share of federal highway taxes; and, increasing truck taxes historically has proven difficult. Among the most significant truck taxes, taxes on fuel increase with truck weight at a far slower rate than cost responsibility, while most weight-indexed taxes and fees, such as state registration fees and the federal heavy-vehicle use tax, cannot be designed to obtain appropriate amounts of revenue from high annual mileage vehicles without significantly overtaxing low annual mileage vehicles. Weight-distance taxes can be designed to be part of a program that better matches taxes to their estimated cost responsibility, but the trucking industry has successfully opposed their use in all but a few states on the grounds that these taxes are subject to high rates of evasion.

The sizes of federal and state subsidies to motor carriers are estimated periodically by highway cost-allocation studies. Significant changes in the subsidies provided by any governmental entity can occur whenever the structure of that entity's highway tax system is changed.

Issues also exist relating to operating subsidies to U.S. flag ships and the possibility that air carriers are not paying their appropriate share of costs for the air traffic control (ATC) system.

The future of operating subsidies for U.S. flag ships currently is unclear. Curtailment or elimination of these subsidies would result in the re-registration of U.S. flag ships in other countries but would have little net effect on shipping costs and no effect on transport rates or demand.

There does not appear to be agreement about the appropriate share of ATC costs to be paid by the air carriers. Figures from a recent CBO study[24] suggest that current user charges, including the 6.25 percent tax on air-cargo waybills, should be increased by about one-fourth for air carriers to meet their full cost responsibility. However, the current financial problems of the airline industry make such a tax increase unlikely in the near future, and the national commission reviewing the financial condition of the industry has indicated that it expects to recommend a 20 percent reduction in these taxes to pre-1990 levels.[25]

Environmental Policies and Restrictions

All modes are affected by environmental policies and restrictions, though the restrictions of concern vary among the modes.

[24] Congressional Budget Office, *Paying for Highways, Airways, and Waterways: How Can the User Be Charged?*, U.S. Government Printing Office, May 1992, pp. 30-37.

[25] *The Washington Post*, July 21, 1993, P. C1.

The water mode is affected by the largest variety of environmental restrictions. About one-fifth of all U.S. ports report that port expansion is "usually or always" constrained by the Clean Water Act policy of "no net loss" of wetlands, and another quarter of all ports are sometimes constrained. Controls on dredge disposal have increased the cost of dredging required for harbors and inland waterways – costs that are borne directly by the Corps of Engineers and, in the case of inland waterways, indirectly by the carriers through the Inland Waterways Trust Fund. Also, some ports and waterways have speed and draft restrictions intended to protect animal or plant life or the disturbance of channel bottoms, and environmental groups oppose expanding the capacity of the inland waterway system because of the effects of barge traffic on the ecosystem.

The Oil Pollution Act of 1990 requires all new tankers serving U.S. ports to have double hulls, regulates navigation systems and manning of single-hull tankers, and requires the phase-out of most such tankers by 2009 (2015 for tankers of less than 5,000 gross tons). The International Convention for the Prevention of Pollution (MARPOL) also mandates the phase-out of single-hull tankers and requires either protectively located segregated ballast tanks or restricted loading. Also, controls on atmospheric emissions of ships while at berth have been considered.

Two related categories of environmental regulations have significantly increased costs and could have some modest effects on demand for truck freight transportation: emissions controls and clean fuel requirements.

Emissions controls on heavy truck engines have been in effect for about 20 years and increasingly strict controls are scheduled to become effective over the next several years. Controls apply to carbon monoxide, nitrogen oxides, hydrocarbons, and particulates. Diesel engines have had to be completely redesigned to meet these requirements at costs of several hundred dollars per engine. Additional controls will require new electronic fuel injection systems and catalytic converters which will increase costs by another several hundred dollars per engine.

When translated into costs per mile of operation, however, the engine and related retooling and production costs are quite small compared with the anticipated higher costs of clean diesel fuels. Based on experience under existing California regulations, national requirements for low sulfur fuels, scheduled to begin later this year, will increase diesel prices about three to seven cents per gallon, and low aromatic requirements, scheduled to begin in 1994, will increase the total increment to about 12 to 15 cents per gallon.[26]

[26] Conversation with Larry W. Strawhorn, Director of Engineering, American Trucking Associations.

More difficult to estimate is the loss of fuel economy due to these regulations. Significant improvements in fuel economy have been made throughout the period in which the emission controls have been imposed. However, knowledgeable industry representatives believe that the costs of the loss in potential fuel economy improvements due to these controls have been even greater than the other costs cited above.

When all of these costs are added, they amount to roughly three to five percent of the typical costs of operation of a for-hire truckload carrier. The net effect of these cost increases on freight demand will be to cause a slight shift from truck to other modes, primarily to rail. Since these cost impacts are expected to be split roughly between the last several years and the next few years, the diversion impacts are expected to have about the same time dimensions.

The California Air Resources Board is now considering the desirability of imposing emissions restrictions on railroad locomotives, at least for local and switching operations and other intrastate services. However, before proposing any such restrictions, the Board intends to consider the emissions effects of any modal diversion likely to result.

The most significant environmental issue affecting air carriers is noise. The federal government has mandated a phased reduction in the number of aircraft that do not meet "Stage 3" noise limits, with all such planes to be removed from U.S. service by January 1, 2000. Older aircraft can be modified to meet Stage 3 noise limits by replacing their engines (at an average cost estimated in 1988 to be just under $10 million) or, in some cases, by installing hush kits (at an average cost of $1.5 million).[27] Installation of new engines has the additional benefit of reducing fuel consumption and related operating costs; however, the cost of new engines represents about 20 percent of the cost of purchasing a new Stage 3 plane.

In addition to the above influences of environmental regulation on modal costs, freight demand is also affected by environmental policies that affect the locations at which raw materials (such as coal and timber) are produced and those at which industrial plants are located.

Safety Policies and Restrictions

Safety regulations have at most a minor effect on freight demand. These regulations increase carrier capital and operating costs while reducing all accident-related costs (insurance, liability payments, loss and damage, and

[27] Cost estimates are from Leeper, Cambridge, and Campbell, Inc., *The All-Cargo Air Carrier Industry: Its Economic Impact and Future Needs*, prepared for the Air Freight Association, Washington, D.C. April 1989.

reliability). The regulations also create some small costs for safety inspections and recordkeeping.

Safety regulations affect carrier behavior only when perceived safety costs exceed the perceived benefits to the carrier (which may be less than society's benefits). Since these perceptions vary across carriers, safety regulations may not affect all competing carriers equally. In the trucking industry, the larger, more established carriers generally believe that good safety practices are in their long-term financial self-interest; while, in part as a result of competitive factors, smaller, more marginal carriers frequently cut corners in order to reduce their rates, risking the possibility that a major accident will put them out of business. In part for this reason, major trucking firms generally have supported the recent trend toward an improved motor-carrier safety-inspection system.

One example of a regulatory action that resulted in demonstrable cost savings is the Federal 55 mph speed limit. Although originally imposed as an energy conservation measure during the 1973 oil crisis, the action caused a dramatic decrease in accidents and fatalities, and came to be accepted as a significant cost saving factor by the motor carrier industry. Of course, much of these cost savings have been eliminated by subsequent increases in rural Interstate speed limits, although many carriers have retained speed limit restrictions on their drivers, and many carriers enforce the limits through electronic monitoring.

The regulation of hazardous materials (hazmat) transport, on the other hand, does increase transport costs. Although we are aware of no data on the costs of hazmat regulation, we believe these costs do represent a significant proportion of carrier operating costs for hazmat shipments. Limited observation of hazmat motor carrier operations as part of previous studies suggests that these costs might reach several percent of operating costs for the products regulated. How these costs relate to safety benefits associated with potential reductions in risks and liability are unknown.

Regulation of very hazardous materials, such as explosives and nuclear waste, is likely to comprise a major share of operating costs and may be an important determinant of choice of mode. No Federal hazmat regulations dictate mode choice or prohibit use of any mode, although the issue of higher risks for truck transport is often raised.

Route restrictions for hazmat truck operations are the responsibility of state and local governments. The extent of these restrictions varies widely around the country, but has not been analyzed, to our knowledge. The amount of such route restrictions is probably increasing, and may become a significant factor in choice of mode in the future. Hazmat trucks are commonly prohibited from using major tunnels and bridges. These restrictions are probably a significant factor in the choice of mode in a few areas, such as in the San Francisco Bay Area, where petroleum products

reportedly move by pipeline more than in most urban regions, because they cannot be transported by truck across the major bridges in the area.

Risk assessment analyses are commonly performed for major hazmat shippers. However, we are not aware of any studies that have developed such data for policy analysis purposes or for general comparisons among modes of transport.

On international shipping routes, U.S. carriers must compete against foreign carriers. Historically, many of the latter carriers were subject to much less stringent safety regulations; though, in recent years, the International Maritime Organization has narrowed these differences appreciably. The extra costs of safety regulation are responsible for only a small portion of the cost disadvantage of U.S. flag carriers (a disadvantage that, as discussed previously, has been mitigated by a federal operating cost subsidy).

The one mode that could possibly see some reduction in the costs of safety regulation is air cargo. Currently aircraft safety inspection requirements are based on aircraft age. Since all-cargo planes generally are operated for fewer hours per week than other commercial aircraft, basing inspection requirements on flight hours (or on a combination of flight hours and age) would reduce inspection costs.

Although changes in safety regulations may have some effect on carrier costs and on modal competition, aside from the effects on the cost of hazmat carriage, these effects are likely to be small relative to those of most of the other factors discussed in this section.

Effects of Changes in Truck Size and Weight Limits

Changes in truck size and weight limits can significantly affect the cost of goods movement by truck. Truck size and weight limits control the amount of payload that can be carried on a truck. For high density freight, the maximum amount of payload is usually controlled by weight limits. For low density freight, the maximum amount of payload is usually controlled by the cubic capacity of the truck, which is in turn controlled by length, width, and height limits. Because increases in truck size and weight limits increase the payload per trip, fewer truck trips are required to carry the same amount of freight. Longer and heavier trucks generally cost more to operate on a per-vehicle-mile basis; however, higher per-vehicle-mile costs only partially offset the cost savings due to fewer trips.

Changes in truck size and weight limits can result in shifts of freight to or from other modes, most importantly rail. Without the diversion of additional freight from rail, more permissive truck size and weight limits would be expected to reduce truck traffic volumes. However, the extent to

which these reductions will be offset by the diversion of freight to trucks is an important issue in the debate over the effects of changes in limits.

Three types of weight limits are commonly applied to trucks: gross weight, weights for single and tandem axles, and "bridge formula" limits that restrict the maximum allowable weight on a group of axles depending on the number of axles and axle group length. Other commonly regulated dimensions of trucks include overall length, trailer length, width, height, and number of trailers. The American Trucking Associations (ATA) regularly produces a *Summary of Size and Weight Limits*, which specifies height, width, length, and weight limits by state; detailed state access provisions for doubles; and special limits on longer combination vehicles (LCVs), turnpikes, and toll roads. More detailed information on size and weight limits, as well as operating requirements, can be obtained from the ATA's *Motor Carrier Advisory Service.* Also, very detailed information on size and weight limits and operating restrictions for LCVs for the 22 states in which such vehicles operate can be found in the March 20, 1992 *Federal Register.* ISTEA required that states provide this information to facilitate enforcement of the ISTEA freeze on LCVs noted below.

The federal government places both "floors" and "ceilings" on state truck size and weight limits. Floors include the requirements (in the Surface Transportation Assistance Act of 1982) that all states allow the operation of doubles with 28 foot trailers on Interstate and other principal highways, and that all states increase their weight limits on Interstate highways to 20,000 pounds for single axles, 34,000 pounds for tandem axles, and 80,000 pounds for gross weight. Federal ceilings on state size and weight limits generally include grandfather exemptions, which allow states to keep more permissive limits if such limits were in effect when the federal legislation was passed. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) froze maximum size and weight limits and operating requirements for longer combination vehicles at June 1, 1991 levels for each state.

Frequently, truck size and weight limits within a state vary by highway system. Thus, just because a state allows longer and heavier trucks on some highways does not necessarily mean that those trucks can be used to access all loading and unloading sites within the state. Most eastern states restrict the operation of double trailer trucks to Interstate and other principal highways, with access to and from this network governed by a permit process or specified provisions based on distance and possibly other factors. "Turnpike doubles" with two 48 foot trailers and gross weights of 127,000 to 143,000 pounds are allowed on turnpikes in several eastern states. However, use of these trucks off the turnpikes is severely restricted. For example, New York restricts turnpike doubles to a distance of 1,500 feet from the Turnpike and operates 32 staging areas for assembling and breaking down these trucks. The need to use staging areas, rather than travel directly from origin to destination, can significantly increase transport costs.

Because federal weight limits are applicable only to Interstate highways, some states may actually have more permissive weight limits on non-Interstate highways. For example, in Delaware, tandem axles limits are 34,000 pounds on Interstates and 40,000 pounds on non-Interstate highways.

The diversion of freight from rail to truck due to changes in limits can have important impacts on railroads. The Transportation Research Board's *Truck Weight Study* estimated that eliminating the 80,000 pound limit on gross weight would, with no other changes in size and weight limits, attract about 20 billion ton-miles of freight from rail to truck, representing a 2.2 percent reduction in rail traffic. This diversion would reduce railroad revenue by about $750 million per year. In addition, the TRB study estimates that railroads would reduce rates on 63 billion ton-miles of other freight movements to avoid this freight shifting to truck, resulting in another $210 million reduction in rail revenue. If truck length limits are also increased, additional diversion of freight from rail to truck would be expected. For example, in a study for the American Trucking Associations, Sydec estimated that about five percent of rail ton-miles would be diverted to truck if the nationwide operation of LCVs (most importantly turnpike doubles) is permitted. The Association of American Railroads (AAR) estimates that nationwide operation of LCVs would directly divert 11 percent of rail traffic to truck. Also, AAR estimates that an additional eight percent of rail traffic would divert to truck as a result of service cutbacks due to decreases in rail traffic and revenue.

Truck size and weight limits are an issue in the current debate over the North American Free Trade Agreement (NAFTA). Canadian truck weight limits are considerably more permissive than those in effect in the U.S. Trucking interests in western states have advanced the concept of "NAFTA Corridors" in which longer and heavier combinations would be allowed on selected Interstate highways in western states. Rail interests oppose this limited end to the LCV freeze as leading to a return of the "ratcheting" upward of truck size and weight limits, ultimately resulting in the nationwide operation of LCVs.

In addition to truck-rail diversion, another freight demand issue bearing on the subject of size and weight limits is the question of whether and to what extent cost savings due to increases in size and weight limits will increase the total volume of freight shipped by all modes combined. If, for example, transport cost savings are passed on to consumers in the form of lower prices, then some increase in purchases and, as a result, more freight shipments may result. However, for most commodities, transport costs account for a very small percentage of the price, and even fairly large reductions in transport costs would produce only a small reduction in the price. Changes in size and weight limits might also affect the total amount of freight shipped by encouraging (or discouraging) the use of centralized production facilities – in effect using more transportation to take advantage of economies of scale in production. It is not clear, however, that cost savings such as might be produced by higher size and weight

limits are large enough to produce significant changes in production methods.

A number of factors complicate the problem of analyzing the effects of changes in size and weight limits on trucking productivity and freight demand by mode:

- The sizes and weight of trucks traveling in different states (or on different highway systems in a single state) are controlled by the most restrictive set of limits faced along their route. Without some consideration of routing, it is difficult to determine the limits applicable to a given vehicle.

- For many commodities, actual shipment sizes are often less than the maximum shipment sizes permitted under size and weight limits.

- Innovative types of operations have been proposed for using doubles to move pairs of trailers from different shippers to different destinations, but the efficiencies such types of operation will be able to achieve is unclear.

- Vehicles that are larger or heavier are generally more specialized in the kinds of commodities they can transport efficiently. Inefficiencies may result when such vehicles are used for carrying other commodities on a backhaul.

- Access restrictions reduce the number of shippers that can be served by longer or heavier vehicles, limiting both the markets that can be served by such vehicles and the opportunities for obtaining backhauls.

- Line-haul costs for new trucks may be affected by restrictions related to safety and traffic operations.

- It may take several years for the effects of changes in size and weight limits to materialize fully because new equipment is often required to take full advantage of these changes.

Congestion

In many urban areas, increasing highway congestion is affecting the efficiency of reliable truck transport, and the reliability required by just-in-time shipping. Highway congestion affects trucking costs primarily by increasing the number of driver hours and vehicles required to haul a given amount of freight and by reducing truck fuel economies.

Recent studies of congestion have distinguished recurring congestion from the effects of incidents such as disabled vehicles, accidents, and construction or maintenance activities. To meet delivery schedules in

congested areas, allowances must be made for the possibility of incident-related delays. Such allowances are costly to truckers, since they increase the time that a driver and vehicle are idle.

Increasing congestion in large metropolitan areas has led to proposals for truck bans during peak periods in some metropolitan areas. In 1988, Los Angeles Mayor Thomas Bradley proposed a plan for reducing congestion which included a truck-permitting program that would drastically reduce the number of large trucks allowed to operate on the streets of Los Angeles during the morning and evening peak period. A resulting study undertaken for the California Department of Transportation recommended against areawide freeway truck bans; however, the study did recommend further research on time-of-day and lane restrictions.[28]

FHWA uses information from its Highway Performance Monitoring System (HPMS) to measure congestion on the nation's highways. HPMS contains data on a stratified random sample of approximately 100,000 highway sections. Among the data items provided for each highway section are annual average daily traffic, capacity of the highway section (measured in vehicles per hour), and peak hour volume-to-capacity ratios. Congestion data from HPMS are summarized in FHWA's biennial report to Congress: *The Status of the Nation's Highways and Bridges: Conditions and Performance.*

Another area of congestion is airport customs clearance. The U.S. Customs Service is working with carriers and airports to improve performance through the use of Electronic Data Interchange (EDI) as implemented in the Automated Air Manifest System. U.S. Customs has installed facilities in some of the integrated carriers' hubs and worked to implement pre-clearance of express packages based on electronically filed documents. Other elements of Customs modernization are being addressed in Congress and through industry/government cooperation.

Technological Advances

One of the most important areas of technological advance in recent years involves the use of computers and telecommunications equipment. Air carriers and many leading trucking companies have implemented sophisticated systems for tracking shipments; integrated carriers now use computers for sorting packages, optimizing the use of both aircraft and ground delivery vehicles, and identifying potential delays or congestion; and computers and telecommunications increasingly are used by the

[28] Grenzeback, Reilly, Roberts, and Stowers, "Urban Freeway Gridlock Study: Reducing the Impacts of Large Trucks on Peak-Period Urban Freeway Congestion," paper presented at the Transportation Research Board Annual Meeting, January 1990.

railroads both to track shipments and to control the operations of classification yards and dispatching centers. Automated tariff filing and the use of electronic data interchange (EDI) are expected to expedite cargo processing at ports and airports. Further advances in the use of such systems should contribute to continuing improvements in transport system efficiency and reliability, especially in the handling of parcel and less-than-truck/container-load shipments.

Other important advances in transport technology have related to rail intermodal transport: the development and use of doublestack container cars, road-railers, and lighter railcar frames for carrying containers and trailers. The new intermodal equipment achieves better fuel efficiency through improvements in payload/tare ratios and, usually, in aerodynamics. These advances, along with the related decision of the railroads to reduce the number of intermodal transfer facilities to a limited number of well-equipped, high-volume sites and the advent of various intermodal operating agreements (discussed previously), have enabled rail intermodal to become competitive with trucks for a growing portion of the long-distance market.

Improved container designs also have increased the efficiency of rail, air, and maritime intermodal services. The Autostack container, which uses a collapsible rack system for carrying automobiles in one direction and other freight on backhauls, provides better protection for automobiles than the tri-level railcars that were formerly used for such carriage and has reversed the shift from rail to truck for longer distance transport of automobiles.

Railroads are benefiting from more efficient engines; locomotives designed during the 1980s are about 15 percent more fuel-efficient than earlier models.[29] Innovative freight-car wheel designs have reduced wear on both wheels and track and have improved fuel efficiency.

Increases in aircraft size and in the internal configuration of aircraft have resulted in increased space available for carrying cargo on passenger planes. Combination ("combi") configurations for wide-body planes permit cargo to be carried on part of the main deck as well as in the belly in order to handle over-sized freight or to improve the integration of air containers into stowage plans. "Quick change" designs, now being implemented in Europe, allow aircraft to be readily converted from passenger configurations for daytime operation to freighter configurations for use at night. Aircraft designs now being explored include: a high-capacity plane designed for exclusive freight operation; and helicopter or tilt-rotor aircraft for short-haul operations. Other technological improvements to aircraft include the development of quieter, more fuel-

[29] Fred Stephenson, *Transportation USA*, Addison-Wesley, Reading, Massachusetts, 1987, pp. 145-151.

efficient engines, the use of new composite materials to reduce aircraft weight, and aircraft designs that allow reduced crewing levels.

Inland water transport can also benefit from a variety of recent technological advances.[30] Systems for monitoring fuel consumption and controlling tow steerage and throttle to optimize fuel use are capable of reducing fuel consumption by 15 to 20 percent. Kort nozzles can also improve fuel efficiency by reducing power loss. Improved equipment for rigging barge tows has been developed that reduces crew requirements, increases safety, and reduces time for splitting and rerigging tows in order to transit locks. Lockage time and safety and lock availability can also benefit from improved lock approaches, tow holding areas, and automated handling in the lock. Improved channel markers have been developed that can be more readily repositioned when conditions change and, once positioned, move less, thus providing more accurate indication of channel conditions and reducing groundings. Tow engines designed to use lower cost, heavier fuel oil (Bunker C and residual) are being developed, but these engines are expected to be more expensive to produce and to maintain.

The Intelligent Vehicle Highway System (IVHS) Act (Part B of Title VI of ISTEA) establishes a new program "to research, develop, and operationally test intelligent vehicle-highway systems and promote implementation of such systems as a component of the Nation's surface transportation systems." IVHS can affect freight demand by improving the efficiency of truck transportation, reducing total logistics costs for truck shipments, and making the use of trucks more attractive to shippers. However, IVHS-related improvements in trucking efficiency are not expected to be of sufficient magnitude to significantly affect the volume of freight shipped by truck. IVHS can also reduce illegal overloading and evasion of motor carrier taxes, through monitoring of truck traffic.

In other areas, the effects of technological advances on transport costs and services are not expected to be significant.

In the maritime area, research continues on hull forms; power plants and power plant systems; propulsor technology; navigation systems; and maneuvering and control systems. However, the cost savings produced by resulting advances are expected to be much less significant than those produced in the recent past by improved cargo handling, larger vessels, and more fuel-efficient technology.

The fuel efficiency of trucks, which has increased by about 20 percent in the past two decades, is not likely to change appreciably, as the

[30] Leeper, Cambridge and Campbell, Inc., *Upper Mississippi River Transportation Economic Study*, prepared for the Maritime Administration, the U.S. Department of Agriculture, and five midwestern states, April 1989.

introduction of new efficiency improvements is expected to slow and their effects are expected to be balanced by new emissions-control standards and fuel-blending requirements. Potential truck productivity improvements resulting from the use of larger or heavier vehicles are a regulatory issue rather than a technological one and have been discussed previously.