

Drivers of Intermodal Rail Freight Growth in North America

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Intermodal rail freight service, in the form of semi-trailers and containers carried by rail in coordination with connecting road and water transport operators, emerged in North America on a few railways during the 1920s and 1930s. Experience gained from these early ventures inspired widespread introduction of intermodal service offerings after 1950. Between 1990 and 2005, rail intermodal traffic grew 87.7 percent, from 6.2 million to 11.7 containers and trailers, and now holds a significant position in the aggregate traffic base of the major North American rail freight carriers. Previous research and other sources of data and information are drawn upon to identify key drivers of this growth within the context of a conceptual model. The driving forces include changes in transport providers' business policies and practices, government deregulation of pricing and other commercial actions by firms in rail and competing modes of transport, advancements in rail intermodal technology, and changes in supply chain management processes by shippers and consignees that have intensified demand for freight service of higher quality and lower cost. Comments on transferability to Europe of lessons learned from intermodal business experience in North America are provided in the concluding section.

Keywords: intermodal rail freight development; freight transport management; government transport policy; North America

1. Introduction

Rail intermodal traffic in North America grew 88.7 percent, from 6.2 million containers and trailers in 1990 to 11.7 million in 2005 (AAR, 2006), and has become an important sector within the aggregate rail freight traffic base. This paper identifies and explains key drivers of the origin and rise of intermodal service within the continent. To do so, the paper first presents a conceptual framework set forth in section 2 below, and then discusses prime aspects of the components within the framework, utilizing information and data drawn from previous research and other sources. That discussion is followed by an exposition of the evolution of intermodal rail freight service from its pioneer era in the 1920s to the present day.

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Both the conceptual framework and its explanatory findings resulted from research performed as part of a European Commission (EC)-sponsored project named *REORIENT*.³ The EC-sponsored project focused on identification of conditions related to establishment of integrated, seamless cross-border intermodal railway freight service within a north-south corridor in eleven Central and Eastern European countries. The results reported in this paper were obtained for the purpose of identifying factors critical to the success of intermodal rail freight service that *could*, either fully or in part, be applicable within Europe and, in particular, the *REORIENT* corridor. Hence, the paper concludes with commentary on such applicability.

2. Conceptual framework – rail intermodal business drivers

Figure 1 portrays the framework of actors and events that this research identified as the basic interrelated drivers of growth in intermodal railway business volume in North America. The components are bracketed at top and bottom by two overarching influences on intermodal freight flows, i.e., globalization and changes in international trade flows, and developments in computer and communications technology. Before proceeding further, it must be acknowledged that the sequences and directions of interrelationships between each component of the framework are complex, and that the relative importance of each component and the linkages of causality between each (i.e., degree of impact on intermodal rail freight performance) cannot be quantified with precision.

Several studies on intermodal freight transport were basic to development of the conceptual framework. Taylor and Jackson (2000) discuss evolution of the U.S. intermodal rail freight industry from the perspective of marketing channel theory and provide a competitive framework of the rail intermodal industry based on Porter's five forces analysis. Shashikumar and Schatz (2000) identify the role of ocean carriers' actions after occurrence of U.S. transportation economic deregulation as being critical in developing international intermodal rail freight transport. They emphasize the importance of ocean shipping economic deregulation in the U.S. in providing ocean carriers with the bargaining power to negotiate with U.S. railroads to provide intermodal freight service. Evers and Johnson (2000) analyzed shippers' perceptions of rail intermodal service. Their conclusions were that the overall performance perceptions were driven by "shipper perceptions of communications, quality of customer service, consistent delivery, transit times, and competitive rates." In their essay on intermodal freight transportation, DeWitt and Clinger (2000) suggest that intermodal rail freight growth in the 2000s will be influenced by the increase in effective supply chain management practices on the part of freight shippers.

To obtain first-hand information about the importance of the factors that led to the growth of the U.S. intermodal industry, structured interviews and informal discussions were conducted with industry executives who had both longevity and breadth of experience in the U.S. intermodal rail freight industry from a career perspective. The conceptual framework was developed from a synthesis of these discussions as well as extensive review of pertinent literature ranging from research-based articles and reports to trade press articles. The industry personnel all had intermodal rail freight experience obtained from work in the intermodal business units of railway companies and in third-party intermodal firms, and as intermodal customers.

While it is difficult to quantitatively or empirically test the conceptual framework, the authors of this article evaluated it using additional qualitative research methodology. The conceptual framework was developed by means of a narrative examination of intermodal rail freight, which is presented below in Section 3. Narrative methods have been found useful for analyzing cross-

³ The authors' portion of the *REORIENT* project was administered by the Larson Pennsylvania Transportation Institute, College of Engineering, The Pennsylvania State University, University Park, PA, USA.

cultural organization research (Soin and Scheytt, 2006). Spicer (2008) discusses the history of ideas as a valid methodological approach in public administration research. Both methods are used in this analysis to help confirm the drivers and identify the changing business models of the North American intermodal rail freight industry.

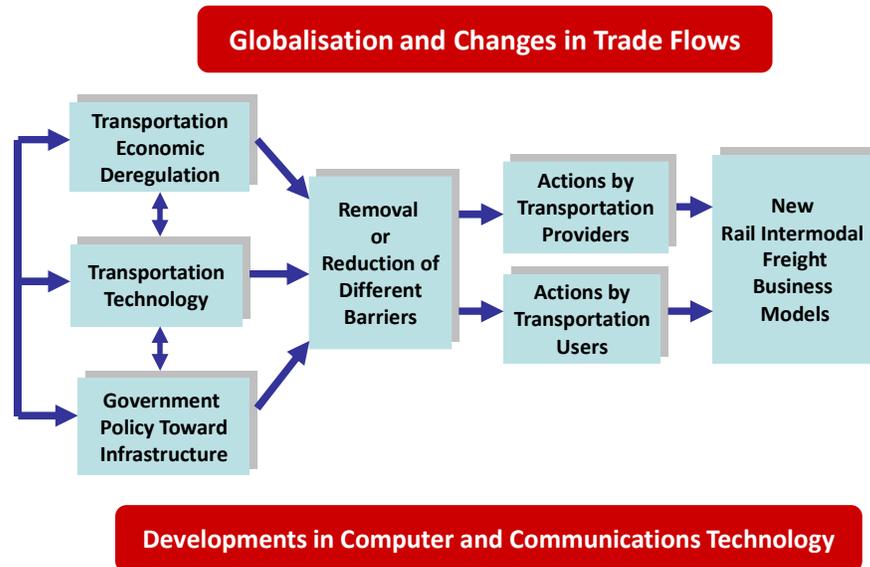


Figure 1. Conceptual Framework of Rail Intermodal Business Drivers.⁴

2.1 Government Policy Makers

Policy choices by government officials that impact most directly and significantly on the viability of intermodal rail freight traffic (and of all other types of rail service) include (1) funding of capital investment, maintenance and repair, and traffic control expenditures for urban and intercity roads and ocean ports; (2) specification of motor truck size and weight limits; (3) charging/taxation for road and port usage; (4) transport safety and national security regulation; and (5) economic regulation of rail and other modes of transport competitive with, and complementary to, rail. A comprehensive review of subject matter relating to each of these policy categories exceeds the ambit of this paper. However, actions and conditions with impact of most immediate relevance to the evolution and current state of intermodal rail freight business are expounded in the following paragraphs.

2.2 Road Infrastructure, Trucking, and Cross-Border Freight Flow Controls

During the second half of the 20th Century, U.S. federal government leadership of the financing, construction, and placement into service of the 46,508-mile National System of Interstate and Defense Highways, together with other major road improvement and expansion projects undertaken by state and local governments, enabled motor freight carriers to reduce their unit costs of operation and significantly improve their service quality (particularly, transit-time and service reliability). Truckers in Canada also benefited greatly from major road-building and

⁴ The conceptual framework presented here has been revised from the framework utilized in the *REORIENT* project. Alterations were made to increase clarity and focus. Readers interested in the original version can obtain it by contacting the authors or accessing the *REORIENT* Final Report at www.reorient.no, D6.2, Implications of New Management and Business Models for Rail Operators and IM Companies.

upgrading projects undertaken by national and provincial governments. In addition to increasing road capacity in terms of total mileage, these expansion and improvement initiatives provided advances in road and bridge load-bearing capacity, lane width, and other elements of road structure design and construction which enabled increases in permissible gross weights, axle weights, length limits, and vehicle combinations (e.g., multiple-trailer operation) for road freight vehicles.

The enhancement of competitive advantages made possible by such infrastructure advancements accelerated motor carriers' penetration of freight transport markets and placed rail freight carriers, operating on their own privately-financed (and taxed) infrastructure, under increasing economic siege after the 1950s (Ainsworth, 1975; Spsychalski, 1997b). Between 1960 and 1990, truck ton-miles in the United States went up 158 percent. Rail ton-miles also rose, but by a much more modest 85 percent. Measured in terms of value, trucking experienced even more dramatic growth within the same time frame. Expenditures for intercity road freight service jumped up by 803 percent, while spending on rail freight service grew by 237 percent (UGPTI and ENO, 2007). The rises in truck traffic and payments for trucking service did not come solely from capture of rail business. Rather, much of it came from new freight movements generated by national economic growth.

Most roads are shared-use facilities, accommodating significant volumes of traffic by different types of vehicles of widely varying sizes and weights. This situation poses the long-standing related issues of (1) assigning or allocating specific elements of road construction and maintenance costs to particular classes of vehicles, e.g., passenger automobiles, motor coaches, and light-, medium-, and heavy-weight trucks, and (2) whether operators of each class of vehicle are paying their 'fair' (or adequate) share of total road costs. It has long and often been contended that road user charges (primarily fuel taxes) paid by operators of heavy trucks do not fully cover the portion of road costs (excluding social costs) that they cause, as evidenced by data obtained from engineering-based studies. To the extent that it might exist, this 'deficit' will result in the underpricing of motor freight service vis-a-vis rail and hence, make possible diversion of freight shipments to truck that might otherwise move by rail. This implies that imposition of 'full cost-based' user charges on operators of heavy trucks would shift at least some truck traffic to rail. However, the extent to which such a shift would actually occur will depend on (1) the cross price elasticity of demand between truck and rail and the degree of fit between rail carriers' physical handling capabilities and service quality levels, and (2) shippers' and consignees' transport service quality requirements and physical access capabilities for sending and receiving shipments by rail vis-à-vis truck (Boyer, 1997; Wilson, 1980).

Since the 1990s, inbound cargo movements from overseas origins and cross-border freight movements within North America have experienced continuing growth. However, they have been subjected to cost increases and declines in service quality stemming from more stringent government efforts to control illegal immigration and importation of illicit narcotics. These negative impacts have been compounded since the tragic events of September 11, 2001 in the United States by implementation of security measures intended to prevent or at least reduce the probability of acts of terror. Actions proposed and taken to prevent the use of international ocean containers as instruments for acts of terrorism thus have become of particular current importance for both users and providers of intermodal rail service (Sarathy, 2006; Taylor et al., 2004; A fence, 2008).

2.3 *Economic Deregulation of Transport*

Economic regulation of transport, as administered historically in North America by quasi-independent commissions⁵, can be defined in summary terms as *government control of key elements of business behaviour by transport firms, on (1) matters internal to a particular transport firm; (2) relationships between transport firms and their customers; and (3) competitive and complementary relationships between transport firms.* As is indicated by the box entitled “Transport Economic Deregulation” in Figure 1, economic regulation no longer applies to intermodal rail freight traffic. Impacts which such regulation imposed during the time at which it did apply will be noted in following sections of the paper.

3. **Evolution of intermodal rail freight - drivers of changing business models**

The evolution of intermodal rail freight service can be examined within the conceptual context of a business model, or of a series of business models of different types. The term business model is very much related to business strategy. In simple terms, it is the firm’s “way of doing business” (Voelpel et al., 2004). Another way of describing a business model is “the combination of ‘who’, ‘what’, ‘when’, ‘why’, ‘where’, ‘how’, and ‘how much’ an organization employed to serve its customers, end users and other stakeholders (including but not limited to employees, partners, suppliers, distributors, lenders, shareholders and the communities affected by the organization’s activities)” (Mitchel and Coles, 2004).⁶ We now turn to an exposition of the ways in which the actors and events specified in Figure 1 have shaped the development, performance, and conduct (business models) of intermodal service through four distinct phases of its evolution.

3.1 *Pioneer Era - 1920s-1952*

Precursors of contemporary intermodal rail freight transport appeared in North America in the 19th Century. However, none grew into widespread use (McKenzie et al., 1989).

The dawn of substantive containerised intermodal service came in the early 1920s with its introduction on two different main line railroads. Both linked Chicago and St. Louis with the Atlantic Coast. They saw container operation as a tool for (1) reducing the terminal cross-dock handling costs, high loss and damage, and low rail equipment utilization that plagued their haulage of less-than-carload (LCL) shipments, and (2) meeting competition for such traffic from the inter-city trucking industry that had emerged after World War I and was expanding rapidly in consort with post-war government-funded construction of hard-surfaced inter-city roads. Both rail carriers ‘retailed’ the sale of containerized service to shippers, just as they did with conventional LCL and full carload service. The containers were small (e.g., 6 x 9 x 7.5 ft.) and had relatively high tare weight (e.g., 2,800 lbs.) to lading capacity (e.g., 6,000 lbs.) Nevertheless, the service grew rapidly for both railroads (Moulton, 1933).

However, realisation of the economic benefit of these pioneering container service ventures was soon blunted by federal regulatory actions taken by the Interstate Commerce Commission (ICC).⁷

⁵ Quasi-independent commissions empowered to regulate transport were established as agencies outside the executive, legislative, and judicial branches of state, provincial, and federal governments. It was the intent of the legislators who created such agencies to insulate them from undue short-term political pressures and to have them staffed with personnel possessing requisite specialised knowledge of regulatory methods and rail transport.

⁶ Other research offers more formal definitions (e.g., Schmid, et al., 2001; Hamel, 2000; and Viscio and Paternack, 1996).

⁷ Quasi-independent federal regulatory agency (see endnote 1 above) charged with administering economic regulation of rail transport between 1887 and its replacement by the Surface Transportation Board (STB) on 1 January 1996 (Spychalski, 1997a).

The two railroads had priced their container movements on the basis of weight and distance rather than the type and value of commodity or product carried. This deviation from the then-traditional and universal practice of value-of-product-based differential pricing of railway freight service was largely disallowed by the ICC, in an attempt to protect rail competitors of the two innovating carriers from loss of traffic and revenue⁸ (White, 1984, p. 32).

Despite this enterprise-dampening regulatory action, several other rail firms, less prominent in size than the two pioneering container operators, also instituted intermodal service between the mid-1920s and the late 1930s. Technologically, they utilized trailer-on-flat car (TOFC) rather than container-on-flat car (COFC) equipment. Most achieved commercial viability through the years following their introduction.

Viewed collectively, these pioneering TOFC services embodied several critical success factors. First was development and application of operational and economically feasible techniques for loading and unloading trailers from rail flat cars, and for securing the trailers to flat cars during rail movement. Second was an available supply of flat cars capable of being equipped for haulage of trailers at modest cost. Third was supply of the service at quality levels (speed and reliability) competitive with over-the-highway trucking. This entailed operation of intermodal service on fixed passenger train-like schedules.

Fourth was avoidance or minimisation of obstruction from economic regulation. In 1935, the U.S. Congress subjected interstate trucking to economic regulation by the ICC. This enabled rail firms to file joint motor-rail carrier rate and service tariffs with the ICC. Revenues obtained from traffic moved under the rates published in the tariff were shared between the railway and the participating trucking firm. The rates themselves embodied type-of-product-based differential pricing. By the late 1930s, at least one railway was also carrying trailers for shippers' 'own account' or private carriage trucking operations.

A sixth critical success factor was the existence of freight market conditions that made TOFC service a viable alternative to over-the-road trucking on the short-to-medium-distance routes (e.g., 250-600 miles) on which most of the pioneering TOFC services were operated. These conditions included (1) economic regulation of the trucking industry, which restricted entry of additional motor carriers into markets served by truckers who used rail intermodal service, and permitted collective pricing among competing motor carriers, and (2) highway operating conditions in the form of truck size and weight limits, motor truck and trailer technology, and road geometry characteristics which gave line-haul movement of trailers by TOFC an economic advantage over all-highway movements (Grant, 1984; DeBoer, 1992).

By the early 1950s, TOFC services of varying scope and scale were being operated on segments of a half-dozen main line railroads. Their apparent success drew increasing attention from other rail firms as a possible means for counteracting rising competition from trucking. The stage thus was set for wider adoption of intermodal (Morgan, 1960a).

3.2 *Toward Industry-Wide Adoption – 1953-1963*

In 1953, the Southern Pacific (SP), a then-dominant railroad in the western states, began piggyback service with a distinctive business model, i.e.:

- Operation of the service on an *intrastate* basis between San Francisco and Los Angeles, so that it would not be subject to ICC-administered economic regulation.

⁸ The ICC's protectionist stance was dictated by the law that specified its powers and duties. In 1920, that law was amended to require that the ICC administer regulation in such a way as to enable preservation of rail service (a) on financially weak segments of the U.S. rail network and (b) for commodity movements unable to bear fully remunerative charges. This required, inter alia, maintenance of a structure of railway freight rates that would enable cross-subsidization between different segments of the network, and between different groups of freight shippers (Locklin, 1966).

- No cooperation with competitive truckers. The SP bought and furnished trailers to its customers and published commodity-based value of service rates for the service.
- Pick-up and delivery of trailers from and to intermodal terminals by SP's wholly-owned trucking subsidiary, the Pacific Motor Trucking Company (PMT).
- Interstate service to Phoenix, Arizona, offered by means of PMT's existing over-the-road trucking route between Los Angeles and Phoenix.

SP's policy of acting as exclusive retail marketer and operator of the service caused truckers to request that the ICC prohibit it. However, intrastate operation of the rail portion of the service made the ICC powerless to act (Hofsommer, 1986; De Boer, 1992).

The truckers' futile protests of the SP's TOFC service raised several questions concerning the regulatory status of interstate intermodal rail freight. Fearing that further pursuit of these questions by truckers could result in regulatory actions detrimental to its established (15 years) successful intermodal service, the New Haven Railroad asked the ICC for resolution of the questions. Space limits preclude full coverage of them here.⁹ Suffice it to say that the ICC answered all of the New Haven's questions in ways supportive of continued development of rail intermodal service (I.C.C., 1954). The ICC's action quickly led the railway industry to establish uniform rules or plans for intermodal traffic. Many of the characteristics of these plans or business models (Figure 2) have carried down to present day intermodal rail business.

In 1954, aided by the ICC's favorable action, the number of piggyback service providers doubled when thirteen main line railroads¹⁰ joined the pioneers. Most significant among them from a business model perspective, and thus deserving of attention in some detail here, were the Pennsylvania (PRR) and the New York Central (NYC).

The PRR was then the largest railroad in North America by several measures, and exerted strong influence over rail industry business and technical policies. It began TOFC operation on a modest scale, utilizing flat cars with carrying capacity for a single truck trailer moved in conventional freight trains and marketed directly to shippers by its own sales personnel.

⁹ Among the most important, each answered in the affirmative, were whether a railway could (a) transport intermodal freight shipments without obtaining authority from the ICC to conduct interstate trucking operations; (b) transport trailers of private truckers; and (c) make joint rates with some motor common carriers and refuse to do so with others.

¹⁰ Atchison, Topeka & Santa Fe; Baltimore & Ohio; Chicago & North Western; Delaware, Lackawanna & Western; Erie; Great Northern; Kansas City Southern; Lehigh Valley; Missouri-Kansas-Texas; New York Central; New York, Chicago & St. Louis (Nickel Plate Road); Pennsylvania; and Wabash.

Plan 1

- Shipper deals directly with motor freight carrier, using motor carrier-provided trailer or container.
- Trailer or container carried by rail for line-haul movement between intermodal terminals.
- Motor freight carrier provides pick-up and delivery (drayage) of trailer or container.

Plan 2

- Shipper deals directly with rail carrier.
- Trailer or container provided by rail carrier.
- Pick-up and delivery (drayage) of trailer or container provided by rail carrier, either directly with rail-owned motor truck or through contract with drayage firm.

Plans 2 1/2, 2 1/4, 2 3/4

- All: Shipper deals directly with rail carrier.
- All: Rail carrier provides trailer or container.
- 2 1/2: Shipper responsible for pick-up and delivery of trailer or container to and from rail intermodal terminals.
- 2 1/4: Rail carrier provides trailer or container pick-up at origin; shipper responsible for delivery of trailer or container at destination.
- 2 3/4: Shipper responsible for movement of trailer or container to intermodal at origin; rail carrier provides road delivery of trailer or container at destination.

Plan 3

- Shipper* deals directly with rail carrier for line-haul movement of trailer or container.
- Shipper provides trailer or container and drayage thereof at origin and destination.

*In 1964, the ICC ruled that rail intermodal service under Plan 3 must be made available to for-hire motor carriers as well as private shippers (i.e., 'own-account' truckers).

Plan 4

- Shipper deals directly with a third-party, such as a freight forwarder or shippers' association (cooperative).
- Third-party entity provides trailer or container, rail car, and pick-up and delivery of trailer or container at origin and destination.
- Rail carrier provides only line-haul rail movement of rail car and trailer or container, and charges for movement of rail car and trailer and container, loaded or empty.

Plan 5

- Shipper deals with either rail or motor carrier for movement on joint rail-truck rates.
- Either rail or motor carrier provides trailer or container.
- Either rail or motor carrier provides pick-up and delivery of container or trailer.
- Rail carrier provides line-haul rail movement of trailer or container.

Figure 2. Intermodal Rail Freight Service Plans

Sources: I.C.C., *Movement of Highway Trailers by Rail*, docket No. 31375, decided July 30, 1954; Ex Parte No. 230, Substituted Service - Piggy-Back, 332 ICC 301, quoted in Locklin, 1966, pp. 870-871.

Soon after this modest start however, the PRR established TOFC service (branded as TrucTrain) between the New York metropolitan area and Chicago with scheduled trains dedicated exclusively to intermodal traffic. Dedicated train operation on fixed schedules between major high traffic volume-generating points provided service quality (transit time and reliability) competitive with then-extant over-the-road truck movements and made possible high utilization of rail rolling stock. This and other features of the PRR's initiative proved to be seminal for the future development of intermodal service, i.e.:

- Use of long-length (i.e., initially, 75 ft.) flat cars with capacity for two 35 ft.-long trailers, which were supplanting the shorter-length trailers (e.g., 24, 26, and 28 feet) of the pioneer intermodal era (Morgan, 1960b).
- Reduction of time and labor expense for transfer of trailers to and from flat cars by development and implementation of a robust simplified trailer hitch mechanism of standard design mounted on the deck of the rail car to replace the plethora of multi-part screw jack/chain and binder systems that had evolved from the 1920s and 30s for securing trailers for rail movement.
- Outsourcing of construction and operation of rail intermodal terminals for loading and unloading of trailers.
- Focus on the hauling of trailers for long-haul truckers for a fixed line-haul rail rate rather than largely on joint truck-rail rates based on the type of product carried.
- "Retailing" of the service by truckers, who controlled customer contact and the price (rate) charged to the shippers. Shippers were charged existing standard type-of-commodity-based motor carrier rates.
- Strong commitment to introduction and development of intermodal service by key senior executives. The PRR's successful TrucTrain service was championed by its chairman and vice president of operations. They counteracted opposition from the company's vice president of traffic (chief commercial officer) who viewed intermodal as a competitive threat to the company's traditional box car (wagon load) business (DeBoer, 1992).

Another distinctive business model element inspired by PRR officers that became instrumental in driving both the universal acceptance and long-run viability of intermodal service was the establishment in 1955 of a rail industry-captive firm (Trailer Train Company, subsequently renamed TTX Company), to (1) own and provide cars specially equipped for intermodal service, renting them to railways on a time-and-mileage basis; (2) promote development of interline as well as single-line intermodal traffic through equipment standardization; (3) maximize intermodal equipment utilisation on an industry-wide basis by means of a nation-wide car pool from which individual railways could more closely align their car supply with actual needs at different points in time; and (4) provide a centralized entity for procurement, financing, maintenance, distribution, and other aspects of intermodal rolling stock supply. Some railways still meet portions of their intermodal rolling stock needs through direct ownership, and some intermodal rolling stock is owned or controlled by intermodal rail service users. However TTX, whose share capital is owned by railway companies and their affiliates, is now the dominant provider of intermodal rolling stock in North America. (Ford, 1955; Morgan, 1960a; TTX, 2003; Derocher, 2004).

In 1958, the concept of operating dedicated intermodal trains on fixed, frequent, fast schedules between hubs (terminals) with business volumes sufficient to marshal trainload quantities of trailers and/or containers was emulated by the PRR's leading rail competitor, the New York Central (NYC). However, technological and managerial traits of the NYC's initiative differed markedly from those of the PRR.

Vertical clearance limits on the NYC's line between Chicago and New York and Boston prohibited TOFC operation. Thus, the NYC and a truck trailer manufacturer devised a container

system utilizing rail cars of skeletonized frame design capable of carrying two containers. The underframes of the containers, named "Flexi-Vans", were equipped to accommodate demountable rubber-tyred bogies for highway operation.

The skeletonized frame rail cars offered a reduction in tare weight in comparison with full deck flat cars. Also, use of containers rather than trailers for on-rail movement entailed less wind resistance and lower tare weight (because of the absence of highway bogies). At intermodal terminals, transfer of Flexi-Van containers to and from the skeletonized rail car required only a truck tractor.¹¹ These technological and operating characteristics yielded savings in both the capital and operating costs of intermodal service. Traffic grew quickly as soon as the new equipment was placed in service. By the early 1960s, the NYC was operating a fleet of high speed Flexi-Van intermodal trains. Unlike the PRR, NYC owned and operated its intermodal terminals. NYC personnel in charge of marketing and operating the fleet, many of them with experience in trucking, *exercised holistic control over Flexi-Van equipment utilisation and selling price, and measured profitability of the service on a route- or lane-specific basis, in the same manner as a well-managed motor freight carrier* (Morgan, 1960b; Shedd et al., 1960).

The just-described managerial powers and practices are italicized for emphasis because they represent essential conditions for achieving and maintaining business success in intermodal rail transport. However, while of seemingly obvious necessity, their application by other railways was less than universal during both early and later phases of intermodal service, as will be noted further below.

Although the NYC's business model for its Flexi-Van service was sound, its use of specially designed container equipment proved to be a barrier for substantial interchange of intermodal traffic with connecting railroads that used conventional TOFC equipment. Most resisted the NYC's attempts to persuade them to invest in Flexi-Van containers and related rail cars despite the cost savings offered by lower tare weight and wind resistance and relatively inexpensive transfer of containers between road and rail at terminals. This, together with changes in vertical clearance limits on its main lines, led the NYC to begin shifting its intermodal traffic to TOFC equipment in 1964.

The same fate befell simultaneous attempts by three other rail firms to use containers (albeit of different design from the Flexi-Van) rather than trailers. By the early 1960s, intermodal rolling stock and terminal operating processes for intermodal service on most railways had become overwhelmingly 'trailer centric'. Loading and unloading of trailers from flat cars at terminals was by the roll-on-roll-off or 'circus loading' method utilizing ramps placed at the ends of one or more tracks on which cuts or rakes of flat cars were placed. Hinged bridge plates at opposite corners on each flat car were lowered to enable a terminal truck tractor driver to move a trailer either backward or forward across the rake of flat cars. Skill and care were required, especially for backward moves; an error by a driver while backing across a long rake of flat cars could tip a trailer over the edge of the flat car. When loading of an outbound rake of flat cars was completed, workers had to manually raise the bridge plates on each car (DeBoer, 1992, p. 65).

3.3 Progress Amidst Rail Industry Crisis – 1964-1980

By 1964, rail intermodal traffic volume had grown to more than five times its level in 1955, and 225 railroads were participating in intermodal service and rate tariffs (Locklin, 1966). In response to this, the ICC in 1964 issued a set of formal rules for the conduct of rail intermodal business.

¹¹ The specially designed rail car contained two hydraulically-operated turntables. A Flexi-Van was loaded by backing it up to the rail car at a 90 degree angle until guide rails mounted on the rear of the Flexi-Van's underframe were aligned with one of the turntables. The driver then unlocked pins in the demountable bogie and backed the Flexi-Van off the bogie and on to the turntable. When the van was fully engaged on the turntable, it was pushed around until it paralleled the rail car and was then locked in place for rail movement.

The rules affirmed the legality of the aforementioned intermodal service plans (Figure 2) that the railway industry had formulated following the ICC's favorable responses in 1954 to questions posed by the New Haven Railroad. Also fortuitously for rail carriers, the ICC rejected a plea from the trucking industry to limit the range of intermodal pricing and service options that rail carriers would be permitted to offer (Ex Parte 230, 1964). The positive thrust of this regulatory action helped drive continuing growth of intermodal traffic. Between 1965 and 1980, total trailer and container traffic rose 83.75%, from 1,664.929 to 3,059.402 (AAR, 2006).

This growth marked one of the few successes during what became a financial crisis of unprecedented severity for the North American railway industry. Conditions became particularly acute in the U.S. Northeast and portions of the Midwest, where by 1972 a majority of the rail carriers were operating under protection of bankruptcy law (Spsychalski, 1997b). Detailed coverage of the crisis exceeds the ambit of this paper. Relevant here is the fact that growth of intermodal service amidst crisis conditions was enabled by a coalescence of (1) changes in human resources, intermodal technology and operations, and commercial practices; (2) projects for demonstration of new intermodal service concepts and technology instigated by the Federal Railroad Administration; and (3) proactive thrusts by incumbent and prospective rail intermodal service users.

On the human resource front, the efforts of progressive railway officers who had achieved success with intermodal initiatives despite internal opposition from less visionary and risk-averse colleagues during the 1950s were reinforced in the 1960s when several large railway companies initiated programs for recruitment of new management talent from universities and elsewhere (DeBoer, 1992). Working in tandem, the progressive incumbents and newcomers identified and took actions to improve the quality, efficiency, and profitability of intermodal service. These actions can be summarized as follows:

- Terminal consolidation and establishment of intermodal hubs: By the 1960s, intermodal terminals, mainly in the form of ramps for circus loading and unloading of trailers onto and off of flat cars, had grown to approximately 2,100 locations. Traffic at many of these ramps was low, often subject to seasonal fluctuation, and/or unbalanced (i.e., trailers loaded either inbound or outbound only). Such conditions made it impossible to serve such terminals at acceptable levels of cost and quality by stopping dedicated intermodal trains every 50 to 100 miles to pick up and/or set out as few as one car containing only one trailer, or by movement of intermodal shipments in conventional car load service trains. The remedy was closure of low-volume terminals and substitution of highway movements of trailers to and from higher volume terminals or hubs (Greenwood, 1999, p. 162).
- Terminal mechanisation: Circus loading and unloading of trailers onto and off of intermodal rail cars was replaced by side-lift and top-lift equipment capable of handling both containers and trailers. Lift-on-lift-off loading was speedier, safer and hence more productive than circus loading. The shift to it, made feasible by widespread acquisition of trailers with side/top-lift-compatible structural design standards, thus complemented the economic benefits of concentrating intermodal traffic at fewer relatively high-volume terminals (Roberts, 1967, 1969; Valentine, 1999).
- Demonstration projects: Historically, research and development for intermodal technology and operations and most other aspects of rail transport in the United States has been left to private sector entities (Gallamore, 1999). An exception was an initiative during the 1970s by the Federal Railroad Administration (FRA)¹² to establish projects for testing the technical and economic feasibility of operating intermodal rail freight service

¹² An agency within the U.S. Department of Transportation.

in shorter-distance (i.e., 200-450 miles) high-volume corridors with relatively frequent, short-length, low cost trains that would capture traffic from all-highway movement. FRA staff who progressed the initiative were largely the aforementioned 'new generation' railway managerial and analytical personnel who had been seconded to FRA service from their posts in the railway industry. Their initial challenge was finding officers within railway companies who favored collaboration with the FRA's initiative and who could overcome opposition to it by fellow officers.

Two projects were implemented. The first, branded as *Slingshot*, ran on a 280-mile-route between Chicago and East St. Louis, Illinois. *Slingshot* was inspired by efforts of FRA personnel but received no FRA funding. The second, *Sprint*, founded with FRA financial assistance, ran 421 miles between Chicago and St. Paul-Minneapolis, Minnesota. Both featured truck-competitive frequencies of between three and five trains per day. Special labour agreements were negotiated to permit operation of the relatively short-length trains with crews of reduced size (i.e., two or three persons rather than the then-common five) working over greater distances for a base day of pay. Another key feature was procurement of so-called 'anchor customers' (United Parcel Service (UPS) for *Slingshot*, and UPS and the U.S. Postal Service for *Sprint*) to provide guaranteed base loads of traffic and revenue.

Both *Slingshot* and *Sprint* continued for several years following completion of their test phases. For its operator, *Sprint* was a success, enabling capture of profitable traffic from all-highway movements. The FRA saw success in both projects. They provided empirical evidence of the results of new operating and marketing concepts, validated activity-based costing techniques, elicited cooperative responses from rail labor on adjustments in labor contracts essential to economic viability of the service, stimulated creativity within both the railway and railway equipment supplier industries, and inspired several other railways to begin operation of intermodal trains under special labor agreements (DeBoer, 1992).

- Proactive support and leadership from customers: The role of United Parcel Service as an anchor or base customer for *Slingshot* requires elaboration here. Although primarily a road transport operator, UPS began using intermodal rail service in 1969 to move trailer loads of parcel express shipments between hubs on lanes (links) in its network in which traffic volume and other conditions made intermodal use of greater economic value than over-the-road trucking. From that beginning, UPS has grown to become the railway industry's dominant customer for domestic (i.e., intra-North American) intermodal traffic. In some lanes, its volume has reached full trainload levels. In many others, the traffic and revenues that it brings to railways as the leading base customer have enabled operation of greater numbers of scheduled intermodal trains, the carrying capacity of which is 'filled out' with trailer and/or container shipments tendered by other intermodal users. Over the years, UPS has taken extraordinary actions to obtain the intermodal service quality that it needs - e.g., putting UPS supervisors in intermodal terminals to work with railway staff in the loading and unloading of UPS trailers and containers (Maisch, 1999).
- Rolling stock innovation - single-level low tare weight cars: By the early 1970s, the shift from circus loading to top-lift transfer of trailers in terminals had eliminated the need for full-deck intermodal rail cars. Simultaneously, growth in rail movement of ocean containers reawakened interest in the use of containers for domestic intermodal shipments. These developments together with a quest for improving the profitability of intermodal business inspired several railway equipment manufacturers and two rail carriers with large intermodal traffic volumes to design, build, and operate lightweight, lower center of gravity intermodal cars that were less expensive to build and operate, and (with some exceptions) could accommodate either trailers or containers. However,

industry-wide realization of the economic benefit of these rolling stock innovations was slow. TTX, by then the single largest owner of intermodal rolling stock, did not acquire post-prototype light weight stock until the 1980s. It wanted to protect its large investment in full-deck flat cars and thus limited technological change to increases in car length and other relatively modest refinements (DeBoer, 1992).

- Rolling stock innovation – double-stack: The post-1956 ‘container revolution’ in ocean transport resulted in growing use of rail intermodal service by ocean carriers. This evolved into three categories: (1) Landbridge service, for movement of containers between the Far East and Europe using trans-Pacific and trans-Atlantic water transport combined with rail intermodal service across North America in lieu of all-water service; (2) Minibrige service, involving substitution of joint water-rail movements for all-water movements to and from U.S. port locations (e.g., transfer of a container from water to rail at a Pacific Coast port for movement to a city on the Gulf Coast or Atlantic Coast in lieu of an all-water movement via the Panama Canal); and (3) Microbridge service, for movement of ocean containers between a port and an interior city.

An early major rail participant in such ‘ex-ocean’ container traffic was the Southern Pacific. During the 1960s, the SP’s research and development department, with support from a senior executive, began a search for ways to reduce the costs and increase the profitability of carrying ocean containers. A seminal result of this effort by 1970 was a design for an articulated double-stack container car. However, the senior executive who had championed the effort left the SP before a prototype of the design could be built.

The design thus lay dormant until a rail carrier encountered severe capacity constraints in the movement of ex-ocean container traffic for Sea-Land Service. This sent a Sea-Land executive with rail experience on an urgent search for a solution. His efforts culminated in collaboration between Sea-Land, SP, and a freight car manufacturer to refine and bring to fruition the concepts for double-stack equipment that had been devised earlier by SP’s research staff. Double-stacking of containers approximately doubled the container carrying capacity of both dedicated intermodal trains and the track required for train movements. Test operations of new double-stack equipment validated its economic value and set the stage for the post-1980 double-stack revolution, to be given attention below (Ingram, 1999 and 2006).

3.4 *Post-Economic Deregulation – 1980-Present*

The financial crisis that threatened collapse of rail service in the U.S. Northeast and parts of the Midwest during the 1970s sparked enactment of legislation in 1976 and 1980¹³ which greatly reduced the comprehensive range of federal economic regulation that had been imposed on the U.S. railway industry onward from 1887. Of major significance for the future of intermodal traffic were provisions in the legislation that empowered the ICC to exempt from economic regulation specific categories of traffic for which competition between rail and other modes had become sufficient to prevent or minimize monopoly abuse of freight service users. Intermodal service, given its high degree of competitiveness with over-the-road trucking, thus stood as a prime candidate for early application of the new exemption power. Regulation of pricing and service offerings for domestic intermodal rail traffic was eliminated by the ICC in 1998, and international intermodal rail traffic in 1981. (Spsychalski, 2002; De Boer, 1992).

Unlike in the U.S., economic regulation of intermodal rail transport in Canada has been minimal. Canadian railway companies’ intermodal services have, from their inception, been shaped largely by market forces (National, etc., 1993; Purdy, 1972).

¹³ The Railroad Revitalization and Regulatory Reform Act of 1976, and the Staggers Rail Act of 1980.

Having gained complete commercial freedom for conducting intermodal business, rail service providers developed and implemented aggressive and innovative business strategies during the 1980s to more effectively compete for intermodal freight. They achieved stunning success. Between 1980 and 1990, the total number of trailers and containers carried by U.S. main line railways doubled from 3,1 million to 6,2 million (AAR, 2006). Improved business practices were prominent drivers of this success. They included efforts to (1) more accurately measure intermodal operating costs and profitability, and (2) identify and implement methods for more effectively meeting customer service requirements while simultaneously reducing TOFC/ COFC unit costs (Greenwood, 1999).

The need for advancements in intermodal rail service quality coupled with achievement of greater efficiency in providing it was intensified by two U.S. federal government policy actions concerning trucking. The first, in 1980, was passage of legislation¹⁴ that almost completely eliminated economic regulation of interstate motor freight transport. The second, in 1982, was enactment of legislation¹⁵ which increased truck size and weight limits. Shorn of economic regulation and the relative rigidity that it had imposed on their pricing and on the points that they could serve, motor freight carriers immediately began to compete aggressively on the basis of price against both one another and against railways. Rate-cutting was particularly deep for full truckload-sized shipments, the category of traffic most susceptible for diversion from both intermodal rail freight service and rail car load service. Numerous trucking firms ultimately failed in this competitive environment, as their total revenues fell below total costs for prolonged periods of time. However, surviving firms benefited from the increases in over-the-road operating efficiency and revenue productivity that were made possible by the increases in truck size and weight limits (Belzer, 2000).

Despite this government policy-enabled increase in competitive pressure from over-the-road trucking, U.S. intermodal rail traffic grew 36.7% during the first half of the 1980s (AAR, 2006). Actions contributing to this result included reductions in trailer and container transit time and increases in service reliability in the form of on-time delivery of trailers and containers. These service quality improvements were achieved by giving intermodal trains priority over those carrying other types of traffic, by (on some railways) raising maximum speed for dedicated intermodal trains to 70 mph. where permitted by track conditions, topography, and weather, and by rigorous adherence to schedules for operation of intermodal trains. In addition, the complete flexibility over pricing provided by deregulation enabled rapid responsiveness to new business opportunities, and vigorous use of demand-oriented differential pricing to optimize revenue generation and capacity utilization in the operation of scheduled, dedicated, semi-fixed consist intermodal trains. With differential pricing, trailers and containers priced to yield the highest profit margins were given first priority in the filling of available train capacity, followed seriatim by acceptance of traffic with successively higher levels of price sensitivity (Ingram, 2006; Schmitter, 2007).

Other dominant drivers of intermodal rail traffic growth, efficiency and service quality during the 1980s included (1) the start of explosive growth in imports of products from Pacific Rim countries, and (2) rapid transition of the double-stack container car from its test phase at the end of the 1970s to a type of equipment with proven operational and economic advantages over other types of intermodal rolling stock. The large increases in international shipments strengthened ocean carriers' ability to tender full-trainload quantities of containers and, simultaneously, strengthened their negotiating power for rates and service with rail carriers. This set in motion a chain of events in which several ocean carriers, building on the pioneering effort by Sea-Land noted previously, took lead roles in inducing acquisition and operation of double-stack cars in fleet-sized quantities.

¹⁴ Motor Carrier Act of 1980.

¹⁵ Surface Transportation Assistance Act of 1982.

At the forefront was American President Lines (APL), a then-leading container ship operator in Pacific trade lanes. APL viewed the cost savings of double-stack over conventional single-level COFC/TOFC cars (estimated at between 20 and 25%, including line-haul, terminal, drayage, and other cost factors) as providing it with an economically effective means for keeping its use of Landbridge and Minibridge services competitive with all-water service that two of its rival ocean carrier were proposing to operate with new low-cost jumbo containerships. APL's business plan embodied operation of dedicated high-capacity trains with APL-owned double-stack cars, and rigorous round-trip management of the equipment, including marketing efforts to obtain domestic shipments for utilization of west-bound backhaul movements of containers and double-stack cars. By 1986, APL together with several other ocean carriers had succeeded in putting into place a proprietary double-stack intermodal service network of about 35 'stack trains' (Down and Wise, 1986).

Double-stacking yielded greater efficiency in the form of both line-haul cost savings (e.g., 30-40% lower per container, vis-à-vis single-level loading) from greater economies of scale in train operation, and greater economies of density in track capacity utilisation. It also enhanced an important element of service quality: use of articulated multiple-unit double-stack cars revealed that their design characteristics virtually eliminated damage to lading from the slack action inherent in train operation and from the vertical shock sometimes experienced with 89-ft flat cars. Articulated single-level multi-platform spine cars capable of carrying either containers or trailers offered similar ride quality advantages. These features made containers increasingly attractive vis-à-vis trailers for intra-North American intermodal shipments, despite the need for acquiring, maintaining, and coordinating the chassis required for trucking of containers to and from intermodal terminals. Between 1990 and 2005, intermodal shipments moved annually in containers rose from about 6.2 million to 2.9 million (AAR, 2006).

As noted earlier, for-hire truckers have been users of intermodal rail service ever since its pioneer era. However, aside from the previously-mentioned extraordinary initiative of United Parcel Service, intermodal service did not begin to win acceptance as a preferred line-haul movement alternative for relatively large portions of the traffic bases of trucking companies until about 1990, when J. B. Hunt Transport Services and Schneider National Corporation, two of the largest long-haul truckload (TL) motor carriers, began shifting their trailer traffic in high-volume lanes to rail. Both companies subsequently converted much of their fleet equipment from trailers to domestic containers, which have grown to lengths (e.g., 48- and 53-ft), widths (8.5 ft.) and heights (9.5 ft.) that match the dimensions of contemporary standard long-haul trailers (Muller, 1999). Since 2000, the combined effects of sharp rises in diesel fuel prices, high turnover in drivers, and increased road congestion have driven numerous other trucking companies to follow the lead of Hunt and Schneider in committing long-distance line-haul movements to rail (Gallagher, 2008; Boyd, 2008).

Other important recent events and evolving conditions critical to intermodal rail traffic growth include:

- Continuous improvements in information technology and in the timeliness and accuracy of information needed for effective management of intermodal service by providers and users.
- Reduced time and increased reliability for interchange of intermodal traffic between connecting rail operators.
- Major capital investments in infrastructure to increase capacity and improve the flow of intermodal traffic, e.g., additional main line track; large-scale intermodal terminals; and enlargement of overhead clearances in tunnels and at bridges to allow operation of double-stack equipment. (Consolidated Rail Corporation, 1995; Norfolk Southern, 2006; Lustig, 2002; Burlington Northern Santa Fe, 2007; Kansas City Southern, 2005).

Intermodal traffic and revenues have become major components (20-30%) of the revenue bases of North American railways (see, e.g., Canadian Pacific, 2007, and Burlington Northern Santa Fe,

2007). Since the 1990s, intermodal service has also come to be seen as generating adequate levels of profitability in relation to the assets required for its supply. A key driver of this achievement has been growth in rail pricing power, as freight transport users' perceived value of intermodal service vis-à-vis all-truck service has risen (Frailey, 2004).

4. Conclusion: selected comments – North America and Europe

Having explicated key drivers of intermodal rail freight growth in North America, we conclude with selected comments on their relevance and applicability to intermodal rail freight in Europe. The word relevance as used here refers to a driver of growth that has proven effective in North America and thus deserves to be considered for application in Europe. Applicability refers to the extent to whether a driver can function under technical, business process, cultural, and political conditions distinctive to Europe.

A business model for North American rail operators of intermodal service that has proven most essential for business success includes (a) running trains dedicated exclusively or primarily to intermodal traffic on fixed schedules between major high traffic-generating terminals; (b) consistent on-time train operation; (c) pricing methods designed to yield acceptable gross and net levels of intermodal revenue; (d) route- or corridor-specific measurement of intermodal financial performance; (e) holistic managerial control encompassing all operational and commercial actions; and (f) technology for timely provision of information, both internally and to customers.

This model is, in principle, of equal relevance in both North America and Europe. Fulfillment of freight shippers' logistics and supply chain management needs requires that the quality and price of intermodal rail service be strongly competitive with that of all-road trucking service. However, full applicability of the model to intra-European international intermodal service is presently inhibited by barriers to timely and cost-effective cross-border freight train operation. The barriers, ranging from technical and economic to behavioural and socio-political, impose a competitive handicap on rail freight transport, since trucks cross borders within the EU without comparable delays. Solutions to technical barriers, albeit sometimes costly, are readily available – e.g., multi-current electric locomotives equipped and certified for operation on two or more national rail infrastructures. Changes in mindsets essential for rendering intermodal service are, however, more challenging and time-consuming to achieve. Prescriptions for diminishing these barriers exceed the ambit of this paper. Suffice it to say here that the need for their timely diminution appears urgent if Europe is to obtain more fully the benefits that greater use of intermodal rail freight transport can provide (Ghijssen et al., 2007; *REORIENT*, 2007).

An intermodal service quality impediment of much greater significance in Europe than in North America is scarcity of track time slots for freight train movements. Except in the U.S. Northeast Corridor and a few other locations, U.S. and Canadian rail systems are predominantly freight-oriented, and service quality-sensitive intermodal trains typically receive priority over other types of freight trains. In Europe, passenger traffic density constrains rail operators' ability to fulfill shippers' time requirements for freight movements.

The present-day business model for most North American intermodal traffic focuses on long hauls (e.g., 600-2,500 miles) and features operation of high-horsepower locomotives drawing long trains often exceeding 100 cars and carrying (with double-stacked containers) upwards of 200 or more containers. Such operation yields significant economies of scale at the train operating unit level, and economies of density in use of track capacity. Productivity increases provided by these business model characteristics have contributed greatly to improvements in the profitability of intermodal service. Also, they have enabled U.S. and Canadian railways to more effectively accommodate the upsurge in international container traffic that has ensued from globalisation and the shift of much manufacturing to Asia and elsewhere.

European intermodal rail freight operators have also gained from technological advances in equipment and growth in international container traffic. However, their attainment of economies of scale in train operation approaching those prevalent in North America is made impossible by well-known infrastructure barriers such as loading gauge constraints (e.g., vertical clearance limits imposed by overpasses, tunnels, and catenary on electrified lines that bar double-stacking of containers), freight car axle weight limits, and signal (traffic control) systems designed for movement of trains at higher speeds and shorter lengths than are common in North America (Reorient, 2007). Nevertheless, the existence of these particular barriers is not as undesirable as it might seem. Lengths-of-haul in existing and prospective European intermodal rail freight transport markets are, in most instances, at what are considered short-to-medium distances in North America. Experience with operation of intermodal service within such distances in the U.S. (e.g., the *Sprint* and *Slingshot* demonstrations discussed above in section 3.3) indicates that its achievement of commercial success requires operation of relatively short, frequent, and fast trains. Train length and frequency are the most critical success factors in short-haul markets because of the time required for (a) draying (trucking) intermodal containers and trailers between shippers' and consignees' premises and rail intermodal terminals; (b) transferring containers between road and rail car; (c) marshaling enough trailers and/or containers to load a train of acceptable revenue-generating size, and (d) – after steps a, b, and c are accomplished – offering a shipper-to-consignee service at least equivalent in value to competing over-the-road trucking service.

The just-discussed sub-topic marks an appropriate point at which to conclude. The comparative strengths and weaknesses of alternative business model characteristics for achieving success with intermodal rail freight service will undoubtedly always be open to debate. Of arguably greatest current importance in both Europe and North America is the minimum rail-haul distance within which economically viable intermodal service can be provided. In Europe, it is of importance because of the existence of relatively few markets with lengths considered long-haul in North America. In North America, most intermodal operators have achieved economic success by focusing largely on long-haul traffic. However, the greatest growth in North American intercity freight traffic has been in short-to-intermediate distance markets. Rail operators' disinterest in seeking ways to capture at least a portion of the growth in these markets has left truckers capture it. The rationale for this disinterest appears to be deserving of scrutiny, given the environmental, energy-saving, and road congestion-reducing advantages of rail vs. truck freight movement.

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