Collective Action Regimes in Inland Marine Port Clusters: The Case of the Tenn-Tomm Waterway System

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This paper examines the innovativeness and competitiveness of the Tennessee-Tombigbee (Tenn-Tom) waterway using a cluster analysis approach. The focus of the case study is on the collective action regimes and local governance within which the cluster operates. In particular, inland marine innovations and collective action problems are examined. These include but are not limited to: system reliability, container-on-barge, funding, governance, hinterland access, knowledge networks and leader firms.

Key words: Economics, Institutes and Policy, Management and Planning

Introduction

The movement of freight on the inland waterway system is crucial for the U.S. economy, but the system faces serious problems and needs to innovate. The importance of the nation's rivers, canals, and lakes in carrying cargo is often overlooked. According to the Federal Highway Administration (2002), 19.3 billion tons of freight were moved by all modes. The inland waterways maintained by the U.S. Army Corps of Engineers (Corps) annually handles over 600 million tons of freight valued at over $70 billion (U.S. Army Corps of Engineers, 2000, 2007; Waterways Council Inc., 2009a). Barges directly serve 87% of all the nation's major cities, accounting for 14% of intercity freight ton-miles. Sixty percent of U.S. grain and 20% of the nation's coal, enough to produce 10% of all electricity used each year in the U.S., moves on the marine highway system (American Waterways Operators, 2009). The amount of freight being carried on the system has leveled off since the 1990s (see Figure 1), but there are several drivers that are likely to cause the system to see greater demand.

Drivers of Increased Inland Waterways Usage

Waterways are the only mode of transportation that have the capacity to handle large increases of freight movement. Furthermore, the system has enough excess capacity that it can handle the increase in domestic and international freight as well as ease increasing highway and railway congestion by carrying cargo that would otherwise travel via those modes. America's inland waterway system currently carries the equivalent of 58 million truck trips each year. Without this system, truck traffic on the Interstates would double or rail tonnage would increase by 25% (Kruse et. al., 2007). International freight movement is expected to double by 2020 to 6 million tons per day and domestic freight movement is expected to increase to 62 million tons per day (American Association of State Highway and Transportation Officials, 2007). With highways and railroads at or near full capacity, the waterways will be in more demand.

In addition to congestion leading to increased demand, rising fuel prices are likely to increase the interest in moving more freight by water due to its energy-efficiency and affordability. Its energy consumption per ton-mile of transported goods corresponds to one-sixth of the consumption by truck and to half that of rail transport (Inland Rivers Ports & Terminals Inc., 2009). One 15-barge river tow has the same capacity as 1,050 trucks and 216 rail cars pulled by six locomotives. As a result, barges can move one ton of freight 576 miles per gallon of fuel while a modern locomotive would move that same ton of freight 413 miles per gallon of fuel, and a truck would move it 155 miles (Kruse et al., 2007). That means barges have energy efficiency 3½ times that of trucks and provide a $10.67 per ton cost advantage (Waterborne Commerce Statistics Center, 2009). Waterborne transportation saves shippers and consumers more than $7 billion annually compared to alternate transportation modes (American Society of Civil Engineers, 2009). Related to the efficiency factors are the environmental and carbon foot print implications of moving freight by water instead of road or rail.

Inland waterway transport generates fewer emissions than rail or truck per ton-mile. The total external costs of inland navigation, in terms of accidents, congestion, noise emissions, air pollution and other environmental impacts, are significantly lower than those of road transport (Flemish Institution for Technological Research, 2004; Sudar, 2005). Inland waterway transport generates fewer emissions of particulate matter, hydrocarbons, carbon monoxide and nitrous oxide than rail or truck on a per ton mile moved basis. With environmental and global warming concerns increasing, there is more incentive than ever to move freight by water.

Congestion, fuel prices, and environmental concerns are expected to lead to increased usage, but funding rehabilitation and maintenance of the waterways is a serious challenge (Grier, 2004). The aging infrastructure and the lack of adequate public funding for the waterways are major difficulties. Over half of the 240 locks in the system are over fifty years old. The replacement value of the nation's lock and dam facilities has been estimated at more than $125 billion (U.S. Army Corps of Engineers, 2000). Assuming that no new locks are built by 2020, another 93 existing locks will be obsolete, rendering more than 8 out of every 10 locks now in service outdated (American Society of Civil Engineers, 2009). Many locks currently in use are too small for today's larger tows (Waterways Council Inc., 2008). They are susceptible to closures and long delays for repairs and are unable to deal effectively with lines and wait times that result from their obsolescence. In 2003 and 2004, several high-profile lock closures brought the problem to the public's attention (McKay, 2004).

Structural Problems with the US Inland Waterways System

With an expected average rehabilitation cost of $50 million per lock, the current U.S. Army Corps of Engineers budget of $200 million per year for lock repairs is woefully insufficient (Water Resources Coalition, 2009). Further exasperating the problem is that recent lock modernization projects have far exceeded their respective budgets and have taken much longer than projected to complete. Operation and maintenance (O&M) expenses for the inland waterway system average around $500 million annually and have remained flat for more than two decades allowing minimal funds for routine maintenance.

Prior to 1986, inland waterway infrastructure was almost entirely a federal general revenue expense. The Water Resources Development Act (WRDA) of 1986 fundamentally transformed the financing of the Corp's water projects, including its commercial navigation projects. The act created 20 cents per gallon tax on diesel fuel to underwrite the cost of modernizing locks and dams. As a result, the barge and towing industry annually pay $80 to $100 million per year into a trust fund (Wilken, 2008). A cost-sharing formula was established under which one-half of a lock reconstruction would be paid from the trust fund and the other half from general revenues. A surplus had been gathering in the Inland Waterways Trust Fund, from $200 million to $400 million from 1992 to 2002, but this has been spent (Mecklenborg, 2007). Other funding sources (e.g., a lockage tax) have been considered but failed to be enacted. The $403 million for modernizing inland waterway locks and dams in the American Recovery and Reinvestment Act (ARRA) should help, but it falls far short of the $1.5 billion that the Waterways

Council, Inc. (WCI) is seeking for lock-and-dam modernization projects (Waterways Council Inc., 2009b). At the current funding level, the inland waterway system moves 1.4 tons of freight per dollar (Vachal, Hough, & Griffin, 2005). This compared to 0.52 tons per dollar by truck. The Highway Trust Fund averages $35.8 billion a year. Of that, 62% is spent on public roads that carry the 11.5 billion tons of trucked freight (Siggerud, 2006). Clearly, more public funding is justifiable and necessary to keep the waterways running efficiently as the current funding system is antiquated and problematic.

Problems with the System Requiring Regional Innovation

Even if the funding issues can be addressed and the infrastructure modernized, the inland waterway system needs to innovate to meet the demands of today's global supply chain. The inland waterways have traditionally been used to carry bulk commodities including coal, grain, chemicals, petroleum products, iron, steel, and aggregates. It has also been a good option for moving cargo that is too large to transport over the nation's highways or rails. This "project cargo" includes freight such as NASA rocket boosters or parts for electric generating stations. However, global logistics demand the containerization of freight. Therefore, the greatest growth in freight tonnage and value is in containerized freight. The U.S. waterway system is ill equipped to handle containerized freight, and thus, cannot take full advantage of the global supply chain.

The intermodal movement of containerized cargo is the biggest trend in freight transportation. Global international trade is expected to double by 2020, but containerized freight is expected to nearly triple in the same time frame (American Association of State Highway and Transportation Officials (AASHTO), 2007). The international trade of twenty-foot equivalent units (TEUs), the standard size of a container, tripled in volume from 137 million TEUs to 387 million TEUs between 1995 and 2008, growing at an average annual rate of about 8 percent (U.S. Department of Transportation Research and Innovative Technology Administration Bureau of Transportation Statistics, 2009). Domestic cargo volumes are also expected to increase by 70% by 2020 with a similar increase in the usage of the standardized shipping container (U.S. Department of Transportation, 2002). If the U.S. inland waterway system expects to increase their role in the modern supply chain, they need to innovative and adopt container-on-barge (COB).

Container-on-barge is already a standard practice in Europe's modernized inland marine highway system. Inland navigation carries 12% of the freight in the European Union and grew 17% in the last 10 years (European Commission's Directorate-General for Energy and Transport Development, 2003). In some European regions, the 'modal share' in terms of ton-miles of inland waterway transport reaches over 40%. Europe began moving containerized freight on their extensive river system in the 1970s in conjunction with the transport of ocean freight in standardized boxes. Limited highway and freight rail infrastructure and supportive public policies (e.g., Europe provides environmental credits to the waterways for taking trucks off the road, which provides additional funding for maintenance and modernization), encouraged the development of COB, but perhaps even more important was the innovative nature of the participants in the European inland waterways system.

Besides COB, another area requiring innovation is the adoption of lean supply chain principals. The U.S. inland waterway system suffers from queues and congestion due to aging infrastructure, but also a lack of business commitment to reliability (Hanson Professional Services Inc, 2007, 2009). It will take innovations in operations to achieve timely and reliable delivery. Many industries (e.g., automotive assembly) have gone to just-in-time (JIT) operations and require freight to be delivered exactly when it is needed in the production process. Any delay in delivery will shut down production as the inventory is in transit. Inland navigation vessels operate at a relatively slow commercial speed, 5-10 miles per hour (mph) versus 10-20 mph for rail, and 20-30 mph for trucks, so barge transport is not practical for urgent goods e.g., perishables (ECMT, 2006). However, most freight used in JIT conditions is not urgent but it must arrive exactly when planned; reliability not speed is the crucial factor. With modern tow operations, using improved and well-maintained infrastructure, freight can be delivered reliably by inland waterways systems if the institutions involved are committed to process.

In order to meet the needs of today's global transportation system, the U.S. inland waterway system needs to adopt new practices and operate differently than it has in the past. The growth of freight tonnage, congestion on alternative modes, environmental concerns, and fuel costs all portend increased utilization of the nation's rivers, lakes, and canals for the movement of freight. There are national barriers (e.g., funding for modernization) that the entire system must address, but regional innovation can be achieved. Container-on-barge and highly reliable delivery are two innovations that require coordination at the regional level and are attainable goals.

Clusters and Innovation

The cluster concept is the most popular way to discuss regional innovation. According to cluster theory, business clusters form because co-located firms enjoy a wide range of economic advantages relative to firms that are geographically isolated from other firms in the same line of economic activity (Blair & Carroll, 2009). Despite some debate on nuanced terminology and how to operationalize clusters, researchers and practitioners alike generally accept Porter's (2000) description of clusters as "geographic concentrations of interconnected companies, specialized suppliers and service providers, firms in related industries, and associated institutions (e.g., universities, standard agencies, and trade associations) in particular fields that compete but also cooperate" (p. 15). The cluster concept is based on the recognition that firms and industries are interrelated in both direct and indirect ways. They each contribute to a region's "collective efficiency"— a combination of external economies and joint actions that explain the higher returns that accrue to firms that are spatially clustered (Krugman, 1991). The promotion of business clusters, with their attributes of dynamic local firms, productivity-enhancing spillovers, concentrations of allied and supporting firms, efficient labor markets, and business culture connectivity, is viewed as a means to stimulate local economic growth, increase employment, and raise income levels, but mostly importantly for this study, innovation.

Silicon Valley is the classical example where tech savvy people can switch jobs without changing parking spaces and networking socially allows cross fertilization of new ideas. Clustering facilitates the spread of specialized knowledge that is improved and developed by dissemination amongst experts. The co-location of a specific industry and it ancillary institutions and suppliers allows horizontal and vertical knowledge to flow among sage individuals and institutions. To put it briefly, having a group of smart people (and organizations) in a setting where they can share ideas and learn from each other on a particular topic leads to new and better ideas. However, not all clusters of firms are innovative. A prerequisite is to have quality physical infrastructure and good governance. The critical drivers of innovation vary from sector to sector, but availability of a well-qualified and specialized talent pool is essential.

Applying the Cluster Concept to Marine Highway Systems

The cluster concept has been applied to many industries, but there has been limited use of the concept as an approach to understanding freight movement systems. De Langen (2004) appears to be the exception. He used the approach to study the port clusters of Rotterdam and the Lower Mississippi. No research was found that specifically examined clusters of inland ports, but de Langen's findings on mixed ocean and river port networks should be instructive for the U.S. inland waterways system.

The first step in cluster analysis is to identify the organizations, public and private, involved with the economic activities of the ports. De Langen and Visser (2005) broke the component clusters into the activities of cargo handling, transport, logistics, manufacturing, and trade. The geographically concentrated interconnected organizations of the U.S. waterways system include the ports, towboats and barges, and shippers. The specialized suppliers and service providers include shipyards, tugs, freight forwarders, and consultants. Firms in related industries include railroads, truckers, and economic development organizations. Associations would include the U.S. Army Corps of Engineers, state waterways associations, and regional waterway development authorities. Taken together these organizations form the collective action regime that governs the inland waterways cluster.

De Langen and Visser (2005) identified five variables that influence the quality of the governance emanating from the collective action regime.

1. The presence of leader firms that desire to develop the cluster.
2. There needs to be collaborative involvement of public organizations.
3. An organizational structure that enables cooperation must exist.
4. There must be cluster consensus and a shared value system.
5. There needs to be openness or "voice" that allows input from all the components of the cluster.

These characteristics should allow the collective action regime to provide good governance which, along with the modernized physical infrastructure and specialized talent pool, is necessary for an innovative cluster.

Methodology

In order to apply cluster theory to the U.S. inland waterways system and to shed light on the local governance and collective action regimes necessary for innovativeness and ultimately competitiveness, a spatial proximate and linked part of the system was selected. The U.S. inland waterway system is comprised of connected navigation systems such as the McClellan-Kerr Arkansas, Black Warrior-Tombigbee (BWT), Columbia-Snake, Red River, Apalachicola-Chattahoochee-Flint (ACF), Arkansas, and the Tennessee-Tombigbee waterway. Each of these could be viewed as a cluster of spatially connected and interlinked companies and related organizations.

The Tennessee-Tombigbee (Tenn-Tom) waterway was selected due to data availability and its similarities to the other navigation systems that comprise the inland water network. The Tenn-Tom is a $2 billion two hundred thirty four mile navigable waterway that connects Tennessee and Tombigbee rivers. It was opened for commercial traffic in 1985 after a long political struggle. The manmade waterway connects 18 states and 14 river systems totaling some 4,500 miles of navigable waterways serving a large swath of southern and middle America. The Tombigbee River empties into the Gulf of Mexico at Mobile so the canal allowed water traffic to avoid travelling hundreds of miles north before turning south and reaching the Gulf of Mexico on the Mississippi river at New Orleans. It also allows the Port of Mobile, which recently added a $300 million dollar container port, greater access to the hinterland.

Commercial traffic has steadily grown each year since the waterway opened in 1985. The Tennessee-Tombigbee moves approximately 10 million tons of commerce each year at an annual savings of nearly $100 million in transportation costs (Tennessee-Tombigbee Waterway Development Authority, 2007). Principal commodities include forest products (44%), coal (27%), construction material (14%), chemicals (8%), and steel (5%). There is basically no COB on the Tenn-Tom (Hanson Professional Services Inc., 2007). Seventeen public ports and terminals are open to commercial traffic and more than 40 waterfront industrial sites offer river access. Major companies have located along the waterway include Boeing, Weyerhaeuser, and steel companies such as SeverStal, ThyssenKrupp, U.S. Steel, Dynasteel, and G&G Steel. A recent economic analysis study found that since 1996 the nation has realized a direct, indirect, and induced economic impact of nearly $43 billion due to the existence and usage of the Tenn-Tom (Edwards, Mixon, & Burton, 2009).

The Tennessee-Tombigbee Waterway Development Authority is the public agency that oversees the waterway. The authority's membership is limited to the governors of Alabama, Kentucky, Mississippi and Tennessee along with five gubernatorial appointees from each state. The authority created the Tennessee-Tombigbee Waterway Development

Council to provide a forum for the multitude of public and private interests in the cluster. The over 200 members of the non-profit organization represent commercial users in the operation and maintenance of the project and addresses research needs and technical matters that may impact its potential benefits. The council is the organizational structure that enables collaboration and the authority involves public organizations. Thus, the Tenn-Tom cluster has two of the five criteria quality governance: the involvement of public organizations and an organizational infrastructure.

Survey

De Langen (2004) created a survey that would, "identify which factors influence the performance of the Lower Mississippi Port Cluster and how" (p. 231). The survey allows the researchers to analyze the influence of both the structure and the governance on the performance of the cluster. The survey consisted of four sets of questions:

1. Questions to assess the embeddedness and linkages of the respondent's organization in the cluster.
2. Questions to find out the opinion of the respondents with regard to a number of propositions, derived from the theoretical framework. The experts are asked to indicate whether or not they agree with the propositions.
3. Questions to access the relative importance of the various variables of cluster performance. Apart from the validity of a variable, the survey questions address the issue of the importance of a variable, compared to the other variables.
4. Questions to compare the strengths and weaknesses of the case study port cluster with competing clusters. These results can be compared with reports and studies to cross check for consistency and to assess the quality of governance, compared to competing ports. This provides a basis for analyzing which governance arrangements are effective (p. 76-77).

The examination Lower Mississippi port cluster identified five important collective action problems including education infrastructure, marketing, innovation, internationalization, and hinterland access. The lack of leader firms, financing, organizational infrastructure, and co-operation were identified as factors limiting the ability of the cluster's collective action regime to address these problems particularly when compared to the port cluster in Rotterdam.

The survey used to examine the Lower Mississippi port cluster by de Langen (2004) was revised for this research in order to examine the Tennessee-Tombigbee port cluster (TTPC). The questions were inserted into an online survey tool, Survey Monkey, and distributed to 21 port directors and 70 tenants, shippers, operators, and affiliated businesses; of these, thirty-three responded to the survey instrument. After initially sending out the electronic survey, follow-up phone calls were made to encourage participation.

Findings

Most of the respondents agreed that internal competition adds to the performance of the port cluster (63.6%) and leads to vitality and vibrant competition (54.2%) but were relatively split on whether increased internal competition would lower costs. However, they did not believe that internal competition was stronger than external competition (17.4%). Indeed, no internal competition was reported most frequently regardless of market segment. All the sectors appear to lack extensive competition with container handling and pilotage being identified as sectors having the least internal competition (See Figure 2). The development of a more internal environment through the entrance of new organizations could improve the performance of the entire TTPC.

The essential ingredients for a cluster (e.g., specialized labor force, interrelated companies) appear to be in place, but some areas need improvement. When asked why firms would want to locate on the Tenn-Tom, all respondents agreed cluster related labor force (69.6%), customers and suppliers (91.7%), and knowledge (87%) were success factors for the TTPC. Congestion, wage levels and power of labor organizations were not concerns. Barriers to starting a new business in the Tenn-Tom cluster were thought to reduce the cluster's performance (75%). These barriers are caused by inaccessibility of knowledge and networks, and the unavailability of local capital. Interestingly, this lack of capital translates directly into a concern for the quality of the local governance (75%). The TTPC seems to have many successful cluster attributes such as efficient labor markets, concentrations of allied and supporting firms, and productivity-enhancing spillovers, but needs improvement in promoting dynamic local firms and business culture connectivity.

Opportunities for cooperation and innovation are thought to be higher the more diverse the cluster population. There was less certainty that the diversity of the cluster population would reduce the vulnerability of a cluster, whereas the diversity of the resource base would. Cooperation between firms in the TTPC was seen to be of more importance compared to cooperation with firms outside the cluster. When asked specifically about the respondents organization, most thought they were moderately diverse in their economic activities and firm size, but not in their international scope.

This lack of diversity is in part the perceived reason for the lack of development of the cluster (50.9%), but the lack of a culture of trust was seen as the biggest reason (90%). Trust was seen as important because it lowers transaction costs and enables cooperation. Leader firms were seen as important for increasing the quality of the governance of the cluster, as were intermediaries. However, there was no clear intermediary that was of the most importance. Ship's agents, forwarders, ship brokers, associations, commodity traders, and non asset-owning logistic service providers were all seen as relatively important but none as extremely important. However, "knowledge intermediaries" were seen as a source of influence on the port cluster.

These "knowledge intermediaries" are particularly important because practically all the respondents (95%) believe that accessibility of knowledge and information sources influence the performance of the port cluster. Most firms in the port cluster access knowledge and information through contacts with "knowledge intermediaries" located in the cluster. However, increased trust and improved networking is needed so the knowledge spreads throughout the cluster.

A number of important collective action problems were identified in the survey (See Figure 3). Problems are present with hinterland access being the greatest issue.

Hinterland access was considered important or very important by 95.5% of the respondents. Marketing and promotion (90%), and training and education (95.2%) were also considered important or very important. International opportunities and innovation were not consistently perceived as being very important.

Discussions of the Findings

The same collective action problems found with the Lower Mississippi port cluster including education and training, marketing and promotion, innovation, internationalization, and hinterland access were also identified in the Tenn-Tom cluster. The lack of leader firms, financing, organizational infrastructure, and co-operation were identified as factors limiting the ability of the cluster's collective action regime to address these problems, but the issues did not seem as severe as De Langen and Visser (2005) found facing the Lower Mississippi port cluster. Further, there are several indications that the TTPC is addressing in the process of addressing its collective action problems.

Five of the ports have come together to form a partnership, GrowPorts, to promote "green energy driven economic development and transportation through the development of a comprehensive, energy-efficient intermodal transportation network connecting the inland waterways of the Tennessee River with the international waterways through Mobile, Alabama" (Growports, 2009). COB and timely delivery are major goals of this new partnership. This organizational infrastructure has already improved cooperation including jointly seeking ARRA stimulus funding, but more competition and leader firms are still needed.

Internal competition contributes to the performance of port clusters since monopoly pricing is prevented, and it fosters specialization and innovation (de Langen, 2004, p. 136). The lack of internal competition, diversity and trust is hurting the Tenn-Tom cluster. Collective action problems that exist and need to be addressed include the lack of innovation (e.g., COB), marketing and promotion, and hinterland access. An example of how the hinterland access can be improved is through revitalization of the shortline railroads that service the Tenn-Tom including the Columbus and Greenville railroad line (Stich, Martin, Waide, & Eksioglu, 2007). Nevertheless, the availability of labor, customers and suppliers and the knowledge base of the cluster are strengths that the collective action regime can build upon.

Leader firms are "firms with both the ability and the incentives to make investments with positive external effects for other firms in the cluster" (de Langen, 2004, p. 194). The Tenn-Tom cluster will need to attract or develop leader firms that can contribute to the understanding of governance in the cluster. The analysis of the collective action problems show the difficulties that arise when leader firms and strong local governance is absent.

There are implications from the findings on the Tenn-Tom's collective action regime for the innovations of container-on-barge and system reliability needed to be part of lean production supply chains. There is extensive transportation knowledge in the cluster along with a skilled workforce, but the level of trust and knowledge information flow needs to be improved. Governance needs to be enhanced to allow for better coordination and the development of the shared vision required for COB and tightly scheduled deliveries. The need for this is evident considering the mixed perceived importance of the international opportunities created by containerization and innovation needed to make it happen. Addressing the shortcomings of the present collective action regime will enable the Tenn-Tom to become more innovative and competitive.

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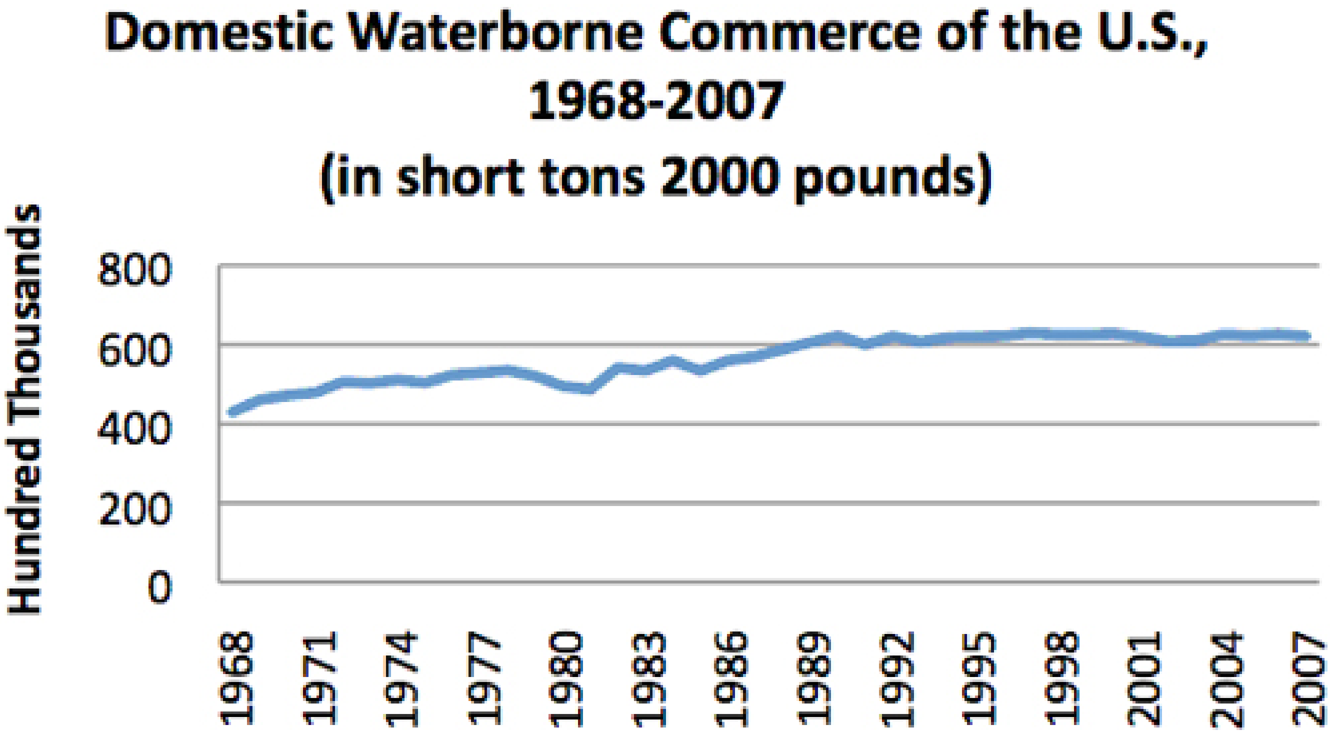

Figure 1 Freight Movement on the Inland Waterways System (Waterborne Commerce Statistics Center, 2009).

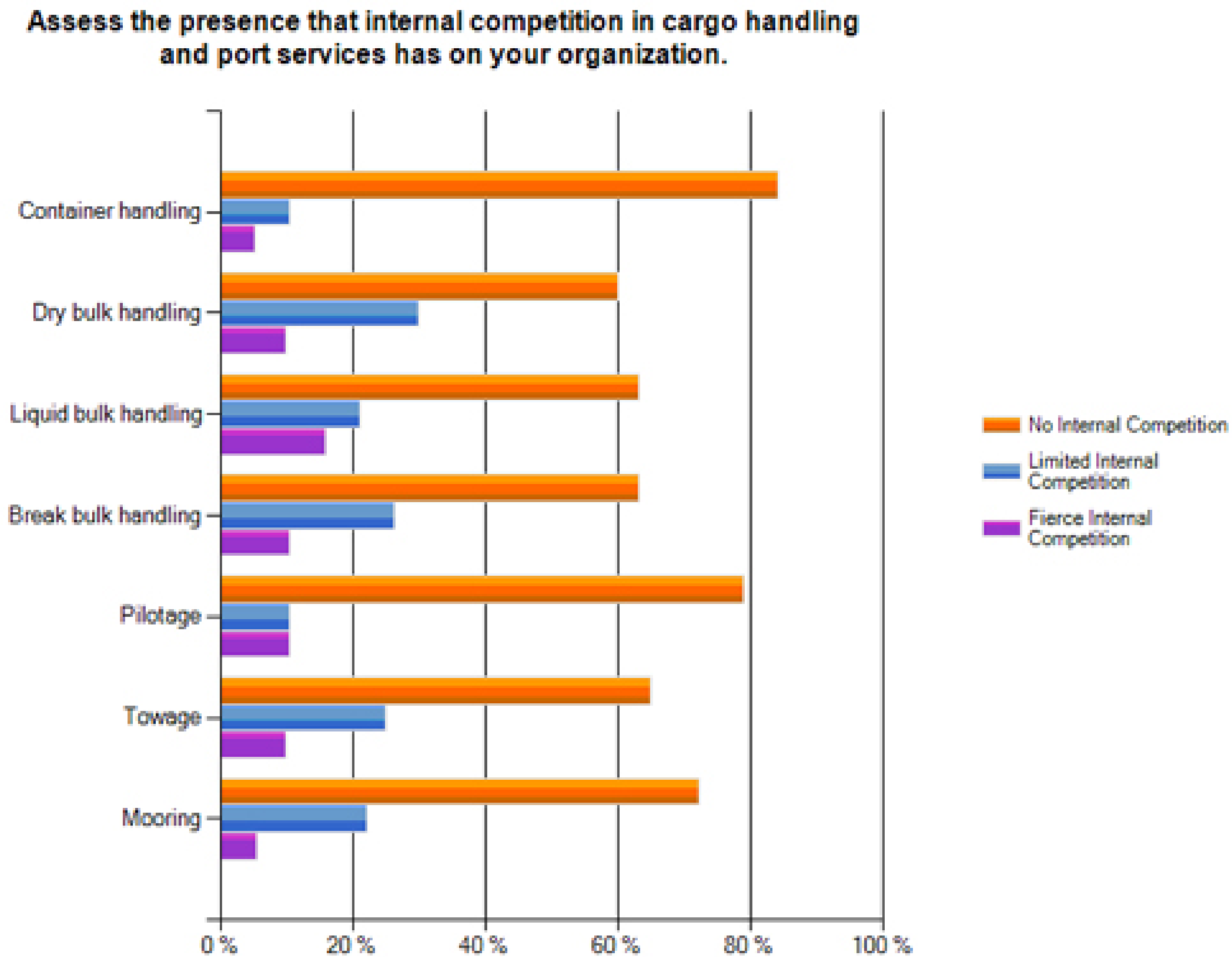

Figure 2. Presence of Internal Competition in the TTPC

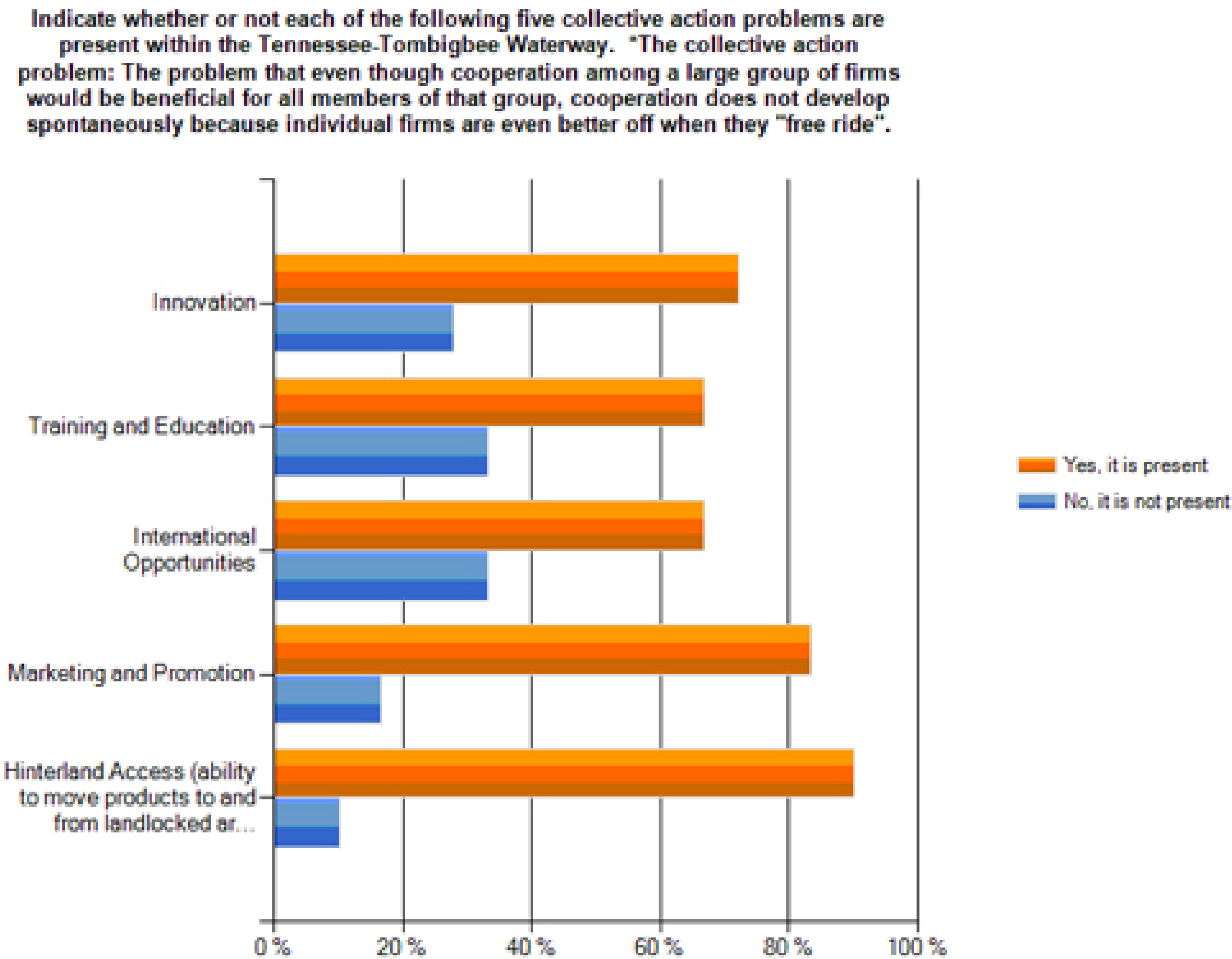

Figure 3. Collective Action Problems of the TTPC