Chapter III — The Domestic and International Transport System

Chapter I discussed the reasons for the current high level of interest in the long-term adequacy of freight transportation services for U.S. agriculture and the plans of the USDA to develop a *Long-term Agricultural Transportation Strategy (LATS)*. Chapter II described how agriculture and transportation influence each other, discussed how transportation facilitates trade, and explained how agricultural producers are heavily dependent upon the availability of transportation services.

In this chapter, an overview of the domestic and international freight transportation system is presented as background to the long-term transportation issues facing U.S. agriculture presented in chapter IV. The unique characteristics of each of the freight transportation modes must be appreciated before the long-term transportation issues affecting U.S. agriculture can be discussed. The most important of these characteristics for each mode include how the basic infrastructure is provided, the structure of firm-level costs, industry-market structure, the service characteristics of the mode, and the long-term traffic trends of the mode.

Motor Carrier Transportation

Overview — Truck transportation is relatively new in the United States, even though its precursor, the teamsters with their wagons and teams, existed for many years. The trucking industry, as we know it today, did not appear in the United States until the early 1900's, and it became important as a means of freight transportation only after World War I.

While all communities depend to some degree upon truck transportation, more than one-half of the communities in this country depend exclusively upon trucks to meet their outbound transportation needs. Public services in both rural and urban communities depend heavily upon the local road networks. Fire and police protection and emergency health services, in particular, require adequate roads because response time is crucial. The quick availability of medical care is an essential quality-of-life component that affects the ability of regions to attract businesses and new residents.

Trucks, which supply transportation services for a wide variety of agricultural products in the United States, have steadily become more important as the road system and equipment have improved. Trucks move virtually all agricultural production from the field and the farm to the first consolidation point, whether it be a grain elevator or packing shed. Trucks are currently the predominant mode of grain transport in the United States, measured on the basis of the total tons moved [Eriksen et al., 1998]. Breakdowns in rail service during 1997 and 1998 have further increased the reliance of grain producers upon truck transportation. For other agricultural products, particularly fresh fruits and vegetables and processed foods, trucks have long been the dominant mode of transportation due to easier access and shorter, more reliable transit times. And, of course, trucks handle nearly all movements of high-value, perishable agricultural products from processing plants to retail distribution centers.

Infrastructure — According to the Federal Highway Administration (FHWA) of the U.S. Department of Transportation (USDOT) there are currently about 3.9 million miles of public roads in the United States [USDOT, FHWA, 1997]. As the annual increase in public road length is relatively small, most construction is for the improvement of existing public roads in order to provide safer, more efficient roads capable of handling greater traffic and loads.[1]

Federal highways comprise 4.35 percent of the roads in the United States for a total of 170,000 miles [USDOT, FHWA, 1996]. These major highways accommodate transportation between metropolitan areas, cities, and industrial centers. Nearly all of these Federal highways are paved and often have greater weight and traffic capacities than State and local roads. The most important of the Federal highways are the interstate highways. The U.S. interstate system has a total length of 46,036 miles. As table 3 demonstrates, although the interstate system comprised only 1.2 percent of the total road miles in the United States in 1996, it carried more than 23.5 percent of all the traffic.

Ranking just behind the interstate system in importance are the so-called "arterial highways," which generally handle longer trips. These include the noninterstate Federal highways and the State highway systems. Most of these roads have greater weight and traffic capacities than local roads, allowing the use of semi-trailers without undue damage to the roadway. These roads are important to agricultural producers in the final and secondary movements of grain to domestic markets, subterminal elevators, and terminal elevators. Table 3 shows that rural arterial roads, which make up 6 percent of the nation's road network, account for 15.3 percent of all vehicle miles.

Collector roads handle the traffic flows between the interstate and arterial roads and the local roads. These roads are important in the initial movement of agricultural products from the farm to wholesale markets or elevators. In rural areas, as table 3 shows, collector roads account for 18 percent of all mileage and nearly 10 percent of all traffic miles.

Table 3—Public road miles and traffic volume by type of road in the United States, 1996

Road classification/type	Miles	Percent of miles	Millions of annual vehicle miles	Percent of annual vehicle miles
Rural:				
Interstate	32,818	0.84	232,447	9.36
Other principal arterial	98,131	2.50	221,356	8.92
Minor arterial	137,359	3.50	157,456	6.34
Major collector	432,118	11.03	190,926	7.69

[1] These improvements include paving, resurfacing those roads previously surfaced, widening roads and bridges, adding lanes, reducing grades, minimizing curves, eliminating grade crossings, and other improvements. All U.S. highways limit the maximum vehicle dimensions and weight. These limits vary from State to State.

Minor collector	273,193	6.97	50,111	2.02
Local	2,119,154	54.07	107,767	4.34
Subtotal	3,092,773	78.91	960,063	38.68
Urban:				
Interstate	13,218	0.34	351,937	14.18
Other freeways & expressways	9,022	0.23	157,412	6.34
Other principal arterial	52,973	1.35	377,720	15.22
Minor arterial	89,022	2.27	298,491	12.03
Collector	87,918	2.24	128,501	5.18
Local	574,524	14.66	208,078	8.38
Subtotal	826,677	21.09	1,522,139	61.32
Total	3,919,450	100.00	2,482,202	100.00

Source: USDOT, FHWA, 1996

Local governments have jurisdiction over a total of 2.9 million miles of road, which is more than 75 percent of the U.S. road system [USDOT, FHWA, 1996]. These roads include county roads, town and township roads, and other local roads. Table 3 shows that rural local roads account for 54 percent of the nation's road network but handle just over 4 percent of the total vehicle miles. Overall, rural roads comprise nearly 79 percent of the total miles but carry less than 39 percent of the total annual traffic. This low traffic density of rural roads suggests that rural areas will have to compete vigorously with urban areas for the funding necessary to maintain their roads. If road funding is based solely on the volume of traffic, the condition of rural roads is certain to decline over time. Yet, these roads are vital to the movement of agricultural production from the farm to the first elevator or marketplace.

Federal-aid highways include segments of Federal, State, and local highway systems eligible for Federal aid. In 1995, there were 950,000 miles of Federal-aid highways in the United States, of which more than 28 percent was rated as being in "less than fair" condition.[2] However, the highway systems in many key agricultural states, particularly those in the grain-producing upper Midwest, are much worse than those of the nation as a whole.

Motor carrier transportation in the United States has benefitted from the contribution of all levels of government to road and street construction. Total highway expenditures were nearly $97 billion in 1996, with State and local governments contributing four times as much as the Federal Government [USDOT, FHWA, 1996]. Highways have received the majority of the Government funds used to promote transportation in recent years.

The Federal Government aids in financing the construction and maintenance of the National

[2] Based on 866,028 reported miles of a total of 950,215 Federal-aid highway miles from a road information analysis of the Federal Highway Administration.

Highway System and other Federal-aid highways. The designation of a public road as a Federal-aid highway does not alter its ownership or jurisdiction as a State highway, a county road, or a city street. A Federal-aid highway simply means that, because of its service value and importance, it has been made eligible for Federal-aid construction and rehabilitation funds. With limited exceptions, Federal-aid highways exclude local and "minor collector" roads, which are typically the responsibility of counties and towns.

Federal highway construction and improvements are currently funded entirely on a user-fee basis, but general taxation funds, user fees, and tolls have all been used to pay for highway infrastructure in the past. Fuel taxes provide more than 83 percent of the Federal Highway Trust Fund that is allocated to the highway account of the Fund [USDOT, FHWA, 1996]. Other funds are obtained from truck and trailer registration fees and property taxes.

State governments administer the work on Federal-aid highways. The Federal Government provides 90 percent of the project cost for interstate highways and 80 percent of the project cost for other Federal-aid highways.[3] The National Highway System included about 159,000 miles of interstate and other highways in 1996, whereas Federal-aid highways, which include the National Highway System, had a total of about 956,000 miles in 1996. Thus, Federal-aid highways comprised a little more than 24 percent of the entire roadway system in the United States.

States obtain more than 55 percent of the revenue they use for highways from various user fees, such as State fuel taxes, motor vehicle taxes, and road and crossing tolls. Some States put these user fees into a trust fund while other States put them into their general fund. Funds received from the Federal Government account for another 26 percent of States' revenues used for highways. Bond proceeds contribute 9 percent of the total revenue States use for highways, while general funds and other State imposts contribute only 5 percent of the State revenue used for highways [USDOT, FHWA, 1996].

In recent years, States have faced difficulties in providing transportation facilities and services. Fuel taxes are levied per gallon of fuel and, thanks to improvements in motor vehicle fuel efficiency, there has been a relative slowdown in motor fuel consumption. Under the *Intermodal Surface Transportation Efficiency Act of 1991* (ISTEA), States have been given greater flexibility in the management of Federal funds, and part of the Federal funding they receive can now go toward economic development projects, mass transit funding, or to other approved uses and transportation modes. However, State and local governments have also been required to allocate funds to certain programs such as noise and air pollution abatement, the mitigation of environmental degradation and undesirable land use patterns, the provision of mobility to the handicapped, and congestion mitigation.

These changes in financing have placed rural transportation uses in competition with urban uses to some extent. Since the traffic volume and the accidents are likely to be higher in urban areas, rural policy makers can expect to see more attention paid to urban issues in the future. Also, the shift in

[3] The ratio of Federal funding varies by State, increasing with the amount of federally owned lands in the State.

political power due to rural population declines in the 1980's may indicate that relatively fewer resources will be available for rural transportation networks [Deller and Walzer, 1997].

Local governments rely mainly upon appropriations from general funds (26 percent) and assistance from State governments (28 percent) to fund their roadways. User taxes from State motor fuel taxes and tolls fund nearly 5 percent of the roadways. Property taxes (12 percent), bond proceeds (13 percent), and miscellaneous funds (10 percent) are other large components of local funding for roadways [USDOT, FHWA, 1996].

Because property taxes fall heavily on those areas dependent upon the farm economy, agricultural groups have pressed for reductions in these taxes. In the 1980's, many States lowered the property taxes on farmland. This reduced assessed valuation in many counties where farmland accounts for much of the tax base and tended to limit the funds used to support services in rural areas. As a result, slower growth in property tax revenues has forced local governments to look for other sources of financing. Since counties and towns often do not have access to income or sales taxes, which tend to grow more rapidly than gas taxes, they tend to be relatively dependent upon funding from the State and Federal Governments.

Cost Structure — Because motor carriers have not had to invest in their roadway and the user charges paid by truckers have varied primarily with miles traveled, the cost structure of for-hire motor carriers in the United States is dominated by variable costs, which average 90 percent of total costs for the industry. The big three variable costs are labor, fuel, and maintenance.

Of all the transportation modes, the trucking industry has the lowest fixed costs. For the entire industry, only 10 percent of total costs are fixed. The only significant fixed expense that for-hire motor carriers incur is the investment and operation of terminals by less-than-truckload carriers. Ordinarily, such costs are a small portion of the total cost of for-hire trucking firms; for exempt motor carriers of grain, these costs are nonexistent because such firms do not use terminals. Although the costs associated with vehicle ownership are also fixed, these costs are relatively small. Vehicle ownership costs are also relatively small for motor carriers of grain because of the lack of a need for specialized equipment and the predominance of used equipment in the industry.

Capital requirements for entry into the for-hire motor carrier industry are low relative to other transportation modes and for small businesses in general. Entry and exit in the industry are facilitated by a well-developed market for used trucks and trailers, which allows for easy acquisition of used equipment by potential entrants and easy disposal of used vehicles by firms decreasing their fleets or leaving the industry. The ease by which capital can move to and from the industry allows aggregate trucking supply to adjust rapidly to changes in demand. Changes in aggregate trucking supply occur both through the adjustment of the fleet sizes of trucking companies and through the entry and exit of trucking firms in the industry. Semi-trailers used to move grain can also be shifted to other products and commodities in other regions when the demand for grain movement in a particular area slackens.

Market Structure and Performance — The motor carrier industry in the United States is complex in that there are several different typs of carriers. A large segment of the trucking

industry in the United States is composed of private carriers, which provide their own transportation by owning or leasing trucks and which haul freight mainly for the private firms that own the trucks. There are more than 500,000 companies in the United States that operate private fleets having more than five trucks. Private fleets do not normally provide transportation to the public but are allowed to charge for intercorporate hauling for wholly owned subsidiaries or to operate as common or contract carriers on their backhaul movements.

The other large segment of the motor carrier industry in the United States consists of for-hire carriers, which can operate either as common or contract carriers. Common carriers haul freight for the general public on an as-needed basis, whereas contract carriers limit their services to those entering into haulage contracts.
For-hire trucking has always been left to private enterprise in the United States. Given the ease of entry into this industry, for-hire highway freight transportation in the United States is characterized by a large number of firms that are generally small in size. More specifically, the for-hire segment of the trucking industry had 54,692 firms in 1993 that operated Interstate Commerce Commission (ICC) regulated trucks. The number of larger firms decreased 30 percent from 1980 to 2,185 firms in 1993. Most of these larger firms are less-than-truckload carriers that operate terminals. The large number of for-hire firms that are generally small in size makes trucking an extremely competitive industry.

Small trucking firms having revenues below $1 million numbered 52,444 in 1993, an increase of 251 percent since 1980. These small firms are mainly truckload carriers and often are comprised of owners operating their own tractors and trailers. The large increase in these smaller firms is due to several factors. Since truckload carriers do not need to invest in terminals and there is a large market in cheaper, used equipment, there are low capital barriers to entry. In addition, regulatory barriers to entry were greatly reduced with motor carrier deregulation in 1980.

Those for-hire trucking firms that haul raw agricultural products are exempt from regulation. Because of the cost structure of the exempt motor carrier operations, with low fixed costs, and the lack of economies of scale, the exempt motor carrier industry consists of many small firms, none of which have an ability to influence market price. Past surveys have found that 86 percent of the motor carrier firms moving grain have fewer than four tractors and that each tractor is driven about 88,000 miles per year [Wilson et al., 1982]. Because of the structure of the industry, particularly the ease of entry and exit, the exempt motor carrier industry closely resembles a purely competitive industry in which rates correspond to marginal costs [Sorenson, 1983].

Due to low fixed and high variable costs, exempt for-hire agricultural trucking is most competitive with railroad and barge competitors on those short-distance movements in which there are relatively few miles for their competitors to allocate their higher fixed costs. However, total costs for motor carriers increase rapidly as the length of the movement increases, and railroads and barges quickly regain their competitiveness with trucks over the longer movements [Sorenson, 1983].

Although the relatively low carrying capacity of motor carriers of grain makes per-ton-mile costs higher than rail and barge costs over most distances, trucks generally have a route advantage in

that they can take less circuitous routes than either railroads or water carriers. In addition, trucks have backhaul capabilities, which extend their effective competitive range. Most of the truck competition with rail is for shipments between 50,000 pounds and 90,000 pounds and between 300 and 600 miles in distance.[4] Trucks dominate freight shipments below 50,000 pounds in size and less than 300 miles in length.

Trucks are much more important in the delivery of grain to domestic markets than to export markets. The amount of grain moved to domestic markets has increased by 101 percent since 1978 ,nd trucks may become even more important to grain movements in the future. Overall, trucks are now the dominant mode of transportation for moving grain to market. In 1978, trucks moved 73.9 million tons of grain, but by 1995, that figure had risen to 154.6 million tons of grain [Eriksen et al., 1998]. If modal market share of grain movements is measured on a ton-mile basis, however, the market share of trucks would be lower, and the market shares of both rail and barges would be higher. The reason is that the length of truck movements of grain is relatively short, while the distances of rail and barge shipments are long.

Trucks provide an important complement to rail and water transportation of raw and processed agricultural products due to the superior access provided by trucks for a portion of the movement. The relationship between truck and rail transportation is striking. While these two modes cooperate on many joint movements, as is attested to by the rapid growth in intermodal movements since 1980, they remain vigorous competitors on many other types of movements.

Government Oversight — Prior to 1980, the interstate trucking of most nonagricultural products was tightly regulated by the Federal Government. For-hire interstate motor carriers had to obtain a "certificate of public convenience" from the ICC. They also had to file their rates and rate changes with the ICC, and were prohibited from discriminating against shippers. The ICC could review and suspend rates it deemed unreasonable, and deny firms entry into a particular market by refusing to issue the certificate of public convenience.

However, the interstate truck movement of livestock, fish, and unprocessed agricultural commodities has been exempt from any type of economic regulation since 1935. The exemption for raw agricultural products was justified on the basis that the perishable nature of many agricultural products and their seasonal movement required the availability of large and flexible trucking supplies [Locklin, 1972]. Agricultural interests were concerned that regulation might limit the supply of trucking services for harvest movements and seemed to anticipate that rates would be lower without regulation [Harper, 1982].

The *Motor Carrier Act of 1980* removed most of the economic regulation affecting the trucking industry and added to the list of exempt agricultural commodities. In addition, agricultural cooperatives, which were restricted in the amount of nonmember goods they could haul, were allowed to haul up to 25 percent of their total interstate tonnage in nonmember, nonagricultural

[4] An exception is the dominance of exempt trucking in the movement of fresh fruits and vegetables to markets, in which the modal share of trucks easily exceeds 90 percent and cross-country movements by truck from production areas to metropolitan markets are common.

goods. Private carriers were allowed to perform intercorporate hauling for compensation for 100-percent-owned subsidiaries after notifying the ICC. The act also allowed private carriers to operate as common or contract carriers on their backhaul movements. However, because the movement of bulk agricultural commodities by motor carrier was already exempt from economic regulation, motor carrier deregulation in 1980 generally had little or no effect on agricultural trucking.

Service Characteristics and Traffic Trends — Trucks have been very successful in taking most of the intercity freight movements away from railroads since World War II. In terms of the movements of high-value, manufactured freight, part of the increased importance of trucking has been due to the development of the interstate highway system. In terms of grain shipments, the truck share of the total volume of grain being shipped increased from 30.6 percent in 1978 to 40.6 percent in 1995. This increase was most likely due to the ability of the trucking industry to adjust rapidly to changes in demand and to be more flexible and responsive to shipper needs than the railroad industry. The trucking industry also has some service advantages that can offset some of their cost disadvantages relative to other modes on smaller size and longer distance hauls.

Since roads are ubiquitous, the trucking industry is a flexible mode that can provide door-to-door convenience, time savings, and lower handling and inventory costs for customers. Trucking usually has the fastest transit times and more frequent service, resulting in lower inventory costs and/or stock-out costs for customers and the ability to adequately support just-in-time (JIT) manufacturing systems. In addition, trucking offers more reliable transit times and smaller shipment sizes, which are critical for JIT manufacturers. Trucking also has fewer losses and less damage than other transportation modes, which allows many agricultural processors to reduce their packaging costs.

Railroad Transportation

Overview — Rail is the only cost-effective transportation mode available to the many agricultural shippers who are not located near markets or river transportation. In contrast to motor carriers and inland barge firms, rail is also the only freight transportation mode in the United States that provides its own infrastructure. This singular characteristic has given railroads a cost structure with high fixed costs and has resulted in an industry of a few large firms with a natural monopoly tendency and a need to practice differential pricing. In the United States, railroads are also the only domestic freight transportation mode that is currently subject to any appreciable degree of economic regulation.

Infrastructure — The U.S. rail industry has a number of characteristics that sharply distinguish its production and supply of freight transportation services from the supply of freight transportation services by other modes. The most important difference is that, with some minor exceptions, the industry's infrastructure is privately owned and operated and access to the infrastructure is

typically limited to the owner of the track.[5] By contrast, trucking firms, airlines, and barge lines operate on infrastructure that is owned and operated by the Government and can potentially serve any shipping point on the network. The combination of privately owned infrastructure and limited access are the primary characteristics that distinguish rail transportation from the other transportation modes.

According to the Association of American Railroads (AAR), 553 railroads in the United States operated 173,896 miles of road in 1996. Ten Class I railroads operated nearly 76 percent, 32 regional railroads operated more than 11 percent, and 511 local line haul and switching and terminal railroads operated nearly 16 percent of the railway network [AAR, 1998].

After reaching a peak of 254,037 miles in 1916, the size of the U.S. railway network has been declining steadily [Harper,1982]. Many miles of Class I trackage have been sold to non-Class I railroads. In 1996, short line railroads operated 47,214 miles of road, or about 27 percent of the road operated in the United States [AAR, 1998]. A total of 39,627 miles of road was owned either by the short lines or by government. Those miles that could not be operated profitably by short line and regional railroads have been abandoned.

Cost Structure — Railroads have the highest percentage of fixed costs of all the transportation modes because they must provide their own roadbed, tracks, terminals, and associated facilities. Depreciation, property taxes, and maintenance expenses are incurred by railroads for these assets regardless of the volume of traffic. Railroad fixed costs normally range from 30 to 50 percent of total costs, but on lighter density lines, fixed costs may be more than 70 percent of total costs. Due to the large amount of fixed costs, railroads are not able to respond as quickly as the trucking and barge industries to significant increases in demand [Coyle, et al., 1994].

Because railroads have large fixed costs and capital requirements, they also have a more difficult problem in effectively utilizing their capacity and allocating their fixed costs than their modal competitors. The fixed cost to trucks and barges of their infrastructure is close to zero, not only because government provides their infrastructure but also because government cost recovery has been through user fees that have functioned as additional variable costs to the carrier. Because the fixed cost burden of railroads is so high, railroads have an acute interest in equipment utilization and in the minimization of movement costs through repetitive trainload movements from the same origin to the same destination.

To recover their fixed costs, railroads must price above marginal cost. However, the ability of railroads to recover their fixed costs is complicated by the fact that many of these costs are

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[5] Virtually the only form of governmental assistance that has recently been provided to freight railroads in this country has been the *Local Rail Freight Assistance Act* (LRFA). Among other things, LRFA provided Federal Government funds for the purchase of abandoned rail lines and the rehabilitation of track. These funds, combined with aid programs of State and local governments, greatly aided the expansion of the short line railroad industry in the 1970's and early 1980's. LRFA funds ran out in the late 1980's, but $3.5 billion has been authorized in the TEA-21 Act. Of the $3.5 billion authorized, $1 billion has been earmarked for short line railroad projects.

"common costs." Common costs are the those that are incurred for a business as a whole and are common to more than one type of output. A railroad's roadbed, rails, and crossties are all "common" costs. Railroads transport many different commodities, so while certain expenditures may benefit all shippers, the allocation of these costs to specific movements can be very difficult [Sorenson,1983].

To utilize their capacity efficiently and to recover their fixed costs, railroads must rely upon "differential pricing." That is, different shippers are charged different rates for the same service. This seems somewhat capricious, but if a railroad charged a single price for its services, some shippers would find it more profitable to ship by another mode. As these shippers withdrew, the railroad would have to raise prices on all its remaining shippers in order to cover its fixed costs. At this new, higher price, a few more shippers would find it economical to ship by another mode, so the railroad would have to raise its prices again and again. If enough shippers diverted their shipping to other modes, the railroad would eventually be unable to cover its fixed costs, and bankruptcy would result. To avoid this fate, railroads charge different rates to different customers.

Under differential pricing, those shippers with competitive alternatives secure low prices. By contrast, those shippers lacking competitive alternatives and having inelastic demands for transportation services face higher prices. Essentially, differential pricing results in a railroad pricing its services "according to what the traffic will bear." The problem with differential pricing is that the shippers paying the higher prices recognize and protest this apparent inequity.[6] Differential pricing allows railroads to exact monopoly rents from those shippers who cannot effectively use other modes of transportation. So, while the presence of high, fixed costs forces railroads to use differential pricing, it also increases the pressure on the political system to restrain railroad market power.

Because railroad fixed costs are such a high proportion of their total costs, the average costs for each carload hauled, as well as firm profitability, is heavily influenced by certain economies in railroad operations. One way to lower railroad unit costs is to increase the volume of traffic over the roadway. In practical terms, railroads can harness economies of density by running longer and more frequent trains [Keeler, 1983].

Railroads also benefit from economies in vehicle size, in shipment size, and in the distance of the shipment.[7] Economies from the size of the vehicle have resulted in a shift of grain hauling from boxcars to 70-ton covered hoppers to 100-ton covered hoppers, and finally to super-jumbo covered hoppers. Because no more labor is required to operate a train of 100 cars than one of 50 cars, and switching costs are the same regardless of the number of cars, railroads also have

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[6] Service levels, like price, can differ between shippers. It is often the case that those shippers who pay the highest rates also receive the worst service.

[7] Different conclusions have been drawn about the presence of economies of scale in the rail industry, or whether railroad unit costs decline as the size of their network increases. Economies of scale differ from economies of density in that economies of scale relate to the size of road network operated by the individual firm.

economies due to shipment size. Recognizing the economies of shipment size, railroads have encouraged the use of unit-trains in grain shipping. Finally, railroads have economies of distance in that their ton-mile costs decrease as the distance of the shipment increases. In total, these railroad economies have prompted railroads to seek the regular, large, long-distance hauls that maximize their comparative advantage over the other modes.

Market Structure and Performance — Because railroads must provide their own infrastructure, they have large capital requirements that effectively serve as a barrier to entry. Thus, the rail industry is characterized by a high degree of concentration (i.e., most rail services are provided by a small number of very large firms) and perceived market power.

Since the *Staggers Act*, the two major structural trends in the U.S. railroad industry have been the continued consolidation of the industry into fewer, larger Class I carriers and the emergence of new short line railroads that operate on lighter density lines abandoned or "spun-off" by Class I railroads. Although data from the AAR indicate that there are over 550 railroads in the United States, the industry currently has only eight Class I railroads. In fact, with the recent approval of the acquisition of Conrail by the Norfolk Southern and CSX Transportation, four Class I railroads handle the bulk of all rail traffic in the United States.

The number of Class I railroads has been declining for years. In 1982, for example, there were 33 Class I railroads; today there are only 8. In many ways, that decline has been beneficial. Some carriers were weak, both financially and operationally, and it was in the public interest to allow those carriers to merge with stronger firms. The loss of competition that resulted from merging weak railroads with stronger firms was often offset by gains in economic efficiency and improved service to shippers. Moreover, a number of strong regional railroads were created as a result of spin-offs from Class I carriers. In some circumstances, these carriers provide additional competition to the Class I railroads.

Since 1993, however, a number of mergers and acquisitions have taken place in which the perceived benefits of consolidation (labor savings, more efficient routs, single-line service, etc.) were a more important factor than financial or operational weakness. These transactions include: the merger of the Chicago and North Western Transportation Company with the Union Pacific Railroad; the merger of the Burlington Northern Railroad and the Atchison, Topeka and Santa Fe Railway; the merger of the Union Pacific Railroad and the Southern Pacific Lines; and the purchase of Conrail by Norfolk Southern and CSX Transportation. In addition, several important regional railroads have been purchased by Class I carriers. As a result, the number of railroads serving the agricultural community has dropped significantly in recent years. Although the trend toward consolidation may be slowing after the well-publicized problems of the UP/SP merger, the Canadian National Railway has filed an application with the STB to merge with the Illinois Central Railroad and both of these roads have entered into a marketing agreement with the Kansas City Southern Railway.

As will be explained in chapter IV, railroad mergers almost always increase the market power of railroads relative to shippers. For grain shippers, railroad pricing in the past was kept in check by the ability of agricultural producers to haul grain to elevators on competing railroads. The recent

rail mergers have removed this option for many producers because the distance to competing railroads is now beyond economical trucking distances.

In addition to the Class I railroads, there are many smaller railroads operating in every region of the country. Although "short line" railroads have existed from the beginning of railroading in this country, the importance of these roads has grown significantly in recent years.[8] In 1996, short lines owned 39,367 miles of road; up considerably from the 9,786 owned in 1970 [AAR, 1998].[9] This increase in short line and regional railroad mileage is a direct result of Class I railroad bankruptcies in the 1970's and railroad deregulation that made it much easier for Class I railroads to abandon, sell, or lease unprofitable line segments. These railroads have often preserved railroad service to many rural communities that would otherwise be without rail service altogether and, in some States, short lines currently operate more than 50 percent of the railroad line.

The many smaller rail firms are an important part of the U.S. railroad system, especially to agriculture and rural shippers. Movements of grain and lumber, while still dominated by the larger firms, play a large part in the traffic base of many short line railroads. In 1995, short line railroads moved approximately 13 percent of the farm products that were shipped by rail [Benson, et al., forthcoming]. Regional and short line railroads often operate as feeder railroads to the Class I systems and are, in many cases, actually affiliated with the Class I railroads.[10]

Since 1980, the financial health of the railroad industry has improved markedly. Class I railroad's annual return on shareholders' equity averaged 2.4 percent during the 1970's, 7.4 percent during the 1980's, and over 10 percent between 1994 and 1996. These increased rates of return on equity are largely attributed to increased managerial flexibility resulting from railroad deregulation. This greater profitability and improved access to capital markets have permitted railroads to invest billions of dollars in their equipment, infrastructure, and information systems.

Even though railroad return on equity has increased, average railroad revenue per ton-mile has fallen more than 50 percent on an inflation-adjusted basis since 1980. Increases in rates of return can occur simultaneously with decreases in prices when major decreases in costs also occur, like those the railroads achieved through significant rationalization of their infrastructure and labor force after railroad deregulation. In fact, decreases in rail rates since railroad deregulation are actually a continuation of a trend that started many decades ago, so the decreased charges cannot be solely attributed to deregulation of railroads. Another factor to consider in evaluating the rate decreases is that today's railroad prices bear less of a relation to the total logistical cost of shipping, particularly for grain shippers. Demurrage terms have been tightened considerably, shippers often provide their own railcar fleets, shippers must now pay premiums to be guaranteed

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[8] Short line railroads include line haul railroads as well as switching and terminal railroads. Line-haul railroads may be local or regional in size.

[9] These figures include miles of road operated by a short line but owned by state and local governments.

[10] Some short line railroads also operate over track owned by state and local governments.

cars during prime shipping periods, and many shippers have been induced to invest in quicker and larger load-out facilities to qualify for particular rail rates.[11]

Due to shipment size economies derived from combining railcars into longer trains, railroads have offered multicar rates for shipments of 25, 50, and 75 cars, which apply only to a small group of commodities – mainly grain, coal, fertilizer, and intermodal containers. In recent years, the size of the shipment required to obtain multicar rates has steadily increased. The savings available from unit-train rates have become increasingly important to grain shippers, but, in many instances, the availability of coloading privileges for one or more shippers to qualify for the reduced rates has been limited or removed.

There is some concern, however, that the railroad successes of the 1980's and early 1990's have played themselves out. The rail service problems in the western United States, which began in 1997 and continue through the present, may be an indication that, for the first time in a century, there is too little rail capacity available to satisfy the demands of shippers. The service failure has also provoked a public debate over the need for and direction of rail regulation. These issues will be discussed in chapter IV.

Government Promotion and Oversight — During the 19th century, all levels of government promoted the development of railroads. Contrary to the popular impression, most of the government promotion of railroads in the 19th century was undertaken by State and local governments, not by the Federal Government. State and local governments promoted railroads in an attempt to attract commerce, and many of the nation's major cities and industrial centers can attribute their development in some measure to commerce generated by railroad transportation. State incentives for railroad development included government purchase of railroad stock, loans and guarantees of loans, cash grants, and tax exemptions [Harper, 1982]. The Federal Government also promoted rail transportation by surveying land for the railroads and providing land grants to encourage railroad development in western States. These land grants were typically sold by the railroads to finance construction of their lines.

Overcapacity was an early and lasting feature of the industry, in no small part because of the intense competition among various municipalities. As local railroads were consolidated into larger rail systems during the 1870's and 1880's, this excess capacity in the system ensured periods of vigorous, even destructive, competition among railroads. These bouts of competition alternated with attempts by railroads and Wall Street financiers to create a sustainable cartel that would boost the industry's profitability. Although each cartel failed, the apparent collusion of railroads and financiers infuriated the public, especially the farmers and agricultural interests who were dependent upon rail transportation.

Because they possessed and exercised market power, railroads were the first industry regulated by the U.S. Government. The *Interstate Commerce Act of 1887* (ICC Act] prohibited price

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[11] Although many shippers have invested in railcars, the per diem rate paid for the use of the railcars is usually not compensatory. Thus, the lack of compensatory per diem rates adds to the total cost of shipping.

discrimination by place, shipper groups, commodities, long haul/short haul, and on a personal basis. The ICC Act also prohibited pooling, or the formation of cartels, and required that rail rates be "just and reasonable." To monitor prices and price discrimination, railroads were required to publish and adhere to these tariffs. The ICC Act also created the ICC and charged it with implementing the ICC Act.

Congress broadened and strengthened the scope of railroad regulation over the ensuing years, and Federal regulation of all facets of the industry became pervasive. *The Hepburn Act*, passed in 1906, allowed the ICC to establish maximum rail rates, increased the ICC's power to regulate joint rail rates, and extended the ICC's power to regulate personal price discrimination. The "commodity clause" prohibited railroads from hauling commodities they produced or owned or in which they had a financial interest. Under *The Hepburn Act*, the ICC could suspend rate change proposals for 120 days to determine rate reasonableness.

The expansion of the U.S. rail system continued through the beginning of the 20th century and the size of the U.S. railroad network reached a peak of over 254,000 miles of road in 1916.[12] Despite this continued expansion, railroad profitability slipped between 1906 and 1920, as the ICC turned down nearly all rail rate increases. Thus, rail service deteriorated, and many roads went bankrupt.

The *Transportation Act of 1920* tried to address the financial needs of railroads by extending ICC regulations to minimum rail rates and by allowing pooling if shown to be in the public interest. Also, the "rule of rate-making" was introduced, entitling railroads to charge prices that would result in a fair return on their investment. Regulation was extended to the control of exit and entry in the rail industry, the issuance of financial securities, and ICC approval of mergers. In spite of its good intentions, this law greatly hampered the ability of railroads to respond to competition, abandon unprofitable lines, cover their fixed costs, and provide flexible service. Thus, the financial health of railroads worsened, as did the physical condition of the rail network.[13]

Nevertheless, railroads remained the dominant mode of surface transportation in the 1920's and 1930's — in 1929, railroads moved 75 percent of intercity freight ton-miles and 77 percent of the intercity passenger-miles in the United States. Even though railroads were responsible for almost 70 percent of intercity freight and passenger transportation in the United States in 1945, their relative dominance began to slip. The new commercial trucking industry, and the beginnings of an extensive network of roads and highways, greatly lowered transport costs. In addition, Government construction of lock and dam systems on the upper Mississippi and Illinois Rivers and the explicit promotion of inland waterway transportation further lessened the railroads' share of intercity freight movements.

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[12] Miles of road operated is the aggregate length of roadway, excluding the mileage of parallel main lines as well as terminal, siding, and switching trackage.

[13] Deteriorating financial health of a railroad is typically mirrored in the physical condition of its infrastructure. When cash flows are inadequate and abandoning lines is very difficult, railroads may opt to defer maintenance — particularly on lighter density lines.

In addition to the increased intermodal competition from trucks and barges, a number of technological advances in traffic control and railcar design occurred in the 1950's and 1960's that increased the pressure on railroads to rationalize their network. These technological improvements enabled railroads to manage greater traffic volumes on a smaller network. And as passenger traffic steadily moved off rail, it is important to recall that the U.S. railroad system was designed at a time when half of the railroad movements were passenger movements [Boyer, 1997]. Thus, the contraction of the U.S. rail network that occurred after World War II was inevitable. Yet, even as the Federal Government subsidized the rail industry's competitors by building the interstate highways, the inland waterway system, and key portions of the nation's commercial aviation industry, regulation of the rail system was not relaxed. In fact, barriers to exit kept railroads from abandoning track or eliminating unprofitable passenger service. As a result, railroads were unable to earn enough money to pay for the maintenance of their equipment and infrastructure throughout the 1950's, 1960's, and 1970's. The poor financial health of many railroads led to numerous bankruptcies and a major restructuring of the rail systems in the 1970's.

Regulatory reform began with the *Regional Rail Reorganization Act of 1973* (*3-R Act*), which was passed primarily to restructure the railroad network in the northeastern United States, and was strengthened with the *Railroad Revitalization and Regulatory Reform Act of 1976* (*4-R Act*), which relaxed regulation of railroad rates, mergers, and abandonments. The *4-R Act* was designed to rescue the rail industry by giving railroads more flexibility and by relying more on market forces to set prices.

However, the *3-R Act* and *4-R Act* failed to revive the rail industry. So, in an attempt to significantly reduce regulation of all phases of railroad operations, the *Staggers Rail Act of 1980* was passed. The *Staggers Act* speeded up abandonment procedures, giving railroads much more flexibility in the configuration of their rail networks and accelerated merger timetables. Perhaps most importantly, the *Staggers Act* permitted railroads to enter into confidential contracts with shippers, thereby enabling railroads to make investments in plant and equipment with a greater degree of certainty that these investments would be profitable.

More recently, the *Interstate Commerce Commission Termination Act of 1995* (ICCTA) eliminated the ICC as of January 1, 1996, replacing it with the much smaller STB. Under prior railroad regulation, all rates and fares of regulated railroads had to be filed with the ICC, and the minimum rates of railroads on specific movements had to equal or exceed the variable cost of the haul. The ICCTA eliminated the requirement of railroads to file tariffs with the STB and abolished the STB's authority to establish minimum rates. A railroad's common carriage rates and service terms had to be disclosed upon request and published in some form for agricultural products and fertilizer. Increases in these rates or changes in the service terms required 20 days' advance notice be given to any person who had requested such rates or made arrangements for shipment under the rate.

Under the ICCTA, the STB also may not suspend any rail rates except to prevent irreparable harm. This contrasts with prior laws, under which the ICC had the authority to investigate and suspend new rail rates on its own initiative. The act also imposed time limits on rate proceedings before the STB, ostensibly to prevent future rate appeals from dragging on 18 years as did the *McCarty*

Farms case.

Because of the complexity and expense of rate reasonableness proceedings, the ICCTA required the STB to establish simplified rate reasonableness standards to apply to cases involving smaller shippers. In December 1996, the STB adopted simplified guidelines that use three revenue-to-variable cost benchmarks as starting points for rate reasonableness analysis. These simplified guidelines have been widely criticized by shippers as still being too complex and unworkable.

Under the ICCTA, the STB also has the obligation to maintain and revise standards and procedures for determining adequate revenue levels for carriers, to assist carriers in attaining the prescribed revenue levels, and to make an annual determination of the revenue adequacy of rail carriers. Shippers have widely complained that the STB has placed undue priority upon adequate revenue levels for railroads and too little priority upon protecting shippers.

Railroad service has also been regulated in an attempt to provide the public with adequate service and to prevent unjust discrimination in service. The ICCTA requires carriers to provide rates and service terms to any person upon request and to provide transportation upon reasonable request. The ICCTA also allows railroads to fulfill their contractual commitments before handling requests for common carrier service. However, the contractual commitments of the carrier must be reasonable in that they do not prevent a carrier from responding to its common carrier obligations. Congress maintained the 40-percent capacity limitation on contracting for the transportation of agricultural commodities, but scheduled this limitation to expire on September 30, 1998. Both the National Grain Car Council and the Railroad-Shipper Transportation Advisory Council recommended that Congress retain this provision. Railroad movements that use cars provided under guaranteed car systems (e.g., Burlington Northern Santa Fe's Certificate of Transportation (COTS) program) are not considered contractual movements.

An important area of jurisdiction for the STB regarding freight service, especially to grain shippers, has been the adequacy of freight car supply [Norton and Klindworth, 1989]. Under the ICCTA, the STB may still require a rail carrier to file its car service rules with the STB even though tariff filing has been eliminated. The STB is also directed to consult as it considers necessary with the National Grain Car Council on matters within that organization's charter.

The ICCTA also eliminated the *Staggers Act*'s detailed procedural requirements for rail line abandonment. The ICCTA retained the requirement that each railroad file a system diagram map with the STB, indicating the lines potentially subject to abandonment. However, the provision that required that the lines potentially subject to abandonment be submitted at least 4 months before an abandonment application could be filed was removed.

The prior statutory deadlines for various phases of an abandonment proceeding were also deleted by the ICCTA. Lines over which no local traffic had moved for 2 years were exempted from traditional regulatory scrutiny and can be abandoned simply by filing a notice with the STB. On active lines, the ICCTA required the STB to balance the economic burden of continued operation against the public's need for the service. In practical terms, STB permission will usually be given to abandon lines on which there are significant operating losses that can be demonstrated. The

carrier's ability to earn more money by reinvesting elsewhere is usually not sufficient to allow abandonment in the face of a strong public need for service, but neither does the railroad have to show an actual operating loss to abandon the line. If the railroad demonstrates such a burden, then evidence of the public's need for continued service will be reviewed under current abandonment procedures and policy. The effect on local businesses, surrounding communities, the local economy, and the environment also may be considered.

The ICCTA retained the power of the STB to approve rail mergers, consolidations, and control transactions. In addition to the criteria required in previous legislation, when a transaction involves the control of at least two Class I carriers, the STB is instructed to consider whether the proposed transaction would have an adverse effect on competition among all carriers, not just those in the affected region. In transactions that are part of a rail unification and coordination project, the STB is directed to give substantial weight to any recommendation of the Attorney General. The ICCTA also streamlined the procedures for rail consolidation proceedings.

The STB's discretion to impose conditions governing mergers and acquisitions was preserved by the ICCTA, but rules have been added to guide that discretion. The conditions may include divestiture of parallel tracks or the granting of trackage rights and access to other facilities. The ICCTA required that any trackage rights and related conditions, which are imposed to alleviate anticompetitive effects of the transaction, should provide for operating terms and compensation levels to ensure that such effects are alleviated. The practice of the ICC had been to leave the negotiation of operating terms and compensation levels to the parties, setting such terms only if the parties could not agree. This practice may be altered under the new rules of the ICCTA. Recently approved mergers by the STB have tended to have more conditions and longer oversight periods, particularly in view of the western rail crisis that followed the UP/SP merger.

Service Characteristics and Traffic Trends — U.S. railroads have certain well-defined service characteristics that make them extremely competitive with other modes of transportation for some types of movements and less competitive with other modes for other types of movements. These service characteristics, and the changing railroad regulatory environment, have been strong determinants of the long-term traffic trends of U.S. railroads.

Overall, railroads have some modal advantages in terms of the transportation services they can provide. In contrast to barges, railroads can offer door-to-door service for some shippers and receivers. Railroads also can be very competitive with trucks for all but the shortest hauls because railroad costs decrease with the length of the movement. Recent performance by railroads on intermodal shipments has shown that rail can be even faster and more flexible in some situations than trucks.

However, where service time as a modal attribute is less important to shippers and receivers, as in grain shipments, the actual service time of rail shipments tends to be worse than that of trucks. Railroads are also less able to compete on those types of shipments for which the reliability and the predictability of transit and arrival times are important to shippers and receivers. Reliable and predictable transportation service is actually of more importance to shippers and receivers of perishable agricultural commodities than the actual transit times because it enable shippers and

receivers to reduce inventory and interest costs and better plan marketing strategies. Agricultural processors using JIT production processes also have a requirement for reliable transportation services, which railroads have occasionally found difficult to provide. In contrast, U.S. railroads have been able to provide excellent on-time service to intermodal shipments.

Another dimension of rail service that has historically been an advantage for rail shippers is access to a variety of receiving points on the U.S. rail system. Of all the modes, trucks provide the best accessibility to alternate receiving points, because highways and roads are ubiquitous, while barge transportation typically offers the worst accessibility to alternate receiving points. Although shippers on a single railroad do not have practical access to all firms located on rail, railroads have historically maintained a national system of freight interchange whereby rail shippers can ship to receivers on other railroads. There are two current problems with accessibility to other shippers and receivers on the U.S. rail system: Railroads after deregulation have found it in their own best interest to encourage single-line shipping for long distances on their own lines, rather than relatively short distance movements to interchange points for joint-line movements with another railroad; and the set of shippers with convenient access to any rail transportation services is decreasing due to the widespread rail line abandonments that have occurred since railroad deregulation. Although railroad mergers have enlarged the single-line access destinations available to shippers, accessibility to other shippers and receivers is a decreasing advantage of rail transportation as a mode. This lack of accessibility results in more time required for the haul and higher transportation costs due to additional handling and overhead costs.

Rail transportation of grain in the United States has also been plagued with occasional perceptions by grain shippers that rail capacity has been inadequate. With the exception of the western rail crisis of 1997 and 1998, these problems have typically been perceived as having resulted from periods of high demand for grain transportation. The truck and barge modes of transportation, on the other hand, have been able to adjust much more quickly to fluctuations in the demand for grain movement because rising prices for grain transportation services signal the need for additional short-term capacity.

Railroads also seem to be lessening the service options available to small rural shippers, in the sense that the Class I railroads have been deemphasizing carload business, preferring that shipments be of unit-train length or for short line feeder railroads to provide the gathering function. Some agricultural shippers on Class I main lines receive worse service than those on branch lines due to the reluctance of Class I railroads to disrupt through traffic by providing carload service.

As previously mentioned, the competitiveness of motor carriers in rates and services has allowed trucking to garner most of the high-value intercity freight traffic since World War II. Thus, the railroad traffic base currently consists of primarily low-value, bulk commodities. As a percentage of total car loadings, the railroad traffic base in 1996 consisted of coal (44 percent), farm products (8.8 percent), chemicals and allied products (8.7 percent), food and kindred products (5.4 percent), and lumber and wood products (3.1 percent). The average length of haul for Class I

railroads was 841 miles in 1996.[14]

Railroads are a very important mode to the movement of grains, oilseeds, and their products in the United States even though the railroad modal share of the total volume of grain hauled decreased from 48.4 percent in 1978 to 40 percent in 1995 [Eriksen, et al., 1998]. Railroad modal share of the overall freight market in terms of ton-miles decreased from 56 percent in 1950 to 38 percent in 1993, and then increased to 40 percent in 1996. In contrast, the railroad share of the total freight market has been relatively stable over the past 10 years. The railroad share of the total freight revenue also decreased significantly from 1950 to 1993, from 64 percent to 22 percent, signaling a shift in the composition of the traffic hauled by railroad over that period.

Inland Waterway Transportation

Overview — The United States has a large natural system of inland rivers and waterways, many of which are suitable for navigation. There are 25,000 miles of navigable waterways in and around the United States. Navigable rivers serve U.S. agriculture in several ways. Barge transportation provides U.S. grain shippers a low-cost transportation mode to U.S. ports for export. Barges also provide a low-cost means of moving fertilizer and other agricultural inputs to production regions. Finally, barge transportation provides competition to the nation's railroads, placing downward pressure on rail rates, which is increasingly important as the U.S. rail industry continues to consolidate. For these and other reasons, the inland waterway system in the United States is a vital transportation link between U.S. grain production regions and world markets.

Infrastructure — Navigable waterways in the United States have been shaped by two forces — nature and the Federal Government. In its natural state, much of the Mississippi River system was not navigable because of flooding, shallow water, and sharp channel turns [Harper, 1982]. Since the 1820's, Congress has passed various legislation requiring the U.S. Army Corps of Engineers (COE) to establish and maintain a system of navigable waterways by removing impediments to navigation, increasing flood plain protection, and creating navigation channels with a guaranteed minimum depth and width. Through *The Rivers and Harbors Act of 1930*, Congress ordered that the existing 6-foot Upper Mississippi River channelization project be modified to provide a channel depth of 9 feet at low water with widths suitable for long-haul, common-carrier service. To this end, the COE constructed a series of locks and dams on the Upper Mississippi and Illinois Rivers. There are 29 dams with 35 lock chambers on the Mississippi River between St. Louis, Missouri, and Minneapolis, Minnesota. Likewise, there are eight locks and dams on the Illinois Waterway. These projects were started in 1930, and the final lock on the Mississippi River was completed in 1963.

Waterway operations on some river segments are seasonal because of winter freezing. Operations and maintenance functions on U.S. inland waterways are provided by the COE, which operates the locks and dams, controls river flow and depth, provides navigational aids, monitors channel navigational conditions, and continuously dredges waterways to maintain a navigable depth of 9

[14] In 1995, regional railroads had an average length of haul of 167 miles, local line haul railroads averaged 41 miles, and switching and terminal railroads averaged 13 miles.

feet on most waterways.

The transportation of bulk commodities on inland waterways is accomplished through towboat-barge configurations in which a fleet of barges called a "tow" is pushed on the river by a towboat. The number of barges that can be assembled in a tow depends upon river width and navigational conditions. The carrying capacity of each barge is determined by water depth. Tows must pass through lock and dam systems on most river segments. Technological advances have led to the use of larger towboats, but increases in the size of barges are limited by lock capacity.

Since the 1930's, technological advances in towboat power have resulted in an evolution of the towing industry. Today, a single towboat will routinely push a tow of 15 barges.[15] These tows are usually five barges long and three barges wide, tied abreast, with one towboat pushing. This configuration allows for the most efficient use of the towboat while minimizing reconfiguration times of the tow at the locks. The vast majority of the structures on the Upper Mississippi System have lock chambers that are 110 feet wide and 600 feet long, but a 15-barge tow cannot transit a 600-foot-long lock in a single pass. To overcome this problem, tows move through the lock in two passes. The towboat pushes the first nine barges into the lock chamber and separates the tow. These nine barges are then “locked through.” Then, the last six barges and the towboat enter the chamber and pass through the lock. Finally, the tow is reestablished and moves on. Under ideal conditions this procedure takes approximately 90 minutes. By contrast, transit time for a 1,200-foot lock is 45 minutes or less. Double-locking a tow substantially increases the cost of barge transportation. Because double-locking takes much longer, congestion-related delays occur as traffic waits to be locked through. Double-locking also requires additional deck hands. Industry representatives estimate that it costs $400 to $500 per hour to operate a towboat.

Several lock and dam replacement projects on the Upper Mississippi and Illinois River systems have been completed since the initial structures were put in place. Most notable was the replacement at Keokuk, Iowa, of the original 600-foot lock at Lock and Dam 19 with a 1,200-foot chamber in 1957. More recently, however, was the total replacement of Lock and Dam 26 at Alton, Illinois (later renamed the Melvin Price Locks and Dam). Construction of this facility was very controversial, and many groups challenged its authorization. Railroad interests were concerned that General Treasury outlays for locks and dams effectively subsidized the towing industry; other groups worried about the effects that construction of this facility would have on the environment.

To secure passage of the new Lock and Dam 26 appropriations, these concerns had to be addressed. This was accomplished through the passage of the *Inland Waterways Revenue Act of 1978.* To prevent the barge industry from receiving subsidies, the act established the Inland Waterway Trust Fund (IWTF), “into which the Congress appropriates amounts equivalent to the revenues received in the Treasury from the tax on fuel used by commercial vessels [Congressional Budget Office (CBO), 1992].” Included in this act was a phase-in schedule of fuel tax rates applicable to certain inland waterways. The initial barge fuel tax was 4 cents per gallon in 1981, and the tax currently stands at 20 cents per gallon. The act also established that the benefits of all

[15]The typical jumbo open-top or covered-hopper barge is 195-200 feet long and 35 feet wide.

new lock and dam projects had to be weighed against their potential environmental damage.

While the *Inland Waterways Revenue Act of 1978* initiated the fuel tax, the *Water Resources Development Act of 1986* authorized appropriations from the IWTF for project construction and rehabilitation. The IWTF and General Treasury funds have split the costs of these projects.[16] To date, the split between the two sources has been 50-percent Treasury and 50-percent IWTF. In addition to authorizing IWTF expenditures, the *Water Resources Development Act of 1986*0 established the Inland Waterway Users Board, composed of members of the towing industry, who advise the COE on project spending.

Since 1978, the barge industry has been taxed to meet new construction needs. Table 4 displays the estimated costs of recent major construction and rehabilitation projects. As this table shows, new projects pose a significant drain upon the IWTF. The need to collect matching funds, or at least projected matching funds, has complicated the authorization of major construction starts. Prior to 1994, new construction was limited by the projected inability of the IWTF to generate the matching revenues needed to fund construction. In recent years, however, the focus on eliminating the budget deficit (and corresponding pressure to reduce discretionary spending, including civil works projects) has called into question the availability of General Treasury funds. Thus, unless commitments are made to undertake new construction projects, the unspent balance in the IWTF is expected to grow.

In addition to cost outlays for new construction and major rehabilitation projects, the Federal Treasury assumes the cost of operations and maintenance (O&M) of the navigable rivers. The COE estimates Treasury will spend approximately $433 million in O&M costs in 1998 on those waterways where the fuel tax is collected. Several groups view this as an additional subsidy to waterway users and have attempted to recoup these costs through higher fuel taxes. But it should be noted that the river system is designed for many uses, not just navigation. For example, the benefits of COE projects include flood protection, industrial and municipal water supplies, recreation, and environmental habitat. So any attempt to recoup O&M costs strictly through fuel taxes would unfairly place the burden on one beneficiary, the barge industry.

Table 4 — Cost estimates for inland waterway construction and rehabilitation projects

Project	Construction type	Completion date	Total estimated cost	IWTF share
			Million	Million
Melvin Price Locks & Dam	New	1993	$950	$425
Winfield Lock & Dam	New	2001	$221.6	$110.8

[16] *The Water Resources Development Act of 1986* does not specify the split between general Treasury and IWTF financing. This division is specified in each individual project authorization. The split has been 50-50, but it is not mandated as such by law.

Olmstead Locks & Dams	New	2006	$1,020.0	$510.0
McAlpine Locks & Dam	New	2006	$268.0	$134.0
Monongahela Locks & Dams 2-4	New	2008	$695.0	$347.5
Mississippi Lock & Dam 3	Rehab	2000	$12.4	$6.2
Mississippi Lock & Dam 14	Rehab	2000	$20.9	$10.5
Mississippi Lock & Dam 24	Rehab	2001	$25.7	$12.4
Mississippi Lock & Dam 25	Rehab	2000	$22.9	$11.5

Source: COE, 1997

Cost Structure — Like motor carriers, inland waterway operators have benefitted from Government development and maintenance of their infrastructure, and this has affected the cost structure, market structure, and pricing performance of the industry. In contrast to motor carriers, however, user fees imposed on inland waterway operators recover only a small portion of the total Federal expenditures for the O&M of the inland waterway system.

Most of the costs of operating and maintaining the inland waterway system have been funded from general tax revenues, although inland barge companies have been required to pay a Federal fuel tax as a user fee. User fee revenue from the barge fuel tax is far less than total annual Federal expenditures on the inland waterways system. Current Federal fuel taxes, for instance, recover less than 10 percent of Federal support of navigation on inland waterways [CBO, 1992].[17] General taxpayers pay the remainder of the cost of water transportation.

It is difficult to make generalizations about operating costs because waterway operating conditions and fleet configurations vary by waterway segment. Nevertheless, barges are recognized as the least cost mode for long-distance bulk movements in the United States [Friedlaender, 1969; Keeler, 1983]. Compared to other modes of transportation, the production of barge transportation services does not require a large capital investment. In addition, barge costs are lower than those of competing modes because of the absence of maintenance costs and because the tractive power to move a ton of floating freight at low speeds through water is less than the power required to move the same tonnage in vehicles rolling on either steel or pneumatic wheels.

Most inland waterway transportation tends to be long-distance movements of heavy, low-value, bulk commodities such as coal, petroleum, certain chemical products, and grain that can be loaded and unloaded mechanically. Loading expenses and slow transit speeds make barges a less desirable mode of transport for higher value traffic. Door-to-door service is not rarely possible with water transportation, which adds to its cost and inconvenience.

Barge transportation also has some size-related economies [MacDonald, 1987]. Size-related economies for barges over other surface modes derive from the carrying capacity of a covered-

[17] Although the Federal Government spent $776 million in support of navigation on the Nation's inland waterways, only $63 million was recovered from taxes on barge fuel [CBO, 1992].

hopper barge being approximately equivalent to 15 covered-hopper railroad cars, which translates into lower per-unit loading and unloading costs.[18] The large capacity of barges also serves as cheap storage for some shippers.

Market Structure and Performance — Although some concentration does exist in the inland waterway industry, the industry is considered to be fairly competitive [Sorenson,1983]. Because barge companies are numerous and entry requirements are low, barge companies do not have price-setting power, and they cannot react strategically to railroad pricing [MacDonald, 1989]. All barge-loading points are potentially contestable to any barge company operating on the river system [MacDonald, 1987].

Helping to maintain competitive pressure in the industry is the fact that grain shippers can procure barge transportation services by purchasing spot-market barge freight at the Merchant's Exchange of St. Louis or by contracting for barge services at some future date with a barge company. Even if barge services are procured through forward contracting by the shipper, barge rates are often based on spot-market barge trades in the St. Louis market. Barge rates reflect current supply and demand conditions in the barge industry and vary by barge-loading point.

Another factor affecting barge pricing is the important role played by grain companies. Four of the top 10 barge firms — American Rivers Transportation Company, Peavey Barge Line, Cargo Carriers Inc., and Bunge — are owned by ADM, Conagra, Cargill, and Bunge, respectively. Together these firms control 39 percent of the fleet. During periods of slack demand, these barge firms are run as independent profit centers providing service to the highest bidder. When barge service is in great demand, however, these companies may retain their service for in-house use, thus helping their grain-marketing operations.

As with trucking, capacity in the inland waterway barge industry is supply elastic and adjusts quickly to demand conditions. Water carriers react to fluctuations in grain transportation demand by shifting barges from other bulk movements if demand is strong or by idling barge capacity if demand is slack. Low fixed costs allow water carriers to "lay up" or idle barges when market conditions no longer allow freight revenues sufficient to cover operating costs.

Government Oversight — Although domestic interstate water carriers were regulated in terms of entry, exit, rates, and service in the *Transportation Act of 1940*, broad exemptions to regulation were also allowed, including the transportation of commodities in bulk [Harper, 1982].[19] The primary rationale for economic regulation of domestic water carriers at the time was to avoid the "problems" of too many carriers and excessive competition caused by the relatively small amount

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[18] Standard size barges carrying grain on the U.S. inland waterway system loaded to a grain depth of 9 feet can carry 1,450 short-tons of grain, a standard covered-hopper rail car will accommodate 95-100 tons of grain, and most grain trucks can be loaded with 22-25 tons of grain.

[19] The *Transportation Act of 1940* allowed the transportation of bulk commodities by water carrier to be exempt if no more than three different commodities were carried in the same vessel or tow, but the three commodity limitation was never enforced and was later eliminated by Congress [Locklin, 1972].

of capital needed to enter the business. Railroads pushed for economic regulation of domestic water transport to protect themselves from price cutting by competing water carriers [Locklin, 1972]. However, the bulk exemptions effectively removed most waterway traffic from economic regulation under the rationale that railroads and barge lines were not direct competitors.[20] The bulk movement of grain in barges is not currently subject to any economic regulation.

Service Characteristics and Traffic Trends — The rate of growth in intercity ton-miles carried by water carriers operating on the rivers and canals of the United States has been substantial since 1939, increasing from 3.7 percent of total intercity ton-miles to almost 15 percent today. The principal advantage of water transportation over other modes is cost. The average cost per ton-mile for shippers of water transport is very low relative to rail and highway transportation. The low costs result from several factors: (1) size-related economies that permit the carriage of large quantities of bulk commodities; (2) little way expense; (3) less tractive effort, and less energy, required to move weight by water at slow speeds than by rail or highway; and (4) low labor costs.

A disadvantage of water transportation in the United States is its relatively slow speed, averaging about 6 miles an hour. Not only are barges are slower than trucks or trains, but the inland waterways (and especially the lower Mississippi) rarely flow in a straight line, thus the point-to-point distance traveled by barges is higher than the other modes. Water transport is slowed further by the need to make and break tows and by delays at locks. Another disadvantage of barge transportation is its geographic limitations. Waterway transportation is much more affected by weather conditions than are railroads. Water levels can influence the operating costs, speed, and carrying-capacity of a tow. In addition, in the northern portion of the country, the inland waterways are unusable 3-4 months during the winter.

Because of these service characteristics, domestic water transport is a realistic alternative primarily for those shippers and receivers located near waterways who ship or receive large volumes of lower or medium-value, bulk commodities.

Maritime Transportation

Overview – The U.S. ports and the maritime industry offer agricultural shippers and exporters access to a vast global marketplace. Ports are the fixed infrastructure in which waterborne commerce is exchanged across a dock from shore to vessel or vessel to shore. Excluding trade with Canada and Mexico, the maritime industry is the dominant mode for the transport of commerce to international markets. Within U.S. coastal water areas, maritime can also serve as an alternative mode to truck and rail for certain movements.

Infrastructure — Throughout the U.S. coastal regions, including the Great Lakes and Saint Lawrence Seaway, there are about 300 commercial deep-draft port facilities, with nearly 2,000

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[20] While this may have been true in the 1940's, when railroad service was primarily by single car shipments, railroads now provide multiple-car and unit-train shipments in direct competition to the large shipments of inland waterway barges.

terminals and 3,200 ship berths [COE, 1998; American Association of Ports, 1998]. Within a port area are highly mechanized terminals operated by one or more stevedore companies with one or more berths for vessels to load and discharge cargo. Ports compete with each other to attract customers by providing an array of facilities with which to move commodities and products across their docks. When choosing a port, agricultural exporters must consider a number of factors including the cost of transporting their commodity from the point of production to the port, the port's ability to store and handle the commodity, the type and number of shipping lines calling at the port, the ocean rates to preferred markets, and the distribution channels available in the importing country. Another port customer, the vessel operator, makes port calls depending upon port accessability, charter agreements, commodity and products to be discharged and loaded, and proximity to foreign and inland commerce points and services available at the port.

Port facilities include bulk, break-bulk, liquid, and container services. Bulk facilities are used to transfer large-unit movements of homogeneous commodities and products like grain from domestic transportation modes and port storage to ocean vessels. Container facilities handle unitized movements of commodities and products; for example, frozen meat in 40-foot, refrigerated containers or bagged lentils and peas in 20-foot dry containers.

Port operations are performed by port authorities, which are created by local and State agencies and can be public, private, or governmental organizations. The port authority coordinates the exchange of commerce between land and sea, which may involve discharging cargo from a ship; storing it on the dock or in a warehouse and moving it into the hinterland; or receiving cargo from the hinterland, storing it on the dock or in a warehouse, and loading it onto a vessel to be transported on water. Important participants at a port include vessel owners and operators; stevedore companies and longshoremen; shippers and exporters; brokers and freight forwarders; truck, rail, towbarge, and tug operators; and local, State, Federal, and international government agencies.

While the value and volume of cargo moved across a port's docks are indicators of its success, the port has important tasks besides operating ship berths and terminals, and coordinating cargo loading and unloading. Ports ensure access to highway, rails, and navigable waterways and provide temporary storage of commodities and products waiting to be shipped. As the global economy has grown, so has the need for port expansion where demand for port services has increased or changed.

As a fixed facility, ports require large capital expenditures. To keep facilities competitive and finance new construction, ports attempt to sign long-term leases with vessel companies, stevedores, and companies shipping commerce. Among the facilities demanded by the shipping community are new bulk facilities, container terminals, and access to on-dock rail service.

Finances are not the only issue influencing port expansion. Port authorities must be sensitive to land-use issues and the effects of expansion on services already being offered. In addition, they must recognize the relationship between the proposed port expansion and local environmental issues, the dredging of sediments, consolidation in the ocean-liner sector, the seasonality of commodity movements, the international business cycle, and changes in public policy toward ports

and maritime trade.

Port development, capital expenditures, and maintenance are financed through port revenues, general obligation bonds, revenue bonds, and public funding — local, State, and Federal. To generate revenue, ports charge vessel owners, stevedore companies, and shipping customers fees for using port facilities and services. Public support for port development has diminished, forcing port authorities to finance development and capital expenditures with port revenues and revenue bonds. In 1996, the capital expenditures of ports totaled $1.3 billion with ports on the Pacific coast making up 70 percent of total expenditures. Most of the expenditures were for cargo facilities, on- and off-terminal infrastructure, and dredging. About 74 percent of the expenditures went to new facility construction while 26 percent went to modernization and rehabilitation.

Harbors and water channels at many ports require dredging of sediment buildup to maintain safe navigable depths for deep-draft vessels. The COE coordinates port maintenance and dredging projects which, until recently, were funded by the Harbor Maintenance Tax (HMT). The HMT was an ad valorem tax on domestic waterborne commerce, imports, and exports that generated $790 million in revenue during fiscal year 1997 [Office of Management and Budget, 1998]. The U.S. Supreme Court ruled in 1998 that the HMT was an unconstitutional tax on exports, and the Administration is currently attempting to develop a new mechanism to fund harbor maintenance that will pass constitutional muster.

Market Structure — Ports transfer commerce from the surface transportation modes (road, rail, and barge) to ocean-going vessels and vice versa. This section describes the vessel owner and operator participants in the maritime industry. These owners and operators ensure that commodities and products are loaded at port regions and arrive at destination ports safely, efficiently, and in a timely manner. Participants in the international maritime industry manage a global fleet of 84,200 vessels. Twenty-seven thousand of these ships are engaged in the various deep-sea maritime trades.

Vessels are classified into 16 categories with 4 of those categories — oil tankers, bulk carriers, general cargo, and liner or container ships — transporting 78 percent of the tonnage. Agricultural products and commodities move predominately on bulk and liner vessels. In the global sea-trade lanes, there are 5,900 bulk vessels with total capacity of 161 million gross registered tons (GRT) and 281 million deadweight tons (DWT).[21] Nearly 2,200 container ships are in the world fleet, with total capacity of 49 million GRT, 55 million DWT, and approximately 9.6 million 20-foot equivalent unit (TEU) slots for containers [USDOT, MARAD, 1998; Stopford, 1997].[22]

Vessel owners and operators participate in a wide range of shipping activity and build ships for the specific maritime trade in which the ship is expected to operate. Ships have an expected life span of 20-30 years and can cost more than $100 million to build. When ordering a specific type of ship, owners determine the vessel size by the cargo to be transported and the sea-trade lane in

[21] GRT is the weight of the ship without cargo. DWT is the carrying capacity of the vessel.

[22] TEU is a common measure used to determine the size of a container ship.

which the ship will operate. For example, bulk vessels vary in size from 10,000 DWT to over 400,000 DWT and carry liquid and dry bulk commodities. Bulk vessels used in agricultural trades are classified by carrying capacity and sea-trade lane. The general classifications include "Handy-size" vessels (20,000 to 40,000 DWT), "Panamax" vessels (40,000 to 65,000 DWT), and "Capesize" vessels (65,000 to over 120,000 DWT). The Handysize vessel will be used to transport grain from the Great Lakes to ports situated in shallow waters or in lower volume trade lanes. The Panamax is the largest vessel capable of transiting the Panama Canal, where vessel size and draft are limited. Panamax vessels are also active in transporting grain from U.S. Gulf and Pacific Northwest ports to Asia. Capesize vessels are too large to transit the Panama and Suez Canals and are used primarily to transport iron ore.

The dry bulk maritime trade is divided into two groups: the major bulks, consisting of iron ore, metallurgical coal, steam coal, bauxite and lumina, phosphate rock, and grain, including soybeans but not rice; and the minor bulks, consisting of steel products, forest products, cement, fertilizers, manganese, scrap, coke, pig iron, sugar, soybean meal, and rice. In 1995, dry bulk agricultural products accounted for 13 percent of the 3.7 billion tons transported in the world's seaborne trade lanes [Organization for Economic Cooperation and Development, 1997].

The transport of bulk agricultural products via maritime vessel is arranged through a competitive vessel charter arrangement called a fixture. A fixture is a contract between the shipowner and charterer, which specifies the details involved in the vessel hauling a specific commodity from a specific origin to a specific destination at a negotiated rate and time. Bulk vessels haul various bulk commodities other than grain to and from many ports. Many fixtures are arranged to maximize vessel capacity at all times. In some instances, vessel operators will pick up cargo from more than one port to maximize the amount of revenue freight. Once the cargo is loaded, it is transported to its destination and unloaded. The operator of that empty vessel will then arrange another fixture to pick up another shipment from the same port or a nearby port and transport it to another destination to repeat the cycle. If a cargo is not available for immediate pickup, the vessel operator may sail empty until a shipment can be secured. Bulk vessels are not necessarily dedicated to specific commodities and can be cleaned between uses.

The development of the liner or container vessel greatly facilitated the international trade of high-value and value-added agricultural commodities and products. The operation and management of a liner vessel are significantly different from those of a bulk vessel. Liner vessels carry containers uniform in size (20, 40, 45, and 48 feet in length), shape (standard, open top, flat rack, auto rack and high-cube) and function (dry, oversized, liquid, and refrigerated cargo).

Liner vessels are increasingly being built larger to transport larger quantities of containers. New vessel orders vary in size from 4,200 to 6,200 TEU. These vessels are also being designed and constructed to carry greater numbers of refrigerated containers. One vessel recently put into service was constructed with more than 700 refrigerated container plugs for reefer containers. That is equivalent to 1.4 million cubic feet of carrying capacity, 20 percent larger than the largest dedicated refrigerated vessel which has 1.2 million cubic feet of capacity [*Lloyd's Shipping*

Economist, 1997].[23] Technological advances in refrigeration design and construction minimize deterioration in commodity quality by slowing the rate of respiration for fresh, perishable commodities and maintaining a constant temperature to ensure that frozen products do not thaw. In some cases, new refrigeration technology even assists the ripening process during transit for certain fruits and vegetables.

Each liner vessel calls upon many ports on a regularly advertised time schedule and has little room for flexibility. Most liner operators participate in a conference system (a government-regulated cartel) that allows carriers to reduce operating and financial risk by fixing rates, pooling revenues, apportioning markets, limiting volume or type of cargo transported, and controlling competition in international ocean shipping. Liner operators provide regular service, charge individual consignments on fixed tariffs, load containers that are accessible for other ports of call, keep the vessel stable and trim, run a fixed schedule, and plan tonnage availability to service the trades. With fixed tariffs and inflexible schedules, liner companies struggle to price commodity shipments and manage fixed-capacity constraints on each vessel. Liner companies occasionally charter liner vessels to meet peak demand or service a special trade lane.

Vessel operators interact with shippers, exporters, and importers; port operators; stevedores; tug operators; classification societies; and local, State, Federal, and international government bodies. The vessels are usually owned and financed through private arrangements for the capital investment. However, in the United States, as in many other countries, vessel owners can qualify for shipbuilding and operating subsidies.

Government Oversight — The operation of ports is governed by local port authorities, whereas vessel owners and operators are regulated by classification societies, flag states, and coastal states. The COE maintains both the deep-draft water harbors and the shallow-draft harbors for the benefit of the ports and vessel operators. The U.S. Department of Transportation (USDOT) oversees and promotes the U.S. ports and merchant marine industry and regulates the ocean liner industry's U.S. operations. To ensure that the quality or condition of the export grain is maintained to the international destination, the condition of bulk vessels and dry containers used to transport grain is inspected by the USDA.

While not government agencies, classification societies are a self-policing arm of vessel builders, owners, and operators. They ensure the safety of life and property at sea through agreed-upon technical standards of design, manufacture, construction, and maintenance of vessels. Their functions are performed by self-developed rules and enforcement; however, they have no legal authority. There are more than 50 classification societies in the world covering 90 percent of the cargo and passenger fleet. They vary in size and country of origin and operation. For instance, one classification society headquartered in the United States has almost 1,500 employees, including 300 engineers in 15 worldwide offices with 425 surveyors in 160 locations. Vessel owners use classification societies to class vessels (through inspections by surveyors) to ensure the vessel is certified as being properly built and maintained [Stopford, 1997].

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[23] One 40-foot reefer container has about 1,000 cubic feet of capacity and is used to transport agricultural commodities that need chilling or to remain frozen during transit.

Each vessel displays the flag of that country whose legal authority it recognizes while at sea. When a vessel is in the territorial water of a coastal state, it must also obey certain laws governing vessels in that nation. The United Nations defines laws of the sea through three conventions (ownership of the sea, right of passage through it, and ownership of the sea bed) and recognizes certain maritime zones in which vessels sail. The maritime zones include territorial seas (usually 3-12 miles from the coast), contiguous zone (typically 12-24 miles from the coast), exclusive economic zone (up to 200 miles from the coast), and high seas (beyond the exclusive economic zone). A vessel must obey the laws that govern the particular maritime zone in which it is sailing. Vessels sailing in the territorial sea have innocent passage through these waters but must adhere to the laws of the coastal state (which might include pilotage and tug requirements). Within the contiguous zone, coastal states have the power to enforce customs, fiscal, sanitary, and immigration laws on vessels sailing within this zone. The exclusive economic zone defines ownership of economic resources such as fisheries and minerals. The high seas are those areas of the sea not included in the exclusive economic zone, territorial sea, or internal waters of a state where vessels can proceed without interference from other vessels and where full legal status is accorded the vessel and its state flag.

The U.S. Maritime Administration (MARAD) promotes the development and maintenance of an adequate U.S. merchant marine, which transports domestic waterborne commerce and a portion of foreign waterborne commerce and is capable of serving as a naval and military auxiliary in time of war or national emergency. There were 14 U.S. bulk ships with total capacity of 321,000 GRT and 538,000 DWT, and 85 U.S. liner ships (private and Government owned) in January 1998 [USDOT, MARAD, 1998]. MARAD also promotes shipbuilding and repair services, efficient ports, effective intermodal water and land transportation systems, and reserve shipping capacity in time of national emergency [USDOT, MARAD, 1997].

The Federal Maritime Commission (FMC) regulates the liner industry and is authorized to take action to ensure that the foreign commerce of the United States is not burdened by nonmarket barriers to ocean shipping. The FMC can initiate countervailing actions to correct shipping practices that negatively affect shipping conditions in U.S. foreign commerce. The *Shipping Act of 1984* gives the FMC the authority to regulate the ocean-liner industry and influences the level of competition in maritime trade by granting broad antitrust immunity to carrier conferences (cartels). To counter the market power of the conferences, the act also encourages carrier-rate and service competition and establishes a freight-tariff filing system. The *Shipping Act of 1984* directly affects maritime rates and services for all high-value and value-added agricultural exporters [USDOT, FMC, 1998].

The economic structure of the bulk and liner industries is influenced by a variety of U.S. laws. The *Shipping Act of 1984* determines how the liner industry can operate vessels and coordinate services, while the *Jones Act* restricts foreign-owned shipping companies and foreign-built vessels from the U.S. coastwise trade. The *Jones Act* requires that any vessel participating in domestic waterborne commerce be U.S.-owned, -built, -crewed, and -flagged. Cargo preference requirements mandate that a certain portion of cargo shipped by the United States be transported on U.S.-owned, - crewed, and -flagged vessels.

Service Characteristics Ports assist shippers and exporters with marketing and special services to forward commerce to vessel operators, who then transport the commerce to various worldwide destinations. Port services ensure safe and secure storage for cargo awaiting shipment, provide bunker fuel and maintenance for vessels, and provide a seamless transfer of cargo between the port and the hinterland through on-dock or near-dock rail and access highways. For bulk agricultural shippers, ports own, lease, or provide services to bulk facility operators. Bulk facilities might include export grain elevators and cold-storage facilities for fruits, vegetables, and high value and value-added commodities. In the United States, there are about 70 bulk export grain facilities with storage capacity exceeding 323 million bushels and average vessel-loading capacities between 11,000 and 190,000 bushels per hour [USDA, Federal Grain Inspection Service, 1998].

The proximity to agricultural production areas and the accessibility of the port to desirable international destinations help determine the port through which various agricultural commodities and products move. For example, approximately 70 percent of all export grain is barged down the Mississippi River from nearby production areas, transloaded into export elevators and, eventually, loaded onto a bulk maritime vessel at a port along the U.S. Gulf Coast.

Because Pacific Rim markets are of growing importance to U.S. agricultural exports, the mix of cargo handled at the U.S. West Coast is worth noting. In 1996, West Coast ports handled about 27 percent of U.S. agricultural exports (bulk and nonbulk) by volume (tonnage) and 40 percent of U.S. agricultural exports by value. Of the agricultural commodities exported from West Coast ports, about 80 percent of the volume goes through the Columbia River ports of Portland, Oregon, and Kalama, Washington, and the Puget Sound ports of Seattle and Tacoma, Washington. Yet, while the California ports handle less than 20 percent of the volume of agricultural exports, the California ports account for 55 percent of agricultural exports by value. This occurs because they handle more high-value and value-added cargo, while Pacific Northwest ports move the bulkier, lower value commodities.

While more than 100 different agricultural commodity groupings are exported through West Coast ports, 20 of these groups account for 80 percent of the export value, and 6 groups account for over 80 percent of the export volume. The variation in export volume and value across ports is striking. For instance, to account for 80 percent of the volume of agricultural exports by port region, the Bay Area ports must move 20 different commodity groups, Southern California 14, Puget Sound 4, and Columbia River just 2. This variation in volume and the number of different commodities handled reveals a certain specialization of West Coast ports in exporting agricultural commodities and products. For example, ports in the Pacific Northwest are important for handling export wheat originating in Washington, Oregon, Idaho, and Montana and corn from the Midwest. The success of moving agricultural commodities and products through West Coast ports depends upon an efficient intermodal system of truck, rail, and barge to get products to the ports for export.

The St. Lawrence Seaway System is a binational waterway, operated by the United States and Canada, which connects the North American “heartland” with the rest of the world. In 1954, the two nations agreed to jointly construct, operate, maintain, and develop a deep water route from the Great Lakes through the St. Lawrence River to the Atlantic Ocean. Each country established

agencies to conduct business — the Saint Lawrence Seaway Development Corporation (SLSDC) in the United States and the St. Lawrence Seaway Authority in Canada. In 1997, bulk movements totaled 31.7 million tons and made up 86 percent of all waterborne commerce volume transported on the Seaway. Grain movements totaled 13.4 million tons (34 percent of which was U.S. grain) and amounted to 42 percent of total cargo volume [USDOT, SLSDC, 1998].

There are 16 major categories of maritime vessels, of which bulk, liner, and refrigerated vessels are most important to agricultural shippers. Each vessel has different capabilities to transport commodities. For instance, homogeneous bulk commodities such as grain are easily loaded into bulk vessels. Recent advances in bulk shipping include technological changes in ship design that make loading and transit times quicker. Liner or container ships have revolutionized ocean shipping and can be visualized as an open box in which containers are stacked on top of one another and fitted within cell guides in ship holds. By standardizing the shipping unit in the form of a container, the volume of commodities and products loaded and discharged from a vessel is more efficient. Efficient loading and unloading speed vessel turnaround while at port and lower vessel operating costs. Advances in refrigerated container design have also expanded the exports of high-value and value-added perishables and meats. Dedicated refrigerated vessels, similar to bulk vessels, transport commodities requiring a chilled environment during transit. Apples, pears, kiwi fruit, and meats are examples of agricultural commodities requiring refrigeration during transit.

While bulk vessels move large volumes of grain to foreign destinations, there are few bulk vessels capable of transporting grain within U.S. coastal areas and the Great Lakes. One of the reasons for this lack of maritime capacity in this trade is that the coastwise transport of waterborne commerce is restricted by the *Jones Act* to U.S.-owned, -built, -crewed, and -flagged vessels.