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Grain Transport: Modal Trends and Infrastructure Implications

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January 5, 2005

Abstract. This report examines the grain-handling system and the infrastructure that supports it. The first part of the report briefly identifies transportation funding issues before Congress that are particularly relevant to grain shippers. The report then describes how grain is delivered to market, including long-term trends taking place and the underlying reasons for those trends. The final part identifies some of the implications these trends have for targeting future investment in the grain-handling system.

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January 5, 2005

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Summary

The 109th Congress is expected to take up reauthorization of funding programs for surface and marine transportation infrastructure that were debated but not enacted by the 108th Congress. Grain shipping has been either a central part or at least an element of the policy debate on many of the infrastructure funding proposals. Most notably, a key infrastructure project under consideration is enlarging the locks on the Upper Mississippi River and Illinois Waterway (UMR-IWW) to speed up passage of barge tows. Grain shipping has also figured prominently in debates over federal aid for rail infrastructure, particularly for short line rail track located in agricultural states. Highway policy discussions particularly relevant to grain transportation include funding rural interstates and other federal-aid designated roads to support the growth of heavy grain hauling trucks and improving the truck routes connecting highways with ports and rail terminals.

Over the past two decades, the amount of grain transported has increased by nearly 70%. While all modes have participated in this growth, they have done so at different rates. Barge modal share has decreased slightly, rail share has decreased substantially, and trucking's share has increased substantially. The doubling of domestic demand for grain and static export demand has favored truck transport because trucks generally have an advantage in moving grain over shorter distances. Barges and railroads favor hauling large volumes of grain long distances, which suits the export market. Farm and rail consolidation has also favored truck transport. Large farms may find it more economical to own their own fleet of trucks because trucking offers more flexibility as to when, where, and how much grain is delivered. By using trucks, farmers can better time their deliveries to grain elevators in order to receive the highest price. As a result of rail consolidation, many of the smaller country elevators and short line railroads are being bypassed in the grain delivery network, leaving grain farmers to rely more on trucks to deliver grain to the larger elevators. While the bulk method for shipping grain dominates, a new logistics pattern utilizing containers is also emerging.

As described in this report, the grain supply chain is a multifaceted system. Changes or developments with one component of the system will likely affect the ability of other components to perform efficiently. The complexity of the grain supply chain raises a number of issues for Congress as it evaluates pending investment decisions in surface and marine transportation infrastructure. One issue is if a systems-level perspective can lead to more sound investment decisions than a mode-specific perspective. Another issue is balancing the desire for transportation efficiency with local economic development concerns. Concern for local economic development raises the question of whether supporting a grain value-chain as opposed to a grain volume-chain would create more jobs and income for rural communities. The additional infrastructure costs that utilizing larger vehicles imposes on others is also an issue. Finally, whether system users should pay a greater share of the cost of infrastructure improvements is a key policy issue. This report will not be updated.

Contents

Grain Transport: Modal Trends and Infrastructure Implications

The 109th Congress is expected to take up reauthorization of funding programs for surface and marine transportation infrastructure that were debated but not enacted by the 108th Congress. Water Resources Development (WRDA) legislation would fund river locks and dams[1] and highway reauthorization legislation would fund interstate and other primary-use highways.[2] The 108th Congress also debated several proposals for funding freight rail infrastructure, including loan guarantees, a rail trust fund, tax-credit bonds, tax incentives, and federal grants.[3] As part of the American Jobs Creation Act of 2004 (P.L. 108-357), the 108th Congress did enact a measure that provides tax credits to short line railroads for upgrading their track beds.

Grain shipping has been either a central part or at least an element of the policy debate on many of these infrastructure funding proposals.[4] Most notably, a key infrastructure project under consideration in WRDA is enlarging the locks on the Upper Mississippi River and Illinois Waterway (UMR-IWW) to speed up passage of barge tows. Grain shipping has been front and center in the debate over this project because grain accounts for about half the total freight tonnage carried on these rivers. Similarly, grain transportation has figured prominently in debates over federal financial assistance for rail infrastructure, particularly for short line rail track located in agricultural states. Railroads carry about a third of annual grain tonnage to market. In the debate over highway reauthorization, total funding and equity issues among states dominated Congressional debate in the 108th Congress, but freight transportation, in general terms, has received considerable attention. Trucks carry about half of annual grain tonnage, or about the same amount that barges and railroads carry combined. Highway policy discussions particularly relevant to grain transportation include funding rural interstates, roads, and bridges to support the growth in traffic of heavy grain hauling trucks and improving intermodal connectors which are the truck routes connecting highways with ports and rail terminals.

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[1] In the 108th Congress, WRDA bills include H.R. 2557, S. 2554, and S. 2772. For legislative developments regarding WRDA, see CRS Issue Brief IB10133, *Water Resources Development Act and Other Army Corps of Engineers Legislation*.

[2] In the 108th Congress, see H.R. 3550 and S. 1072. For legislative developments regarding highway reauthorization, see CRS Issue Brief IB10138, *Surface Transportation: Reauthorization of TEA-21*.

[3] See H.R. 2571, H.R. 1617, S. 1961, H.R. 876, S. 1703, and section 4632 of S. 1072.

[4] For the purposes of this report, "grain" refers to corn, wheat, and soybeans, even though soybean, unlike the other two, is technically an oilseed and not a grain.

This report examines the grain-handling system and the infrastructure that supports it. The first part of the report briefly identifies transportation funding issues before Congress that are particularly relevant to grain shippers. The report then describes how grain is delivered to market, including long-term trends taking place and the underlying reasons for those trends. The final part identifies some of the implications these trends have for targeting future investment in the grain-handling system.

Infrastructure Funding Issues Relevant to Grain Shipping

The infrastructure issues identified below are particularly relevant to shipping grain. These are infrastructure segments that have been targeted for investment in legislation debated in Congress. They are briefly described here because there are other CRS reports cited below that discuss these infrastructure segments in more detail.

Mississippi and Illinois River Locks

One infrastructure investment proposal Congress is evaluating is whether to upgrade locks on the Mississippi and Illinois Rivers. Several of the lower locks on the Upper Mississippi River have been targeted for extension from 600 feet to 1,200 feet to enable larger barge tows to pass through more quickly, and thus reduce the cost of barge transport of exported grain and other bulk commodities. Many of the current locks were built between 1930 and 1950. Standard tows since then have grown from 600 feet to over 1,100 feet — nearly the length of four football fields. The lock chambers targeted for extension can only accommodate 600 foot tows and therefore the standard tow must move through the locks in two passes, requiring break up and reassembly of some tows. Passage through a 1,200-foot lock can take about 45 minutes or less but transiting a 600-foot lock takes approximately 90 minutes, which can produce queuing delays for other barges.

Specific plans for these lock improvements are discussed in greater detail in CRS Report RL32574, *Proposed Authorization of Upper Mississippi River - Illinois Waterway Investments.* The potential benefits of these lock improvements are heavily dependent on agricultural trade patterns. Evolving agricultural trade patterns and projections for future agricultural cargo on these waterways is discussed in CRS Report RL32401, *Agriculture as a Source of Barge Demand on the Upper Mississippi and Illinois Rivers: Background and Issues*.

Short Line Railroad Track

Of the170,000 miles of rail track in the United States, about 50,000 miles of track is owned by about 550 short line and regional railroads. Many short line railroads operate trades that were formerly part of a main line railroad's network but were abandoned by the main line railroad due to low profitability on that route. Of the more than 100,000 miles of tracks that Class I railroads have abandoned since 1980, about 50,000 miles of that track has been acquired by short line railroads. Before abandonment, the main line railroad typically deferred maintenance on these sections of track, focusing their resources on their trunk lines. As the main line railroads transition to the use of the larger 286,000 pound railcars, short line railroads need to upgrade their track beds and bridge structures to support these heavier cars and continue their role as collectors and distributors of main line traffic. The short line rail industry estimates that it could cost almost $7 billion to upgrade their rail systems to accommodate the heavier cars.[5]

Rural Roads and Bridges

The continuing trend toward greater reliance on trucking in the grain delivery system (as discussed further in the next section) has led to increasing concern with the wear and tear on rural roads and bridges. Many of these roads and bridges were built before this trend was evident and therefore were not designed for this type of traffic. Since many of these roads are located in sparsely populated rural counties, the tax base may be insufficient to meet the cost of maintaining these roads. Although rural roads and bridges are the responsibility of local and state governments, they are mentioned here because the expense of maintaining them to accommodate heavy grain hauling trucks has fueled the debate over public support for preserving short line rail service. Proponents of short line rail assistance contend that it might be more cost-effective to provide public aid to maintain short line rail service in affected areas than to reinforce rural roads and bridges.

Capacity of Main Line Railroads

Railroad main lines are experiencing high track utilization rates. Much of the main line network is single tracked. Double or even triple tracking, and increasing the number of sidings would allow more time sensitive freight trains to pass less service sensitive trains. Some industry analysts contend that the privately financed Class I freight railroads are failing to keep pace with the growth in demand for freight transportation capacity.[6] Because freight railroads are critical to the nation's economy, upgrading and expanding their infrastructure, according to proponents of public support for rail infrastructure, should be a federal government concern. Capacity problems are most acute during the fall peak shipping season. Grain farmers complain of railcar shortages and train delays that cut into their potential profits. Class I railroads argue that they cannot be expected to build their physical plant to meet a relatively short-lived spike in demand that occurs around harvest time.

Legislative proposals for accelerating investment in rail infrastructure include creating a rail trust fund, expanding the Railroad Rehabilitation and Improvement Financing program (RRIF), and tax incentives. Repeal of a 4.3 cents per gallon rail diesel tax was enacted as part of the American Jobs Creation Act of 2004 (P.L. 108-357). Arguments for and against federal assistance to main line railroads are

[5] U.S. House of Representatives, Committee on Transportation and Infrastructure, Subcommittee on Ground Transportation, Hearing: *Short Line Rail Infrastructure Needs,* 106th Congress, 2nd Session, July 25, 2000.

[6] In this report, the terms Class I railroad and main line railroad are used interchangeably. Class I railroads are those with operating revenues of at least $277.7 million in 2003.

discussed further in CRS Report RL31834, *Intermodal Rail Freight: A Role for Federal Funding?* dated August 18, 2004.

Intermodal Connectors

Intermodal connectors include facilities such as the access roads to marine and rail terminals. These routes are typically short segments of road, generally less than two miles in length, that connect freight terminals to the highway system. Many of the connector roads, especially those leading to seaports, are in older, industrialized areas and have a preponderance of at-grade rail crossings that impede traffic flow. Two recent Department of Transportation (DOT) surveys have found these access roads, in many cases, to be inadequate to accommodate the heavy truck traffic they handle. The pavement may be in poor condition or the intersections and width of the roads are not designed to handle large trucks. The results of these surveys and the policy issues they raise are discussed further in CRS Report RL31887, *Intermodal Connectors: A Method for Improving Transportation Efficiency?*

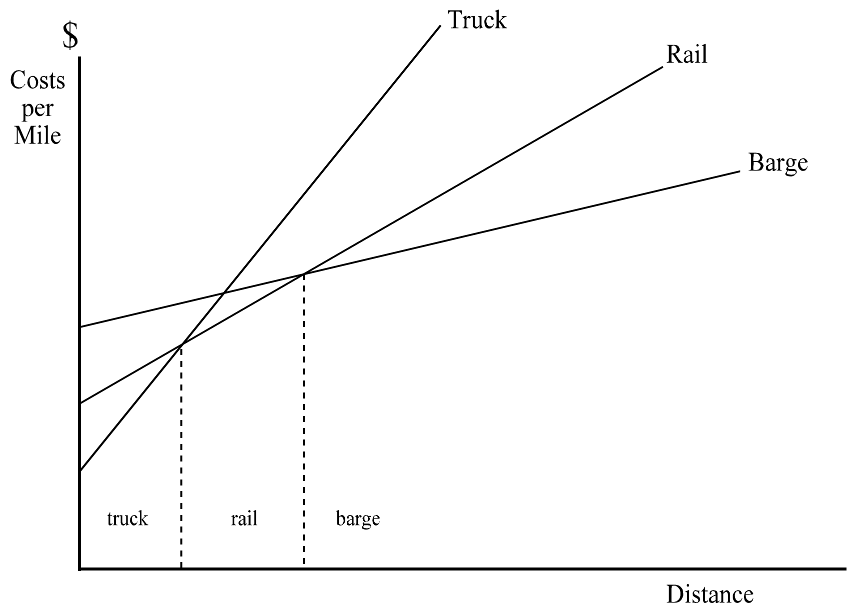
To address the issue of deficient intermodal connectors, the highway reauthorization bills would create a "Freight Intermodal Connectors" program which would allow states to set aside a portion of their federal highway funds to improve these roads to cargo hubs. Highway reauthorization is discussed further in CRS Issue Brief IB10138, *Surface Transportation: Reauthorization of TEA-21.*

While the infrastructure segments identified above are presented as separate issues, viewed from the perspective of the grain supply chain, there is a high degree of connectivity among them. An examination of the grain supply chain can help prioritize investments in these infrastructure components.

The Grain Supply Chain

Trucks, trains, and barges both compete and complement one another in moving grain to successively larger elevators. Grain elevators accumulate a critical mass of product that creates economies of scale in shipping bulk grain. Between origin and final destination, most grain shipments have traveled by two or more modes of transportation. Trucks traditionally have an advantage in moving grain for shorter distances (less than 250 miles) and therefore function primarily as the short haul gatherers of grain. Railroads have a cost advantage in moving grain long distances. Barges have even a greater cost advantage than rail in long distance transport but only where a waterway is available. Barges, moreover, cannot compete with trucks and trains in terms of transit time, and waterways are not always available due to ice, floods, or drought. **Figure 1** illustrates the cost advantages of the three grain hauling modes in terms of shipment distance.

Figure 1. Modal Cost and Distance



Source: USDA, *Agricultural Transportation Challenges for the 21st Century,* Appendix B, n.d., n.p.

Due to these modal cost advantages relative to shipment distance, domestic and exported grain tend to exhibit different transportation patterns. If grain is being sold in the domestic market, depending on the distance, either trucks or short line railroads move the grain from the country elevator to the domestic processor, feed manufacturing plant, or off-farm feed lot operator (livestock farmer). The U.S. Department of Agriculture (USDA) reports that in 2000, trucks transported about two-thirds of grain tonnage sold in the domestic market while railroads carried about one-third, and barges carried less than 2%.[7]

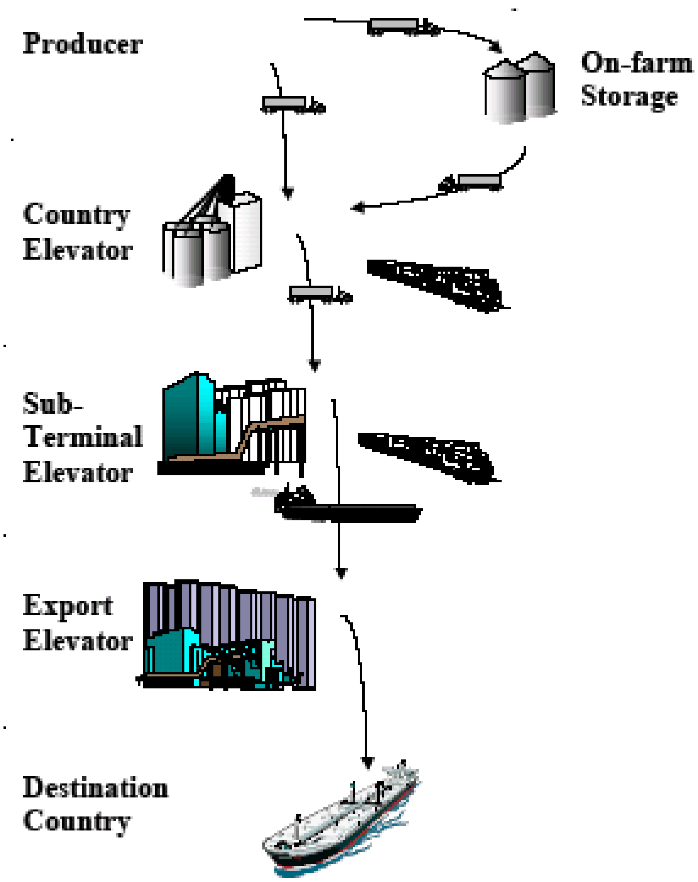
Much of the grain exported has to travel long distances to reach U.S. ports, so Class I railroads and barges are the primary modes in moving grain for the export market. The USDA reports that in 2000, barges transported 55% of exported grain tonnage, rail transported 38%, and trucks transported 7%.[8] The preponderance of exported corn and soybean moves by barge since these crops are grown relatively close to either the Upper Mississippi, Illinois, or Ohio Rivers. Barges transport 90% of the corn moving to Center Gulf ports while railroads transport 10%. The high level of interdependence between the barge and grain industries is evidenced by the fact that four of the top ten barge operators are owned by grain companies (ADM,

[7] USDA, *Transportation of U.S. Grains: A Modal Share Analysis, 1978-2000,* October 2004, p. 10.

[8] U.S. Grains Council, *Value Enhanced Grain Exporter Manual*, 1999, p. 74.

ConAgra, Cargill, and Bunge), which together control about 40% of the barge fleet.[9] The preponderance of exported wheat moves by rail since wheat production is concentrated in the central and northern plains, farther from waterway access.[10] **Figure 2** shows which modes are typically used in the transport links to reach seaports for exported grain.

Figure 2. Typical Modal Flow of Grain for Export



Source: U.S. Grains Council, *Value Enhanced Grain Exporter Manual*, 1999, p. 44.

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[9] USDA, *Agricultural Transportation Challenges for the 21st Century*, Washington, D.C.

[10] USDA, *Grain Transportation Prospects*, USDA/STB Grain Logistics Task Force Working Group, November, 1998.

Growth In Tonnage Transported

Since 1978, the amount of grain transported has increased almost every year. Grain tonnages increased from 242 million in 1978 to 404 million in 2000, an increase of 69% in 22 years. The growth in demand for grain transportation is the result of increases in grain production but also because of an increasing amount of grain used off the farm from which it is grown. More grain used to feed cattle and poultry is moving off-farm because of a continuing trend toward consolidation of livestock and poultry production into large-scale operations, which purchase significant amounts of feed grown off-site. Livestock and poultry production is moving away from major feed-grain-producing states to areas of deficit grain production, thus increasing demand for feed-grain transport. The growth in ethanol production, other industrial uses of grain, and food products made from grain also requires transportation of the product off the farm to domestic processors.

While all modes have participated in the growth in demand for grain transportation, they have done so at different rates. From 1978 to 2000, tons of grain hauled by truck increased 170%, tons of grain carried by barge increased 43%, and tons of grain carried by rail increased 13%. The reasons for these differing rates of increase are explained in the following section.

Modal Shifts in the Supply Chain

Long term trends in the amount of grain sold domestically versus exported has shifted modal market shares. The majority of grain is sold in the domestic market. The USDA reports that from 1996 to 2000, nearly 70 % of grain movements were for the domestic market.[11] Moreover, the amount of grain transported for the domestic market has been increasing steadily, from 123 million tons in 1978 to 280 million tons in 2000, an increase of 128%. Typically, about 80% of corn, 65% of soybeans, and 50% of wheat production is sold domestically.[12] The smaller export market is much more volatile than the domestic market. After surging during the 1970s, the amount of grain exported has fluctuated erratically but overall has been about the same since the late 1970s. In 1978, 119 million tons of grain was exported while in 2000, 122 million tons of grain was exported. As can be seen in these tonnage figures, in 1978 nearly the same amount of grain was exported as was sold in the domestic market but in 2000, about two and a quarter times more grain was sold domestically than exported.

Figure 3 illustrates the impact these trends have had on modal market shares for grain transport. These modal shares are based on the transportation mode used for the last leg of a grain shipment within the United States (i.e., to a domestic buyer or to a U.S. seaport or land border crossing for export). The Transportation Services Branch of the USDA has calculated these modal market shares from 1978 to 2000.

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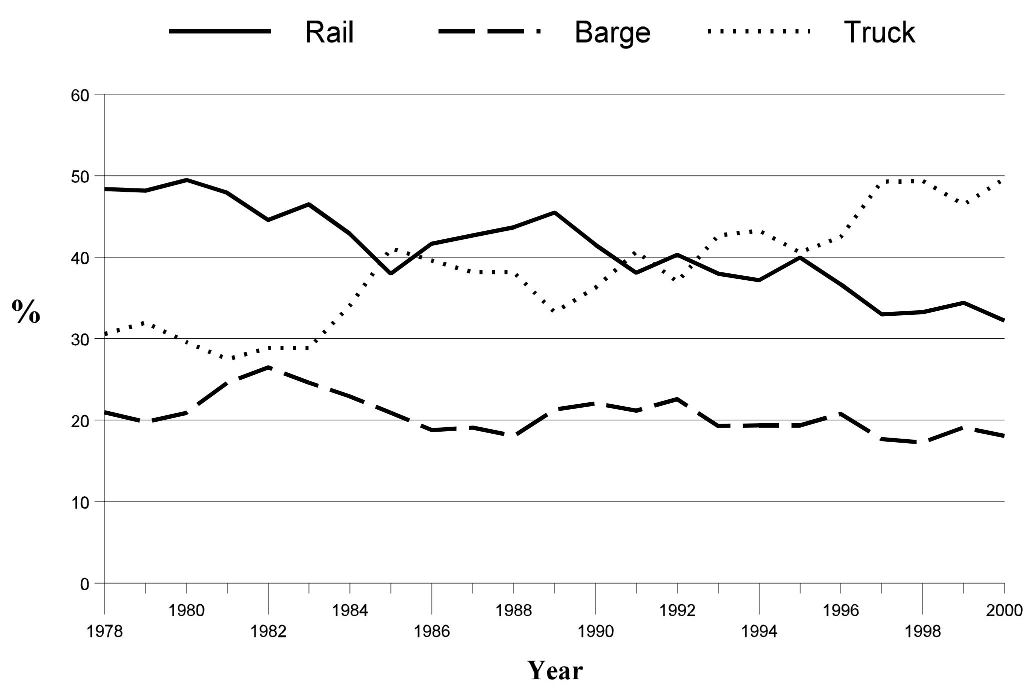
[11] USDA, *Transportation of U.S. Grains: A Modal Share Analysis, 1978-2000,* October 2004, p. 6.

[12] Figures are for 1999, Chris Hurt and Lee Schrader, *Long-Term Structural Shifts in Grain, Oilseed, and Animal Industries in the United States,* USDA, Nov. 2000.

Since 1978, barge modal share has decreased slightly, rail share has decreased substantially, and truck share has made up the difference. From 1978 to 2000, truck's modal share increased significantly from 31% to 49%, while rail's market share dropped significantly from 48% to 31%, and barge's dropped slightly from 21% to 18%. Increasing domestic demand and static export demand has favored truck transport because, as mentioned above, trucks generally have an advantage over rail and barge for shorter haul shipments. Also, domestic buyers tend to buy grain in smaller volumes because they operate throughout the year.[13] Smaller shipment size fits the characteristics of truck transport more than rail and barge. Class I railroads and barges are more interested in long distance, trainload or bargeload-size shipments, which suits the export market more than the domestic market.

Figure 3. U.S. Grain Transportation Modal Shares, 1978-2000
(based on tons hauled)



Note: Data are for the last shipment leg in the United States.
Source: USDA, *Transportation of U.S. Grains: A Modal Share Analysis, 1978-2000*

Farm and Rail Consolidation Increases Truck Hauls

In addition to the shift from on-farm to off-farm livestock feeding, higher levels of domestic corn processing, the more than doubling of domestic demand for grain

[13] Larry Kaufman, "Booming Grain Business Has Small Shippers Seeing Red," *Trains,* April 2004.

while export demand stagnates, farm consolidation (fewer but larger farms) and Class I railroad rationalization (fewer miles of tracks, but more trains) have contributed to trucking's predominance in grain movements. Due to farm and rail consolidation, the smaller country elevators and short line railroads are increasingly being bypassed in the grain delivery system. Trucks are replacing short line railroads in the grain collection function — the movement of grain for relatively short distances. In one survey, industry experts predicted that one in four of the more than 10,000 grain elevators in today's network will no longer be in existence a decade from now.[14]

Farm Consolidation. Between 1980 and 1998, the number of farms decreased by 15% while the average size of farms increased by nearly 11%.[15] Larger farms may find it more economical to own their own fleet of trucks and move their product directly to the sub-terminal elevator or to the processor or feed lot. Farmers receive payment at delivery and thus can receive payment faster if their product moves by truck rather than short line railroad. For farms with sufficient on-farm storage, trucking offers farmers more flexibility than rail as to when and where they deliver their product. They can adjust delivery times and amounts more easily to obtain the highest grain price. Other reasons farmers may use trucks rather than short line railroads is that trucks are more dependable, truck rates are lower, and because the rail line available may not serve the most profitable market.

Rail Consolidation. The construction of rapid load-out facilities on Class I railroad networks has also contributed to greater reliance on trucking for the initial leg of a shipment. Class I railroads are exploiting operating efficiencies by consolidating their trackage and rolling stock around larger, sub-terminal elevators. These larger elevators have enough grain to not only load longer trains but also trains using larger and heavier grain cars. New super jumbo covered-hopper railcars have loaded weights of 286,000 to 315,000 pounds compared with 263,000 pounds for the traditional cars. The larger elevators are also equipped with high-speed loading gear which can fill a mile-long train in 15 hours or less. Less time spent loading at the terminals means that trains can increase their turnaround time, making more trips in a given period.

In addition to streamlining the loading process, railroads have streamlined their train operations with new configurations. The rail consolidation process emphasizes unit and shuttle trains, de-emphasizing carload service in favor of shipment sizes that can fill entire trains, and operating from single origins and destinations rather than multiple origins and destinations.[16] These unit-grain-trains are designed to reduce switching costs and delays, thereby improving car cycle times. By concentrating on the long-haul portion of grain movements, Class I railroads have simplified their operations, making more efficient use of railcars, locomotives, train crews, and track.

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[14] Kimberly Vachal, *The Long-term Availability of Railroad Services for U.S. Agriculture*, paper presented at the Transportation Research Board's 81st Annual Meeting, January, 2002, Washington,D.C.

[15] Jerry Norton, *Transportation Implications of Structural Shifts in U.S. Agriculture*, USDA, AMS, July 1998.

[16] Unit trains are typically 50-54 car trains while shuttle trains are typically 100-110 car trains.

One study estimates that in 1999, approximately 50% of U.S. rail shipments of corn and 10% of rail shipments of wheat were handled by unit trains.[17] The Class I railroad tactic of increasing the density of grain movements over their track is consistent with their strategy in moving other commodities as well. From 1970 to 1999, the number of ton-miles of all commodities carried by Class 1 railroads increased by 87 percent while the number of miles of railway operated by Class I railroads declined by 43 percent.[18]

North Dakota Inverse Rail Rates: An Illustrative Example

The influence that Class I railroad strategies can have on the grain delivery system is illustrated in North Dakota. The practice of so-called "inverse rate" pricing by the Burlington Northern Santa Fe (BNSF) Railroad drew a lot of attention in the state and was the subject of a congressional field hearing. At the hearing, a grain farmer located near Gladstone in the southwestern part of the state described how he trucked his grain to a subterminal elevator in Jamestown located 160 miles to the east, even though his local elevator was located only 20 miles from his farm.[19] The reason he trucked his grain to the more distant elevator was because he received a better price for his grain at that elevator than from his local elevator. The subterminal elevator gave him a better price because grain farmers are paid the price of grain minus the cost of transportation, which in this case was the cost of rail transportation to a seaport in the Pacific Northwest (PNW). The BNSF Railroad charged less to ship grain from eastern North Dakota than western North Dakota to PNW ports even though the distance is farther (hence the term "inverse rates"). From the subterminal elevator in Jamestown, the BNSF would then haul the grain back west, passing through the grain farmer's yard located near Gladstone on its way to a PNW port.

While inverse pricing may seem peculiar, from the railroad's perspective, it is a sound pricing strategy. Traditionally, grain produced in eastern North Dakota would be sold in the domestic market or exported via the Port of Duluth (for shipment through the Great Lakes) or via Minneapolis or another Mississippi River port (for barge transport to the Port of New Orleans). Thus, trucks or barges would capture most of the inland freight revenues for shipment of eastern North Dakota grain and eastbound rail shipments would be for relatively short distances. However, if the BNSF Railroad could encourage the movement of this grain in the opposite direction — that is, west to PNW ports, it could capture all of the inland transport revenues because this route would utilize BNSF's rail network over a much longer distance. In eastern North Dakota, the BNSF also faced competition from Canadian Pacific Railroad which can carry grain to the Port of Vancouver, BC. To compete with these alternative routes, BNSF had to reduce the cost of eastern North Dakota to PNW grain movements so that it could lower its rates. To do this it streamlined and simplified its train operations, employing the rail rationalization strategy described above. In so doing, it resulted in rail rates to PNW ports from eastern North Dakota costing less than from western North Dakota. (In western North Dakota, there is no competing railroad and it is farther from Duluth and the Mississippi River, making these destinations cost prohibitive.) While this pricing strategy benefitted grain farmers in eastern North Dakota, it aggravated grain farmers in western North Dakota.

Source: Senate Committee on Commerce, Science, and Transportation, Field Hearing entitled *Rail Freight Transportation in North Dakota,* March 27, 2002, Bismarck, ND. S. Hrg. 107-1057.

Differential Pricing. The inverse rail rates described in the text box above are part of a more widespread railroad pricing concept commonly referred to as differential pricing. It is an important concept to consider when evaluating how

[17] Kimberly Vachal, *The Long-term Availability of Railroad Services for U.S. Agriculture,* 81st Annual Meeting of the Transportation Research Board, January 13-17, 2002, Washington, D.C.

[18] Transportation Research Board, *Freight Capacity for the 21st Century,* National Academy of Sciences, Washington, D.C., p. 19.

[19] U.S. Senate, Committee on Commerce, Science, and Transportation, *Rail Freight Transportation in North Dakota,* March 27, 2002.

inland waterway infrastructure improvements may affect grain producers with waterway access versus those without access. Through differential pricing, a rail network can act as a mechanism by which the competitive dynamics in one part of a railroad's service territory influence the rates charged to shippers located at other parts of the network. Differential pricing stems from the fact that railroads can charge a higher price to customers whose demand for service is relatively price inelastic, while charging less to customers who have other shipping options (i.e., their demand is relatively elastic). It means that rail shippers with the fewest alternatives (for instance, where truck or barge is not economically feasible) pay a higher portion of a railroad's fixed costs.

Differential pricing has a lot to do with how railroads pay for their infrastructure. Railroads primarily finance their infrastructure on their own, therefore, track maintenance and construction is a fixed cost. In contrast, trucks and barges finance their infrastructure through the payment of fuel taxes charged per gallon (in addition to taxes on equipment in the case of trucks) which are deposited into the federal highway trust fund. Thus, for trucks and barges, infrastructure is not a fixed cost but a variable cost. Their infrastructure costs vary in proportion to the amount of fuel they consume (which is generally in proportion to the amount of cargo they haul).

A New Logistics Pattern Utilizing Containers

Refrigerated Products. As discussed above, higher levels of domestic grain processing and off-farm livestock production are responsible for increases in domestic grain transport. While the export of bulk grain has remained flat in recent years, bulk grains are also used as inputs in more highly processed farm products that are exported. For instance, part of the growth in domestic demand for feed grains is due to increased Asian demand for livestock and poultry products.[20] Frozen or chilled animal products are exported in refrigerated containers. Despite the long overland hauls to seaports, a large share of frozen and especially chilled meat product exports are moved by truck rather than railroad because of the product's high value and high service requirements (in terms of transit time and temperature control).[21] To the extent this trend continues, one can view it as the replacement of bulk grain export movements by barge down the Mississippi River to Gulf ports with truck shipments of grain to domestic feed lots and a subsequent truck movement of containerized meat exports to West Coast ports. Per unit of weight, the containerized transport system is more expensive than the bulk system and therefore tends to attract higher value agricultural products.

Specialty Grain Varieties. Also, a small but growing quantity of grain is exported in containers. About one million tons per year, accounting for only about 1% of U.S. grain production, is exported in containers. However, a recent spike in dry bulk ocean freight rates, which have surged to their highest levels on record, has increased interest in utilizing containers for exporting grain. One study expects that

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[20] Chris Hurt and Lee Schrader, *Long-Term Structural Shifts in Grain, Oilseed, and Animal Industries in the United States*, USDA-AMS, November 2000.

[21] Chilled meat requires tighter temperature specifications than frozen meat.

containerized grain shipping will grow to about 3% of U.S. grain production over the next five years.[22] Although it is still a fledgling grain distribution channel, it is worthy of inclusion when reviewing grain flow patterns because it has important implications for infrastructure investment decisions.

Containerized grain exports follow a logistics pattern separate from traditional bulk grain exports. Bulk grain can be loaded into containers packaged in bags stacked on pallets or in raw bulk form using open top containers that have canvas tops and whose interiors are lined or have been sanitized. Utilizing containers, the grain producer can control the shipment from the farm to final overseas destination rather than merely from the farm to the first elevator. While grain exported in the bulk manner is treated by ocean carriers as a fronthaul move, containerized exports are treated as backhauls and are priced accordingly.[23] The persistent U.S. merchandise trade deficit manifests itself in container shipping as the problem of having to ship empty containers back overseas. To reduce the number of containers that have to be shipped back empty, ocean lines typically reduce their rates for export shipments. The rate differential between inbound and outbound shipments depends on the current trade imbalance in goods shipped in containers. Shipping lines may rate outbound shipments merely to recover the variable cost of shipping the container back rather than at a remunerative rate. Thus, U.S. producers of relatively lower valued products, which typically would not ship via containers, can take advantage of the containerized trade imbalance. However, even though outbound container rates are generally rated at a discount, it is still much less expensive to export grain by the traditional bulk method. Hence, the small portion of grain that is exported in containers tends to be higher-valued and specialized grain varieties,[24] which are purchased in smaller quantities, and must be kept separate (often referred to as "identity-preserved" grain) from the co-mingling of product that occurs with the elevator-based system. Also, the Class I railroad promotion of trainload-size shipments in the elevator-based system is incompatible with the shipping requirements of specialized grain markets, while the container-based system can facilitate this market.

Grain exported in containers follows a similar modal path as other containers originating from locations far inland. A truck will typically deliver the container to the nearest intermodal rail ramp from where it moves by intermodal train to a seaport. Ports in the Pacific Northwest are the leading gateways for containerized grain as Asia is the largest purchaser of these products.

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[22] Kimberly Vachal, Tamara VanWechel, Heidi Reichert, *U.S. Containerized Grain & Oilseed Exports Industry Survey, Phase I,* November 2001, prepared for the USDA.

[23] See for instance, Bill Mongelluzzo, "Backhaul Bonanza, U.S. Food Exporters Are Expanding Their Markets in Asia," *Journal of Commerce*, November 10-16, 2003, and "Container Drain," *Traffic World*, November 29, 2004, p.30.

[24] Examples of specialty grain products are low saturated fat soybeans, soybeans with altered carbohydrates that are more easily digested, organically produced grains, wheat with specific baking characteristics, corn with high protein content, and wheat that produces a creamy colored noodle.

Issues for Congress

As described in this report, the grain supply chain is a multifaceted system. Changes or developments with one component of the system will likely affect the ability of other components to perform efficiently. The complexity of the grain supply chain raises a number of issues for Congress as it evaluates pending investment decisions in surface and marine transportation infrastructure.

Mode-Specific versus Systems-Level Perspective

The process for making decisions on where to target investment in transport infrastructure is largely mode specific. Railway investment decisions could be characterized as primarily "market-driven." They are made in the private sector (by the railroads themselves), although some short line railroads may be either owned or subsidized by state departments of transportation. Road and waterway investment decisions could be characterized as primarily "policy-driven" as they are made in the public sector. State and local governments have primary responsibility for roadway investment decisions. Waterway infrastructure investment decisions are made at the federal level.

Given the seemingly disjointed and dispersed nature of this decision making process, an issue for Congress is whether to develop a coordinated infrastructure investment strategy that supports the needs of an increasingly interconnected grain-handling system. The benefit of a coordinated strategy is that it can lead to a grain distribution system that allocates grain to the mode or modal combination best suited to a particular shipment's service requirements, thereby reducing the nation's overall cost of shipping grain. Analyzing transportation investment from a supply chain perspective can lead to a more coordinated or integrated approach. However, an integrated strategy is difficult to develop because transportation is still largely administered and funded along modal lines. A GAO report on grain transportation states, "efforts to improve grain transportation tend to concentrate on individual transportation modes rather than on the transportation network as a whole," and that without "an integrated analysis that considers interrelationships between the various components of the grain transportation system... implementing wise policies is difficult."[25] Although this GAO report was written in 1981, its recommendation is no less relevant today. The high degree of intermodal functioning in today's grain supply chain essentially means that policy decisions affecting one mode affect all other modes. Any major capital project, even if mode-specific, is likely to affect the interrelationship among all the freight modes, as well as their grain customers. Optimizing an individual component of the grain handling system without considering the whole system could merely divert traffic from one route to another without appreciably improving the performance of the overall system.

Proposals for providing financial aid to short line railroads to upgrade their track illustrates the need for a systems-level perspective. For instance, the short line grant program prescribed in the Senate version of the highway bill in the 108th Congress

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[25] GAO, *U.S. Grain Transportation Network Needs System Perspective to Meet Future World Needs,* CED-81-59, April 8, 1981.

(S. 1072) requires the DOT to "ensure the award of a grant is justified by present and probable future demand for rail service by the railroad." Determining which short lines have a viable economic future largely depends on where the larger sub-terminal elevators are located. Where these larger elevators are located, in turn, is largely dependent on the routing decisions of the Class I railroads. The policy issue is whether financial aid to short line railroads can be successful in preserving their service in light of market pressures for large volume rail shipping methods and the greater flexibility that trucking offers grain producers.

Transportation Efficiency and Economic Development

In evaluating grain transportation investment choices, it is important to define whether the objective is economic efficiency or economic development. The supply chain perspective adopts economic efficiency as its primary criterion for evaluating investment choices. However, Members of Congress may also weigh local economic development as equally or more important than economic efficiency concerns when evaluating transportation funding choices. Promoting transportation efficiency on a national scale and promoting local or regional economic development are often not compatible. As exhibited in the bulk grain delivery system, there is an economic incentive for bulk grain shippers and carriers to pursue a high volume logistics strategy. This strategy consolidates grain handling operations around a limited infrastructure in order to maximize the use of their fixed and mobile assets. Rural towns and remote communities located near elevators or rail lines that have been abandoned or seen a reduction in business as a result of this process are negatively affected. Legislators concerned with the economic development of these regions have a desire to provide resources to these areas. However, consolidation in the grain delivery system means that some facilities will be abandoned and thus greater risk for public investment in these facilities or the infrastructure that provides links to these facilities. Some investment choices in the grain-handling network, therefore, involve a trade off between a national concern for transportation efficiency and a local concern for economic development.

Volume-chain and a Value-chain

As identified in this report, three grain supply chains can be distinguished: (1) export of bulk grain, (2) bulk grain for the domestic market, (3) and the export of containerized specialty grain products and containerized refrigerated meat products in which grain was used as feed. Each of these supply chains are tied to their own infrastructure network. The bulk export system relies most heavily on river navigation and Class I railroad trunk lines to reach seaports. The domestic bulk market relies more heavily on rural interstates or short line railroads to reach domestic processors and livestock farms. The container export system relies heavily on interstate highways, railroad trunk lines, and efficient intermodal interchanges at rail ramps and marine terminals.

An issue for policymakers is prioritizing limited public resources among these various supply chains. In one sense, the export supply chains involve a choice between a volume chain and a value chain. In terms of tonnage, the bulk export system dominates but in terms of value, the container export system gains more significance. By weight, only 15% of all U.S. agricultural product exports were shipped in containers in 2002, but by value, over 52% of all agricultural trade was shipped by this method.[26]

Grain producers with access to the UMR-IWW navigation system, particularly corn and soybean farmers that export much of their product via this system, advocate investment in lock extensions. They note that Brazil and Argentina are becoming increasingly competitive as global suppliers of grain because of their lower production costs. U.S. competitiveness in this market, they contend, is highly dependent on the superior efficiency of the U.S. inland transportation system. To compete in the global marketplace, these waterway shippers argue that it is vital that the lock system be upgraded to accommodate the prevalent use of 1,100 foot barge tows.

Other observers, noting the relatively low margins in the export of unprocessed, bulk grain, question whether "winning" this market does not in actuality mean losing. They assert that a wiser investment strategy would be to focus on the infrastructure segments that support the relatively higher margin food products market. These observers contend that the grain processing and food manufacturing industries generate more jobs and income for rural communities than does the exportation of unprocessed, bulk grain. Therefore, if economic development is the policy goal, they argue that investment in the infrastructure that supports the domestic or containerized export supply chains deserves careful consideration.[27]

Vehicle Size and Infrastructure Demands

Competitive forces push grain carriers to move more grain, move it faster, with less assets, and at a lower cost. This puts pressure on carriers to utilize larger vehicles. Railroads deploy longer trains using larger and heavier rail cars, barges utilize longer tows, and trucks maximize the size and weight of their trailers up to the legal limit. While increasing vehicle capacity improves operating efficiency and reduces freight rates charged by a particular mode, the cost savings may be merely shifted on to others resulting in no net benefit to society. For instance, heavier railcars require short line railroads to upgrade their track beds and bridges to handle the new cars. They, in turn, are seeking public aid from state and federal taxpayers to fund these upgrades. While longer barge tows reduce barge costs they also require lock extensions for efficient passage. Half the construction cost for new locks are paid for by general taxpayers. General taxpayers also pay all of the costs of maintaining the locks. Some trucking firms want to increase federal weight limits to 97,000 pounds which would reduce truck operating costs but would increase road maintenance costs for other motorists and local taxpayers as well as for truckers.

If the additional infrastructure costs of larger vehicle size are born by others, carriers can be expected to discount these costs when calculating the costs and

[26] Kimberly Vachal, Tamara VanWechel, Heidi Reichert, *U.S. Containerized Grain & Oilseed Exports Industry Survey,* July 2003, prepared for the USDA.

[27] See for instance, Bruce A. Babcock, "Processing or Exports: Which Path for U.S. Grain," *Iowa Ag Review,* Summer 2004.

benefits of deploying larger vehicles. In other words, to the extent that infrastructure costs are external to a carrier's cost analysis, their decisions regarding vehicle size will be biased in favor of larger vehicles. Thus, a potential issue for policymakers is whether infrastructure costs cannot be paid for by the carriers to a greater degree in order to more accurately reflect the additional costs of bigger vehicles.

Who Should Pay for Infrastructure Improvements?

The discussion above raises the issue of the appropriate cost share arrangement between general taxpayers and system users for infrastructure improvements. As mentioned earlier, Class I railroads primarily finance their infrastructure on their own. Trucks pay for their infrastructure through fuel taxes and other fees although a DOT cost allocation study suggests that the heaviest trucks tend to underpay (80% of the costs they generate on the highway system) while other highway users tend to overpay.[28] Barges also pay for their infrastructure via a fuel tax but a CBO study indicates that this user fee contributes only a small fraction of the total cost of their infrastructure.[29]

The continuing trend toward consolidation in the grain delivery system raises the issue of whether the system's users, who are increasingly fewer in number and larger in size, should not shoulder a greater share of the cost burden for their infrastructure use. In addition to an issue of fairness, the level and manner in which user fees are assessed affects system efficiency. Some transportation economists assert that the fuel-based tax system used to finance highway and waterway infrastructure could be refined to include congestion tolls and other fees which would be more closely tied to the time and place of infrastructure use. Alternative pricing mechanisms, they contend, could maximize the throughput of existing highway and waterway infrastructure, reducing the need to build additional infrastructure.

Assessing Competitive Balances

As described in this report, the grain-handling system encompasses many market dynamics. This report has focused on the competitive dynamics among transportation modes based on their operating characteristics. Among grain hauling modes, competition is most fierce between trucking and short line railroads for shorter haul shipments and between barges and Class I railroads for longer haul shipments. Of likely interest to transportation policymakers is the affect that infrastructure funding decisions could have on the competitive balance among modes. If the interrelationship among the various components of a supply chain are not examined or not quantified, policies may work at cross-purposes. For instance, increasing truck weight limits while at the same time providing financial assistance to short line railroads would be mutually inconsistent. Similarly, policymakers may consider the affect that the transition to larger railcars will have on future demand for

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[28] U.S. DOT, *Federal Highway Cost Allocation Study*, August 1997 with Addendum in May 2000.

[29] CBO, *Paying for Highways, Airways, and Waterways: How Can Users Be Charged?* May 1992, p 53.

barge transportation. Conversely, they may consider to what extent the heavy draw from general treasury funds to finance river navigation is encouraging the railroad rationalization process or if it could require offsetting financial aid to railroads in the near future.