MODELING REVENUES FOR EXPEDITED FREIGHT SERVICES

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ABSTRACT

We demonstrate the development, testing and application of statistical models for studying actual billings (net of discounts) for expedited freight services. The models reveal the structure of net tariffs and point to situations where business activities, pricing structures or negotiated discounts need review They enable carriers to identify customers whose revenues are deficient considering services rendered, and terminals where revenues are deficient considering their mix of business. The models also affirm that the overwhelming determinants of monthly charges to shippers are the fundamental cost drivers for the industry, namely number of shipments, weight of shipments, and distance shipped.

INTRODUCTION

Since deregulation of the U.S. interstate trucking industry in the 1980's, motor carriers have set base rates and negotiated individual customer discounts that purportedly reflect the costs of providing service, competitive pressures, and the anticipated value of the customer relationship. In this dynamic business environment, freight carriers need periodically to determine whether the net rates paid by specific customers, or in specific market segments, are commensurate with the services delivered. With data from a major U.S. motor carrier, we develop analytical models to address this issue. Our research has two purposes – first to demonstrate tools that can help a carrier identify situations where base rates might need restructuring or discounts may need renegotiation, and second to assess the extent to which net rates paid by shippers appear to be determined by the services they actually receive, versus anomalies from uneven competitive pressure in an unregulated marketplace.

Harmatuck (1992), from economic analyses of cost structures, asserts that the LTL industry is highly competitive, with limited economies of scale and without significant barriers to entry. Baker (1991) observes large ranges in published freight rates and ranges of discounts. More specifically, we use monthly data for actual shipments by individual customers for each origin-destination (lane) pair in a North American route network. Our analysis is minimally confounded by freight classification and service levels, as the shipments typically occur between the carrier's own terminals in two cities. We construct statistical models to produce norms for effective freight rates, study deviations from normative rates on several dimensions, and discuss the significance of such information to carriers and shippers.

CONSTRUCTION OF STATISTICAL MODELS FOR EFFECTIVE RATES

In Figure 1, we summarize the factors identified in published research as affecting negotiated rates for LTL shipments. The net freight rate paid by a shipper, whether measured in cents per pound or dollars per ton-mile, depends upon the published rate, the discount negotiated with the customer, and the blend of shipments (classification, weight and distance) that occurs. The discount is affected by the relative negotiating power of the two parties (carrier and shipper), the perceived risk (uncertainty) associated with contractual arrangements and by the quality of the customer relationship.

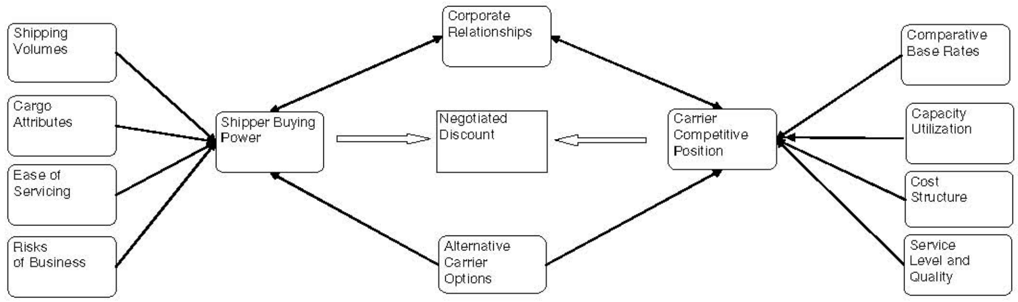

Figure 1 – Factors Affecting the Negotiated Discount

In a competitive business, revenues should cover the fixed and variable costs of the firm, with a reasonable return on investment. For a freight carrier, major costs include labor, fuel, equipment, general overhead, and customs brokerage and documentation for international shipments. Considering the complexity of allocating costs in a manner transparent to terminal managers and shippers, we proposed a statistical approach to the problem whereby the norms are derived from data that are readily available in monthly summaries of shipments for each customer in each shipping lane.

We began with models that consider the number of shipments, weight shipped, and nominal distance, allowing for interdependency between weight and distance. After exploring the affects of various variance-stabilizing transformations, we settled on the basic form and then expanded the models to include surrogates for the other factors that influence the cost of doing business. City size, for example, stood for traffic congestion and local factor costs. The number of listed competitors stood for degree of competitive pressure. In brief, the following basic polynomial model emerged for determining expected revenues (and thence revenues per mile and revenues per ton-mile), showing (in Figure 2) conformity with theoretical expectations.

Revenue = β_0+12.4*(total shipments)+.0352*(total weight) -6.40*10^{-9} * (total weight)^2 +.199* (total ton-miles) -4.23*10^{-8} * (total ton-miles)^2 – 3.06*10^{-5} * (lane distance*total ton-miles) (1)

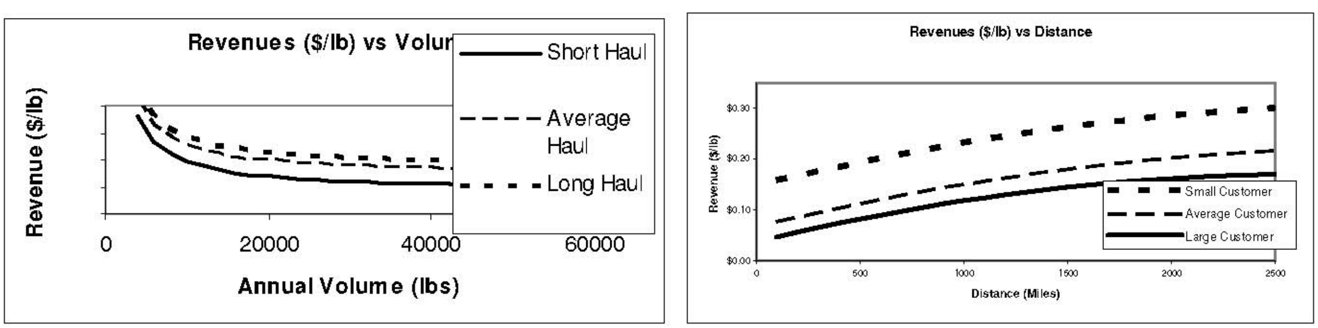

Figure 2: Net freight rates per lb. drop with volumes and increase with distance at reducing rates

An alternative model with logarithmic structure was also constructed. The polynomial model captured the typical effects of reduced benefits from consolidating shipments as the size of shipments increases (Table 1), whereas the logarithmic model, by structure creates constant proportional reductions in cost with consolidation. In that vein, the polynomial model was preferred.

Table 1 -Comparative Tariffs (cents per lb) from Polynomial Model and Logarithmic Model

Lane Mileage	Average Weight	Total Shipments	Total Weight	Total Distance	Ton-Miles	Poly (¢/lb) Consolidation Savings (%)	Log (¢/lb) Consolidation Savings (%)
500 500	250 500	50 25 50 25	12,500	25,000	3,125	17.9 15.4 13.8 13.0 11.7	16.4 14.9 8.6 13.9 12.7
500 500	500 1,000	50 25	12,500	12,500	3,125	9.5 11.3 10.5 7.3	8.6 12.6 11.6 8.6
500 500	750 1,500		25,000	25,000	6,250		
			25,000	12,500	6,250		
			37,500	25,000	9,375		
			37,500	12,500	9,375		
1,250	250 500	50 25 50 25	12,500	62,500	7,813	23.3 20.8 10.6 18.4 17.1	21.7 19.8 8.6 18.4 16.9
1,250	500 1,000	50 25	12,500	31,250	7,813	6.7 16.7 15.9 4.9	8.6 16.8 15.3 8.6
1,250	750 1,500		25,000	62,500	15,625		
1,250			25,000	31,250	15,625		
1,250			37,500	62,500	23,438		
1,250			37,500	31,250	23,438		

Augmented models with surrogate variables for business environments still revealed the expected nonlinear effects of weight and distance and their interactions. After adjusting for weight and distance, shipments in smaller cities carried a premium. Large international gateway cities (which also have more competitors) carried a discount relative to other centers. Northeastern corridor cities, where operating costs are highest, carried a premium. Eastbound and northerly shipments carried slight premiums. International business shipments, contrary to expectation, carried a discount per pound (raising the question of whether the company was recovering the extra costs involved). Ceteris paribus, the top customers paid lower net rates. Charges were less for shipments from cities where more carriers provided services. Over all, the additional terms representing incremental factors were highly statistically significant (at the .001 level and in the expected direction), but the average net revenues in a lane primarily reflect the fundamental services delivered (weight, distance and their interaction). The basic model explained 89% of variation in customer-lane revenue; the augmented model explained 90%.

When selecting customers or business segments for scrutiny, consideration must be given to both the absolute aggregate revenue deficiencies and relative aggregate revenue deficiencies (percentage of aggregate expected revenues). The magnitudes of revenue deficiencies and surpluses ascribed to customers and terminals depend somewhat upon the structure of the models (and variable-stabilizing transformations) employed. They also depend on the segments of business used in the calibration (e.g., traffic at a specified terminal or nationwide). Awareness of these effects is also required when examining business activities for a customer or market segment.

CONCLUSION

The models have provided valuable managerial insight. In using them, it is important to consider the results of both local and nationwide calibrations to avoid targeting a company with small volumes in one market but high volumes system-wide. Similarly, it is useful to employ fundamental rate models based on number of shipments, weight and distance, as well as augmented models that take other factors into consideration. Using the former alone ignores the impact of factors that necessarily affect rates and discounts; using the latter alone removes performance variability that the carrier is trying to measure. Performing its analysis and reviewing the results accordingly, this carrier has successfully addressed anomalies in its charges and concentrated on retention of its most profitable business.

NOTE: An unabridged version of this paper with references and extensive statistical results is available from the authors.