Journal of Transportation Management

Volume 10 | Issue 1 Article 4

4-1-1998

Some propositions regarding rail-truck intermodal: an empirical analysis

Paul R. Murphy
John Carroll University

James M. Daley
John Carroll University

SOME PROPOSITIONS REGARDING RAIL-TRUCK INTERMODAL: AN EMPIRICAL ANALYSIS

Paul R. Murphy
John Carroll University

James M. Daley
John Carroll University

Using data compiled from a recent of businesses located in a major metropolitan area, the present paper evaluates a series of propositions concerning rail-truck intermodal. In general, the study results tend to support the various propositions, and key findings suggest that users and nonusers of intermodal transportation have different perceptions about the quality of, and barriers to, intermodal service.

Intermodal transportation may be one of the most misunderstood concepts (Jennings and Holcomb, 1996) in the logistics discipline. In some instances, intermodal is not even defined, resulting in an assumption that there is an implicit knowledge about what is meant by intermodal. Alternatively, there are myriad definitions of intermodal, such as (Coyle, Bardi, and Novack 1994) "...the use of two or more modes of transportation in moving a shipment from origin to destination."

Indeed, there are so many definitions of intermodal (Jennings and Holcomb, 1996) "...that researchers, government bodies, and practitioners may wind up spending more time arguing over its definition than implementing its ideas." For purposes of this paper, intermodal transportation will refer to (Jennings and Holcomb, 1996) "...a container or other device which can be transferred from one vehicle or mode to another without the contents of said device being reloaded or disturbed."

While intermodal transportation has registered impressive growth during the past two decades, there has been relatively little academic research dealing with intermodalism. In fact, a review of two key logistics journals, **Transportation Journal** and the **Journal of Business Logistics**, reveals a total of three empirical studies on intermodalism in the five year time period from 1993 to 1997. These articles are summarized below.

Jennings and Holcomb (1996) used interview-type case studies to learn about

noncontainerized intermodal (transload) movements by mode and by commodity. Transload activities tend to involve large volume or large-sized commodities; shippers, rather than carriers, are the initiating party for transload movements. Transload shippers cited a variety of reasons (e.g., service abandonment, location) for being involved in transloading activities.

Johnston and Marshall (1993) looked at shipper perceptions about intermodal equipment in six categories such as cubic capacity, ease of loading and unloading, and cleanliness. They found that various types of intermodal equipment have different strengths and weaknesses. For example, TOFC (trailer-on-flatcars) trailers are perceived to be strong in cubic capacity, but weak in cleanliness; RoadRailers are strong in cleanliness, but weak in capacity.

Harper and Evers (1993) investigated competitive issues in intermodal rail-truck (IRT) service among manufacturers in the state of Minnesota. Their research suggested that IRT service was not available to many potential customers, that larger firms tend to use IRT, and that shippers do not have a very good perception of IRT. In particular, shippers emphasized the seriousness of poor IRT transit times.

THE PRESENT STUDY

The Harper and Evers research is particularly valuable because a portion of it looked at the perspectives of both users and nonusers of IRT services with respect to select intermodal issues. Their findings involving the users and nonusers serve as an excellent source for the development of a series of propositions concerning rail-truck intermodal. The present paper will evaluate the various propositions using data compiled from a recent study of business organizations located in a major metropolitan area. These propositions will be developed below.

One portion of the Harper and Evers research involved a mail survey of manufacturers located in the state of Minnesota. Their findings (1993) suggested that larger firms were more likely than smaller firms to be users of IRT services. The Harper and Evers research also investigated the modal splits of users and nonusers of IRT services. Their findings suggested different modal split patterns between users and nonusers for their outbound shipments. More specifically, IRT users tend to rely more heavily than nonusers on truckload (TL) motor carriage service, while less-than-truckload (LTL) service is the preferred form for IRT nonusers. Furthermore, based on aggregate figures, IRT tends to be a secondary mode of outbound transportation among IRT users.

Proposition 1: IRT users will be larger than nonusers.

Proposition 2: IRT users will have different modal usage characteristics than nonusers for outbound shipments.

Proposition 3: IRT users will make heavier use than nonusers of TL motor carrier service, while LTL service will be the preferred form among IRT nonusers.

Proposition 4: On an aggregate basis, IRT will be a secondary mode of outbound transportation for IRT users.

Harper and Evers (1993) also investigated user and nonuser perceptions of IRT service. Their

findings suggested that there were noticeable differences between users' and nonusers' perceptions of IRT service. Indeed, nonusers indicated a "substantially lower" overall perception (mean score = 2.18, where 1 = poor and 5 = excellent) of IRT service than did users (mean score = 3.10).

Proposition 5: IRT nonusers will have a substantially lower perception than IRT users of the overall quality of IRT service.

Proposition 6: IRT users and nonusers will differ with respect to their perceptions associated with the barriers to rail-truck intermodal.

Proposition 7: IRT nonusers will have stronger opinions than IRT users concerning the barriers to rail-truck intermodal.

METHODOLOGY

The propositions concerning rail-truck intermodal will be evaluated using data collected from a survey dealing with goods movement in Northeast Ohio. More specifically, the Greater Cleveland Growth Association (essentially the Chamber of Commerce for Cleveland, Ohio) commissioned the authors to work with them to develop, distribute, and analyze the goods movement study. The primary purpose of the study was to develop a comprehensive perspective concerning the strengths and needs of the goods movement system in Northeast Ohio, with Northeast Ohio defined as a 13 county region.[1]

Due to collaborative nature of the research (i.e., economic development group and academia), the authors had significant input into, but not total control of, questionnaire design and sample frame development. With respect to the former, the survey could not be distributed until its contents were acceptable to both the Growth Association as well as several other peer economic development groups (e.g., the Akron Regional Development Board).

In addition, while we developed the composition parameters of the sampling frame (e.g., suggestions attempting to ensure industry and geographic representativeness), the actual sampling was the responsibility of the Growth Association and its peer development groups. As a result, the sampling frame reflected their desires to collect comprehensive, community-wide information as opposed to a sampling frame comprised of people with a greater familiarity with goods movement issues (e.g., transportation supervisors, traffic managers, and the like).

The Growth Association, in collaboration with the other economic development groups, presented us with a sampling frame of 2,170 Northeast Ohio companies, to include 150 of Northeast Ohio's "top" or "leading" firms (as defined by the various economic development groups). Our inspection of the sampling frame suggested that a substantial number of seemingly inappropriate organizations and/or individuals (i.e., those with limited knowledge and/or exposure to goods movement issues) had been included in the study. (The initial sampling frame, for instance, included the person who snow plows one of our driveways during the winter!) Removal of identifiably "inappropriate" members reduced the

sampling frame to 1,510. We received 146 responses to the study, of which 116 were usable, for an effective response rate of 7.7%.

In terms of demographic characteristics, the 116 organizations appear representative of the Northeast Ohio business community. For example, each participant conducts business in one or more of the 13 counties. Approximately one-half of the participants are engaged in some type of manufacturing activity, with another 20% involved in wholesale or retail trade. Moreover, the participants encompass a variety of firm sizes; 40% employ between 1 and 10 workers, while 30% employ more than 100 workers. Tonnage figures exhibit a similar profile: nearly 40% of the participants report annual shipment volumes of less than 100 tons, while slightly more than 25% report annual volumes of greater than 10,000 tons.

The goods movement study asked respondents for a combination of detailed attitudinal and factual information. With respect to intermodal rail-truck issues, respondents provided information about the percentage of outbound volume moving by IRT, as well as perceived barriers to IRT service. For the purposes of this paper, a participant indicating that "0%" of their outbound shipments moved by rail-truck intermodal was classified as a nonuser of rail-truck intermodal services. Over one-third of the respondents could not, or would not, provide information about their outbound shipment patterns. Of the remaining respondents, 85% indicated **no usage** of rail-truck intermodal; thus, 15% of the respondents are **current users** of IRT service. Interestingly, in the Harper and Evers (1993) study, less than 30% of the actual survey respondents were actual users of rail-truck intermodal service.

EVALUATION OF PROPOSITIONS

Proposition 1: *IRT users will be larger than nonusers*. Two measures of firm size will be used to investigate this proposition, namely, total number of employees and total shipment volume. In the present study, firm size (employees) was measured as a categorical variable, that is, 1-10 employees; 11-100 employees; greater than 100 employees. Comparisons of IRT users and nonusers in terms of firm size (employees) indicate that the nonusers are fairly evenly distributed across firm sizes; 38.1% of the nonusers employ between 1 and 10 workers, while 33.3% employ more than 100 workers. By contrast, IRT users indicate a much different profile: less than 10% of the users employ between 1 and 10 workers, while over 60% employ more than 100 workers.

Although outbound volume was captured as a continuous variable, for analysis purposes it was categorized into three groups, namely, less than 100 tons; 100 to 10,000 tons; more than 10,000 tons. Analysis of the nonusers' tonnage volumes reveals that approximately three quarters report annual shipment volumes of less than or equal to 10,000 tons. Eighty percent of the IRT users, by contrast, report shipment volumes of more than 10,000 tons.

Both the employee and tonnage results appear to suggest a relationship between firm size and the use or nonuse of IRT services, a finding that tends to **support** Proposition 1. Furthermore, while IRT users tend to be larger firms, nonusers can be found in a variety of different firm sizes. For example, nearly 25% of the nonusers report annual volume in excess of 10,000 tons, and might be potential customers for rail-truck intermodal service,

considering that the vast majority of current IRT users have annual volume of greater than 10,000 tons.

Proposition 2: *IRT users will have different modal usage characteristics than nonusers for outbound shipments.* As previously mentioned, participants were asked to indicate the percentage of total volume shipped from the major metropolitan area by various transportation services, to include air freight, truckload motor carriage, rail-truck intermodal, among others. Results for modal usage are presented in Table 1, and appear to suggest that IRT users and nonusers have different modal profiles. On an aggregate basis, for example, IRT nonusers report a greater reliance on air transportation than do IRT users. Alternatively, IRT users are much more likely to use truckload motor carriage than nonusers. These results tend to **support** Proposition 2.

TABLE 1
MODAL USAGE CHARACTERISTICS—OUTBOUND VOLUME

Mode	Nonuser (% of volume)	User (% of volume)
Air	12.82	2.25
Truckload motor carriage	29.58	49.43
Less-than-truckload	48.19	37.59
Rail	3.28	.56
Rail-truck intermodal	.00	4.80
Water	.22	1.13
Other	4.64	.09

Note: Percentages may not sum to 100 because of item nonresponse.

Proposition 3: *IRT users will make heavier use than nonusers of TL motor carrier service, while LTL service will be the preferred form among IRT nonusers.* The information in Table 1 indicates that IRT users do indeed make heavier use of truckload motor carriers than IRT nonusers; in fact, nearly 50% of IRT users' volume involves TL motor carriers, compared to 30% for IRT nonusers. Moreover, LTL is a popular form among IRT nonusers, involving nearly 50% of their outbound volume. On a relative basis, less-than-truckload is the most popular modal alternative for IRT nonusers, while truckload motor carriage is the most popular alternative for IRT users. These findings tend to **support** Proposition 3.

Proposition 4: *On an aggregate basis, IRT will be a secondary mode of transportation for IRT users.* As shown in Table 1, the two most popular forms of transportation for IRT users are TL motor carriage and less-than-truckload (LTL) service, both of which

combined account for over 85% of the IRT users' shipment volume. Rail-truck intermodal, by contrast, represents slightly less than 5% of the IRT users' shipment volume. These findings tend to **support** Proposition 4.

However, analysis of the relative importance of the users' modal split characteristics (Table 1) reveals rail-truck intermodal to be the third most popular form of outbound transportation for IRT users, behind TL and LTL service. Interestingly, IRT service also ranked as the third most popular mode for outbound shipments in the Harper and Evers (1993) study.

Proposition 5: *IRT nonusers will have a substantially lower perception than IRT users of the overall quality of IRT service.* Using a 1 (poor) to 5 (excellent) scale, survey participants were asked for their perceptions about the overall quality of rail-truck intermodal service. The average rating among IRT nonusers was 2.81, compared to 3.18 among IRT users. Thus, while the nonusers do have a lower perception than the users, the difference between 2.81 and 3.18 would not appear to qualify as "substantially lower." Thus, there appears to be **partial support** for Proposition 5.

Proposition 6: *IRT users and nonusers will differ with respect to their perceptions associated with the barriers to rail-truck intermodal.* The barriers to rail-truck intermodal, which appear in Table 2, were drawn from those identified in the *Intermodal Index*, an annual study (last conducted in 1994) which was co-sponsored by the Intermodal Association of North America and the National Industrial Transportation League. Note that the *Intermodal Index* appears to have developed the barriers to intermodal through content analysis of an open-ended question. The present study, by contrast, asked respondents to evaluate each barrier along a 1 (strongly disagree) to 5 (strongly agree) scale.

Results for the barriers to rail-truck intermodal, presented in Table 3, indicate some noticeable ranking differences between IRT users and nonusers. For example, "slow speed" emerged as the top ranked barrier among IRT nonusers, compared to tied for seventh among IRT users. Similarly, "price", the second ranked barrier among nonusers, was the tenth ranked barrier among users. Alternatively, lack of equipment, which tied as the top barrier among IRT users, ranked seventh among nonusers. Furthermore, the Spearman coefficient of within-group ranks was approximately 0, which suggests that there are notable ranking differences between IRT users and nonusers. These results tend to **support** Proposition 6.

Proposition 7: *IRT nonusers will have stronger opinions than IRT users concerning the barriers to rail-truck intermodal.* For purposes of this paper, "stronger perceptions" will be operationalized by stronger agreement with the barriers to rail-truck intermodal that are listed in Table 2. Note that each of the barriers is presented in a "negative", or non-positive, framework (e.g., "intermodal prices/rates too high"). Thus, greater agreement with the respective barriers will be seen in higher average ratings for them.

The information in Table 3 indicates that IRT nonusers have the higher average ratings for eight of the ten barriers. Furthermore, several of the barriers are characterized by noticeably higher average ratings for IRT nonusers. For example, the average rating for "price" by the nonusers was 3.73, compared to 2.40 for users, a difference of over 1.30 (out of a possible maximum difference of 4.00). Likewise, "slow speed" has an average rating of 3.76 among

IRT nonusers, compared to 2.91 among IRT users, for a difference of .85. In addition, the IRT nonusers' average rating for all 10 barriers was 3.25, compared to 3.00 for users (calculated by adding the scores for all 10 barriers and dividing by 10). These results tend to **support** Proposition 7.

TABLE 2
BARRIERS TO RAIL-TRUCK INTERMODAL

Intermodal transit time is too slow or unreliable; truck is faster than intermodal (hereafter referred to as "slow speed")

Intermodal prices/rates too high ("price")

Lack of availability of service/equipment ("service availability")

Ramps/railroads are too far away ("distance")

Damage rate is too high/heavy damage using intermodal ("damage")

Intermodal equipment not sufficient ("lack of equipment")

No need for intermodal services/trucking meets needs ("no need")

Customer designates service/someone else determines mode of service ("customer choice")

Multiple stops/too many stops ("stops")

Insufficient volume/loads not large enough ("low volume")

Source: 1994 *Intermodal Index*, p. 20.

TABLE 3
COMPARISON OF USER AND NONUSER BARRIERS TO RAIL INTERMODAL

Mean score (rank)

Barrier	Nonuser	User
Slow speed	3.76 (1)	2.91 (7.5)
Price	3.73 (2)	2.40 (10)
Multiple stops	3.62 (3)	3.18 (4)
Service availability	3.31 (4)	3.27 (2)
No need	3.18 (5)	3.27 (2)
Distance	3.16 (6)	2.91 (7.5)
Lack of equipment	3.13 (7)	3.27 (2)
Customer choice	3.12 (8)	3.09 (5)
Damage	3.05 (9)	3.00 (6)
Low volume	2.98 (10)	2.73 (9)
Average score	3.25	3.00

Mean score: 1 = strongly disagree; 5 = strongly agree
Spearman coefficient of rank correlation = 0; not statistically significant

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

In general, the study results support the findings from the Harper and Evers (1993) research. As such, the results from this study, in conjunction with the findings from the Harper and Evers research, lead to the following propositions concerning IRT service:

1. IRT users tend to be larger than nonusers.
2. Some current IRT nonusers have the size characteristics to make them potential IRT users.
3. IRT users have different modal usage characteristics than nonusers for outbound shipments.
4. IRT users tend to favor TL service, while LTL service is the preferred form among IRT nonusers.
5. On an aggregate basis, IRT will be a secondary mode of outbound transportation for IRT users.
6. On a relative basis, IRT will be one of the three most popular forms of outbound transportation for IRT users.
7. IRT nonusers and users will have different perceptions about the overall quality of IRT service.
8. IRT nonusers will have a lower perception than IRT users about the overall quality of IRT service.
9. IRT users and nonusers will differ with respect to their perceptions associated with the barriers to rail-truck intermodal.
10. IRT nonusers will have stronger opinions than IRT users concerning the barriers to rail-truck intermodal.

The study's findings present a number of implications for various intermodal stakeholders, to include IRT users, IRT nonusers, and IRT service providers. Using this information, the various stakeholders could evaluate relevant IRT issues. Current IRT customers, for instance, could use the results to learn about relevant demographic characteristics and select perceptions of other IRT customers. Such information could help companies to assess their modal split strategies relative to like-minded organizations.

In a similar vein, IRT nonusers could utilize the results to learn about relevant demographic characteristics and select perceptions of other nonusers. Moreover, those nonusers who are seriously considering the use of IRT are provided with valuable information to strengthen their position. Intermodal's "slow speed", for example, is frequently cited as a major shortcoming by IRT nonusers; IRT users, by contrast, do not view intermodal's "slow speed" as a major barrier.

The study results also appear to offer several important implications for IRT service providers (e.g., carriers and intermodal marketing companies). For example, the findings suggest opportunities to expand IRT's market penetration, in the sense that some current nonusers appear to possess "favorable" demographic attributes such as sufficient annual tonnage volumes. The challenge for IRT service providers involves moving some (or all) of these companies from nonuser to user status.

Furthermore, the findings suggest that IRT service providers should pursue multiple managerial strategies with respect to addressing the various concerns of IRT users and nonusers. Our research indicates, for example, that current users are most concerned that intermodal equipment is not sufficient to meet their needs. Nonusers, by contrast, most concerned about the speed and reliability of intermodal transit times.

Third, IRT service providers might study ways to address the apparent misinformation about rail-truck intermodal service in the sense that there appear to be noticeable gaps between the perceptions and realities of IRT service. For example, Harper and Evers (1993) discovered low cost to be the primary reason for using IRT service; likewise, our results indicate price to be the lowest ranked barrier among IRT users. IRT nonusers, by contrast, view price as one of intermodal's most significant barriers.

Finally, further research is needed to evaluate the robustness of the propositions presented at the beginning of this section. For example, the present study focused on shippers located in a major metropolitan area. Are the propositions applicable to shippers in more rural locations? Similarly, Harper and Evers (1993) indicated that their study was best generalized to "...areas in the country that have relatively good IRT service." Are the propositions applicable to shippers who might not have access to good IRT service? Moreover, both the present study (Great Lakes region) and the Harper and Evers (Minnesota) study were conducted among shippers located in "northern" states. Are the propositions applicable to shippers located in other US regions? Are the propositions applicable to shippers located in non-US regions?

ENDNOTES

1. The 13 counties were: Ashtabula; Columbiana; Cuyahoga; Geauga; Lake; Lorain; Mahoning; Medina; Portage; Stark; Summit; Trumbull; Wayne.

REFERENCES

Coyle, J.J., E.J. Bardi, and R.A. Novack (1994), *Transportation*, Fourth edition, West Publishing.

Harper, D.V. and P.T. Evers (Spring 1993), Competitive Issues in Intermodal Railroad-Truck Service," *Transportation Journal*, 32(3): 31-45.

Jennings, B.E. and M.C. Holcomb (Spring 1996), "Beyond Containerization: The Broader Concept of Intermodalism," *Transportation Journal*, 35(3): 5-13.

Johnston, M.L. and S. Marshall (Fall 1993), "Shipper Perceptions of Intermodal Equipment," *Transportation Journal*, 33(1): 21-30.

AUTHOR BIOGRAPHY

Paul R. Murphy is professor of business logistics at the Boler School of Business, John Carroll University. He has an A.B. from the University of Notre Dame, and an M.B.A. and Ph.D. from the University of Maryland, college Park. Paul has published extensively in transportation and logistics journals, and is a co-author of *International Logistics* and *Contemporary Logistics*. His current research interests include international logistics and social responsibility in logistics.

AUTHOR BIOGRAPHY

James M. Daley has a Ph.D. in marketing and transportation, and an M.S. in management, both from the University of Arkansas. His B.S.B.A. in finance is from the University of Alabama. A professor of marketing, Dr. Daley currently serves as Associate Dean, Boler School of Business, John Carroll University. He has published over 45 major journal articles and continues to conduct research concerning issues in supply chain components.