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Basing rate adjustments for motor carriers on statistical evidence

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BASING RATE ADJUSTMENTS FOR MOTOR CARRIERS ON STATISTICAL EVIDENCE

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ABSTRACT

Pricing services of motor carriers is a dynamic process, with continuous pressure from customers to offer competitive rates and discounts. This can lead to a profusion of special arrangements with rates that poorly reflect the services rendered. This article shows how standard database systems and statistical models can be used to extract useful information from bills of lading to assist in the pricing of freight services. Summaries of business performance are produced according to terminal facility, shipping origin, shipping destination, individual shipping lane and individual customer. User-friendly statistical models are constructed to produce benchmarks for rates and revenues considering the services rendered. Differences between actual and benchmark levels of performance help to identify situations that may call for managerial reinforcement or corrective intervention. With illustrations from a major motor carrier, the authors discuss how even small motor carriers can develop such models and use them for planning their rate adjustments and managing customer relationships.

INTRODUCTION

Freight carriers, operating in a deregulated business environment, engage in a form of value-based pricing. They set their base rates and then negotiate individual customer discounts while considering the costs of providing service, competitive pressures, and the anticipated value of the customer relationship. They strive to reach different market segments with differentiated service characteristics and with flexible pricing mechanisms, thus deriving revenues from some premium services, capturing business from competitors and achieving a higher utilization of corporate assets. Airlines, hotels and rental cars engage in a similar form of "yield management" as they set spot rates for restricted fares and offer weekend specials, perhaps with greater consideration to customers' willingness to pay. In such competitive environments with their peculiar pricing mechanisms, freight carriers need periodically to examine the results of their rate structures and discounting practices to determine the net effects of their pricing and service decisions and to adapt corporate strategies accordingly. In doing so, they must systematically address key questions such as:

1. How has the organization's business evolved throughout the transportation network?

2. Are there imbalances in the use of facilities and equipment?

3. How do rates vary throughout the service system? How are they related to market characteristics?

4. Are the effective rates at specific terminal origins, terminal destinations, or for specific customers, commensurate with the services delivered?

5. How should rates be adjusted at certain locations, on particular shipping lanes, or for particular customers or groups of customers?

In this article, the authors describe the development and use of analytical tools that were created to help a motor carrier address such questions. The company provides time-definite delivery services for less-than-truckload (LTL) shipments among a network of terminals located throughout the U.S. and parts of Canada. Although the focus is on the operations of a large North American motor carrier, the basic approaches employed and the issues confronted are relevant to companies in many competitive service industries. The presentation illustrates the use of standard statistical tools to extract information from computer records of bills of lading in order to:

1. Present a comprehensive picture of carrier activities and sources of revenue

2. Establish benchmarks for rates and revenues commensurate with services delivered

3. Identify terminals, shipping lanes and customers that may require managerial attention or intervention

4. Design a program of customer support and rate adjustments to improve corporate performance.

The process represents a form of data mining for pricing decisions. It involves the production of comprehensive statistical summaries that provide overviews of corporate performance in several dimensions, the creation of statistical (regression) models for explaining variation in performance, and the use of the resulting information to develop strategies for rate adjustments. The work can be accomplished with standard statistical software and data management tools.

BACKGROUND

In the two decades since deregulation of the U.S. interstate trucking industry, an array of alternative services has emerged for less-than-truckload (LTL) shipments involving traditional LTL carriers; truckload (TL) carriers who "top-off" partially filled trailers on a contract basis; private carriers who contract for use of backhaul capacity; freight forwarders and consolidators; express package deliverers; railroads and airlines with trucking alliances, etc. (Elzinga, 1994). Shippers weigh numerous characteristics of the terms and quality of service when selecting a carrier (Lambert et al., 1993). On one hand, larger carriers use sophisticated information technology and stronger credit lines to competitive advantage, resulting in greater industrial concentration (Rakowski, 1988; Boyer, 1993). On the other hand, smaller firms find creative market niches by offering services such as time-definite delivery with computerized tracking, etc., in selected markets under simplified pricing structures (Schulz, 1999).

In this dynamic business environment, freight carriers rely increasingly on information technology to increase efficiency and improve service. Roy (2001) describes analytical tools (including optimization models) used in the trucking industry for tactical planning and operational support. He mentions the need for analytical support that is tailored differently for decisions at the strategic, tactical and operational levels.

In a less grandiose and more tangible frame, Brachman et al. (1996) discuss the concept of knowledge discovery in databases (KDD) and associated tools for data mining. They do so with a view to finding relationships which explain phenomena, identifying deviations from norms, and forecasting. They assert that much of this activity (including data cleaning, model development, testing, verification, interpretation and use) occurs through the use of traditional tools for statistical analysis (e.g., SAS), but also point to the development of proprietary packages which are developed for specific industries (e.g., fraud assessment for financial services, quality control systems for aircraft manufacturers and management of telecommunications networks). They note that general tools have been developed for visualization, query and clustering elements of data (e.g., Clementine, IMACS, MLC++, MOBAL and Recon), but their use is often *ad hoc*, and demanding in terms of technical skills.

In addressing the aforementioned strategic questions, it was desirable to create analytical support that could be employed on a periodic basis by marketing personnel without intensive background in computer information systems or statistics. Further, the authors wished to utilize the power of statistical tools and models, in some instances relying on theoretical underpinnings for development of benchmarks. The scope of analysis ranges from the broadest review of corporate performance (system-wide) to the activity of an individual customer in a specific shipping lane (involving a particular origin-destination pair).

PROVIDING PERSPECTIVE ON CORPORATE PERFORMANCE

The first step in producing tools for analyzing the carrier's effective rate structure (i.e., actual rates net of discounts) is to provide a comprehensive perspective on aggregate corporate performance, with an ability to identify important patterns through time and to drill down to levels of primary managerial attention. At different points in the review cycle, the focus may be system-wide, on a marketing region, on an individual terminal (as an origin, destination or both), on an individual shipping lane (origin-destination combination), or on an individual shipper (customer). There is also the spatial (geographical) element to consider when depicting corporate activity. The focus may be on customers with certain attributes in particular geographical markets (e.g., all large airline companies with business at the JFK freight terminal). It may also involve different time intervals (e.g., a particular reporting period or time following a significant event, such as the opening of a new terminal, establishment of a major competitor, or a catastrophic event such as the destruction of the World Trade Center). Supporting analytical tools must make it easy for managers and analysts to compare performance among entities and groups of entities.

Elemental data for the corporate performance profiles are embedded in bills of lading, which give the weight and revenues associated with individual shipments (roughly 100,000-150,000 shipments per month in this case). Monthly summaries of these transactions are created to serve as the core of a data mart (a mini data warehouse) which incorporates further information about road mileages between terminals, customer attributes, characteristics of cities where terminals were located, number of competitors operating in various markets, etc. A combination of customer number, origin terminal, destination terminal, and month defined the unit of aggregation for the activity dataset. Summaries include the number of shipments in the month, the total weight shipped, and the total revenue derived from the services. The data mart thus includes

- monthly activity summaries for all combinations of customer number, origin and destination

- cross-references from customer number (which may identify subsets of activity for a company according to organizational structure, product line or geographical area) to company name (name of the customer)

- mileage tables which show driving distances between shipping origins and destinations and allow statistics to be produced which reflect the distance shipped (a critical component of cost and revenue)

- terminal characteristics such as longitude and latitude (to allow computation of spatial distances and identification of direction of traffic flow), size of city, number of competitors, etc.

- geographic data and annotation information to allow the depiction of information on maps.

Corporations often ship under different divisional names, yet wish to receive credit or consideration for the total volumes that they ship when negotiating their discounts. An important activity in connection with creation of the data mart therefore involves the conversion of shippers' names to a common format for consolidation of corporate shipments, and the consolidation of records for the same organization which appear with different spellings (as may be caused, for example, by blanks and special characters in a name, misspellings, upper-case versus lower-case characters, and the inclusion of qualifiers and abbreviations).

The revenues collected and the distribution of fixed and variable costs for a freight carrier depend greatly on the weight of the shipment and the distance involved. Performance must always be viewed in the context of weight and distance. Accordingly, the key performance statistics for summaries system-wide, by terminal, by origin, by destination and by shipping lane (origin-destination) are:

- number of customers served
- total number of shipments
- total weight of shipments
- total revenue (dollars)
- total ton-miles shipped
- average weight (lbs.) per shipment
- average revenue ($) per pound
- average revenue ($) per ton-mile
- average distance (miles) per shipment
- average revenue ($) per shipment
- average ton-miles per shipment.

The data elements used in creating these statistics were obtained from individual bills of lading and maintained in a Microsoft Access database. The Statistical Analysis System (SAS) was used to create a prototypical data mart and perform the statistical analysis. Analysts can control processing for creating datasets, building models, generating reports, etc., without altering the statistical programs. Selective reporting, performance of ABC analysis (creating cumulative statistics for selected attributes in declining order according to their aggregate contribution to the total), and choice of processing options are controlled through "keyword parameters." The processing parameters also allow the analyst to specify choice of time frame, choice of sorting criteria, naming of summary datasets, selection of screening criteria for exception reports and detailed reports, and restriction of the analysis to focus on an activity for a particular terminal. Large bound copies of summary reports (affectionately known as the "stone tablets") are helpful in providing perspective in periodic reviews of corporate performance and during spontaneous discussions as issues arise. Such summaries should be updated periodically (perhaps quarterly). For particular studies, one can easily produce performance summaries covering a designated time period for chosen groups of entities (e.g., customer categories such as freight forwarders, major urban terminals, terminals at which a particular competitor has a strong presence, international gateways, etc.). In Table 1, several summaries, which are comprised in the standard reporting options, are illustrated. Maps are also useful in showing imbalances between inbound and outbound traffic, commodity flows, etc. In Figures 1 and 2, maps are used to provide perspective on the geographical configuration of the company's terminal activity in the U.S.

In summary, the presentation of perspective on corporate performance relies on the storage of bill-of-lading data in a "data mart" with complementary data such as mileages, rates, terminal environments, customer characteristics, etc. It includes the periodic production of extensive reports for perusal and reference, the generation of comparable statistics on demand for entities under study, and GIS tools for conveying spatial aspects of the transportation network and business activity.

STUDYING EFFECTIVE RATES AND EVALUATING THE CUSTOMER RELATIONSHIP

The effective rate paid by a customer depends upon the published rate structure, which reflects the industry's basic cost structures, competition and targeted margins, the discount extended to the customer, and the blend of shipments that occurs. The customer's discount is usually negotiated in light of competitive pressures and anticipated volumes, with a greater discount offered to a customer who is expected to ship larger volumes. Sometimes the anticipated volumes fail to materialize. Total weight shipped may fall below expectations, or the resulting business may be primarily short-haul when a substantial amount of long-haul business was anticipated. When revenues (and resulting contributions to profit) fall below expectations, the rates offered to a customer may need to be adjusted. A tool is needed for an objective review that considers the services delivered, related costs, and competitive conditions.

There are various cost elements that should be considered when setting the base rates for a service and negotiating discounts for customers. The main cost drivers are summarized in Table 2. For the basic benchmark, a model that estimates total revenue based upon the number of shipments, weight shipped and distance shipped is employed. The statistical models that are created allow for interdependencies between weight and distance, thus adjusting the impact of weight on expected revenue, in accordance with the distance involved. More complex models are then developed to incorporate details regarding the terminal cities and traffic (for example, city size, geographic region, direction of flow, etc). Surrogate measures such as size of city and general price indices may be employed for the degree of traffic congestion and local factor costs (warehousing space, labor, fuel etc.).

Cost is, of course, not the only consideration. Competitive carriers can put a cap on rates that may be charged in a market. The number of competitors (derived from listings in yellow pages or industry associations) can serve as a surrogate for competitive pressure, which is correlated with city size. The more complex models provide additional explanatory power and help to identify factors other than the basic cost drivers which have impinged on rates. However, they "explain away" some of the differences to which managers should be sensitive. It is therefore valuable to look at the system both ways (first considering the basic cost factors and then considering the additional factors that impinge on rates).

Results for both the basic and complex rate models will depend on the data used to calibrate them. For example, when studying the rates charged at a particular terminal, the model is first calibrated with data involving shipments into or out of that terminal. The model is then calibrated using all shipments system-wide for the same period. This enables the isolation of revenue deficiencies for a particular customer at a terminal (in comparison with other customers, after adjusting for all services delivered at that

TABLE 1
EXCERPTS FROM PERFORMANCE PROFILES

profile of ALL terminal shipments from 12/2000 to 11/2001 11:40 wednesday, January 23, 2002 1

--- Origin = xxxxx(masked for confidentiality) ---

YEAR	MONTH	No. of Cust	Total no. Ship	Total lb Shipped	Dollar Revenue	Total ton-mi	Av. lb per Ship	$ Rev. per ton-mi	$ Rev. per lb	Av. Mi. per Ship	Av. Rev. per Ship	Av. ton-mi per Ship
2000	12	64	232	139,693	25,803	92,700	602	0.278	0.185	1,273	111	400
2001	1	70	283	133,508	25,813	91,740	472	0.281	0.193	1,326	91	324
2001	2	72	277	160,000	29,476	103,228	578	0.286	0.184	1,307	106	373
2001	3	74	332	170,143	32,196	112,866	512	0.285	0.189	1,305	97	340

profile of ALL terminal shipments from 12/2000 to 11/2001 11:40 wednesday, January 23, 2002 42

--- DEST= xxxxx (masked for confidentiality)---

YEAR	MONTH	No. of Cust	Total no. Ship	Total lb Shipped	Dollar Revenue	Total ton-mi	Av. lb per Ship	$ Rev. per ton-mi	$ Rev. per lb	Av. Mi. per Ship	Av. Rev. per Ship	Av. ton-mi per Ship
2000	12	143	574	304,458	55,035	163,840	530	0.336	0.181	1,088	96	285
2001	1	128	652	406,676	71,073	214,910	624	0.331	0.175	1,086	109	330
2001	2	142	584	325,136	55,961	162,243	557	0.345	0.172	1,083	96	278
2001	3	143	698	412,509	72,996	221,556	591	0.329	0.177	1,101	105	317

profile of ALL customer shipments from 12/2000 to 11/2001 11:40 wednesday, January 23, 2002 84

OBS	CUSTOMER	No. of origins	Total no. Ship	Dollar Revenue	Total ton-mi	Av. lb per Ship	$ Rev. per ton-mi	$ Rev. per lb	Av. Mi. per Ship	Av. ton-mi per Ship
1	A (masked)	76	89,881	9,073,032	32,445,774	604	0.280	0.167	1,122	361
2	B (masked)	74	91,682	9,007,802	33,978,714	572	0.265	0.172	1,186	371
3	C (masked)	76	55,846	7,556,810	32,069,517	844	0.236	0.160	1,274	574
4	D (masked)	76	76,003	6,691,877	23,481,678	511	0.285	0.172	1,130	309

FIGURE 1
IMBALANCES IN TERMINAL SHIPMENTS

FIGURE 2
REVENUES OUT OF ST. LOUIS

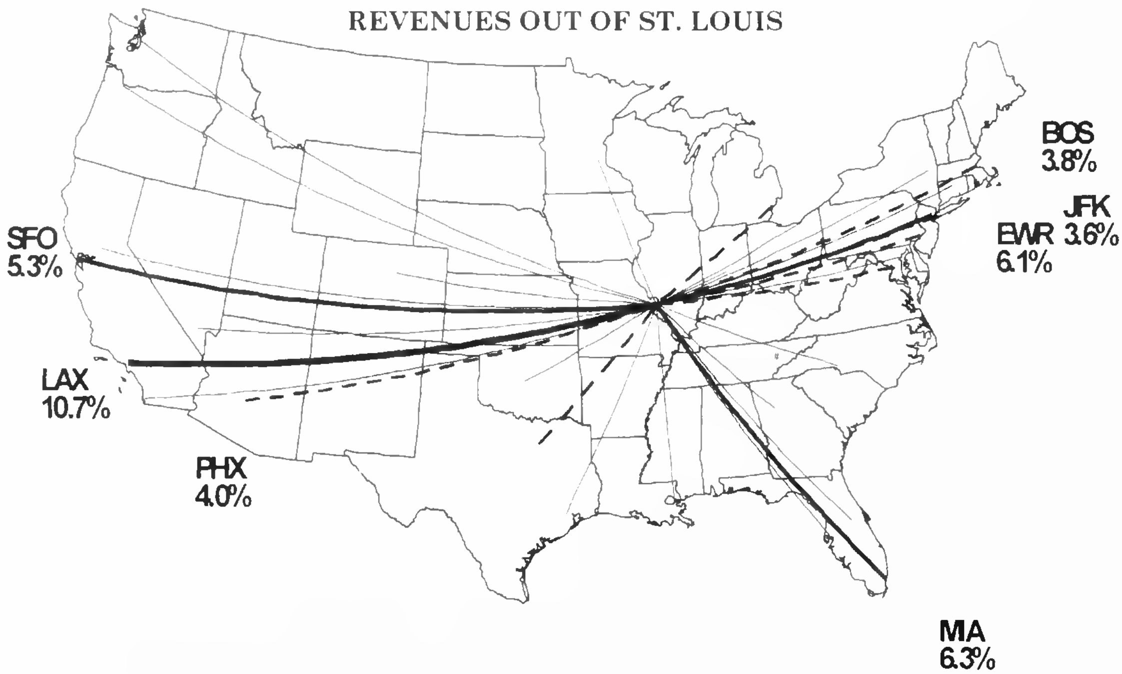

TABLE 2
MAJOR COST DRIVERS

Cost Category	Cargo Density	No. of Shipments	Weight Shipped	Distance of Shipment	Local Factors	Traffic Congestion	Internat'l Shipment
Labor-Line Haul			X	X		X	X
Labor-Terminal	X	X	X		X		
Fuel	X		X	X	X	X	X
Tractor	X		X	X		X	X
Trailer	X		X	X		X	X
General Admin.		X			X		X
Local Delivery	X	X	X		X	X	
Customs Broker							X

terminal) in light of the customer's business elsewhere on the system. This would help to avoid offending a customer with a rate increase based on analysis only at one location when the customer is paying rates above the norm elsewhere. For example, the model, when calibrated with shipments originating at an individual terminal for a one-year period, comprised 8,362 customer-lane combinations and explained 96% of the variation in \$11.6 million of revenue. The model for the entire system for the same year was based upon 146,368 customer-lane combinations and explained 91% of the variation in \$193 million of revenue. As mentioned earlier, the results of the model can be aggregated in various ways to produce managerial reports giving benchmark and actual revenues by customer, origin, destination, region, etc.

When the resulting benchmarks were aggregated for the 76 shipping origins with shipments into the chosen terminal, the model explained over 99 percent of the variation in monthly revenues and 79 percent of the variation in revenues per pound. The deviations between expected revenues (generated from the model) and actual revenues (in the raw data used to calibrate the model) depend further on the time frame selected for analysis and upon the section of the network used in calibrating the model. Using data for an entire year avoids seasonal biases. Using the most recent month ensures currency and allows attention to be directed to current developments. It is recommended that the analysis be performed in different ways and further information should be sought to deal with material differences. A system-wide calibration should also be performed and the results compared with those for the chosen geography.

For the system-wide model, the actual and expected (benchmark) revenues that are produced for each customer and lane are aggregated to search for patterns by terminal, size of city served by the terminal, marketing region, and customer type. The results for each customer are also aggregated and material differences between actual and expected revenues are reported. Table 3 presents a comparison of actual and expected (basic benchmark) revenues according to the size of the city in which the terminal was located. The terminal cities were grouped according to the size of their associated metropolitan area (with 10 designating the top percentile—i.e., the 10 percent of cities with largest population). As might be expected, the largest negative deviations (where expected revenues exceed actual revenues) generally occurred at the busiest origins (in largest cities) where competition is thought to be stiffest.

HIGHLIGHTING SITUATIONS THAT MAY CALL FOR RATE ADJUSTMENTS

Revenues and rates from the regression models serve as the benchmark against which actual revenues and rates are judged. Using the expected revenues from the model in conjunction with actual revenues, weights and distances, the actual effective rates and expected effective rates are compared in terms of revenue per pound and revenue per ton-mile. By analyzing the differences between the actual rates and the expected rates, individual terminals, shipping origins, shipping destinations, shipping lanes, or marketing regions can be identified for which there appear to be systematic deficiencies in revenues. Similarly, areas where business is especially lucrative can be identified (pointing to origins, terminals, shipping lanes, or marketing regions for which the deviations of actual revenues from expected revenues are positive). Finally, guided by these "residual variances" from the statistical models, the model can be used to search for the influence of other factors on corporate performance.

The same principal applies to a review of pricing for an individual customer. To give perspective on the total value of the business relationship, the customer's expected revenues and actual revenues can be accumulated across all lanes and months used for the analysis and compute the difference between the two totals. Customers can be sorted according to the differences between their actual and expected revenues, and a report can be printed showing the summary statistics for all customers whose differences exceed a chosen threshold (defined by a minimum aggregate revenue deviation based on a stated minimum number of shipments). Subtotals by lane can also be produced for a customer to identify significant differences at that level. Lanes where actual revenues are less than expected would be candidates for upward pricing adjustments. Lanes where actual revenues are greater than expected would call for reinforcement of the beneficial customer relationships. The next section discusses how managers might use such information to design pricing experiments for improving corporate performance.

A SYSTEMATIC APPROACH TO VALUE-BASED PRICING

Models based on cross-sectional analyses of this sort provide some insight about the potential effects of changing general rate structures and service levels. It is impossible, though, to infer the effects of such changes on the behavior of individual customers or customer groups. Additional corporate intelligence is required to estimate how individual customers or customer groups may respond to rate changes. Ultimately, the effects can only be assessed by imposing the changes and observing the results. The differences between the actual and benchmark revenues should be used to guide in the design of marketing experiments for assessing the consequence of altering rates in specific markets or for specific customer groups.

TABLE 3
SYSTEM-WIDE TOTAL REVENUE DEVIATION AGGREGATED BY CITY RANK

City Rank Category	Actual Revenue	Expected Revenue	Deviation (Act. - Exp.)	% Deviation
10	61,313,174	63,356,459	-2,043,285	-3.2
9	37,924,670	39,326,468	-1,401,798	-3.6
6	16,752,318	16,734,710	17,609	0.1
7	19,898,685	19,810,838	87,847	0.4
2	3,241,228	3,121,147	120,081	3.8
3	4,294,813	4,077,087	217,726	5.3
1	2,097,118	1,838,983	258,135	14.0
4	8,588,509	7,690,684	897,825	11.7
5	12,965,521	12,045,443	920,078	7.6
8	25,802,159	24,810,499	991,660	4.0

Consider the case of making rate adjustments at a designated terminal. When reviewing the discounts offered to customers there, it is suggested that the residuals (deviations between actual and expected revenues) from the statistical models be used to cluster the customers into three categories: (1) Low for customers whose actual revenues are materially below the expected values, (2) OK for customers whose actual and expected revenues are essentially equal, and (3) High for customers whose actual revenues exceed expectations by a material amount. This can be done using data for the individual terminal on one hand, and for the entire system on the other hand (thus creating nine possible categories into which the customers could be slotted). Table 4 presents the results of such a categorization for a specific terminal of interest. (In this case, 1 percent and at least $1,000 was used to designate a material difference.) Using these criteria, the 1,023 customers with shipments originating at the illustrative terminal in a one-year period were grouped. The row classifications divide customers using models developed on the basis of monthly shipments for lanes involving that terminal. The column classifications divide customers on the basis of monthly shipments for all lanes system-wide. The right-most column and the bottom row are totals across the columns and rows, respectively. At the terminal alone, the vast majority of customers (850 / 1023 = 83 percent) fell within the OK category, with only 9 percent in the Low category and 8 percent in the High category. System-wide, the distribution was more even, with 43 percent in the Low category, 40 percent in the OK category and 17 percent in the High category. By combining the three groupings from both the individual-terminal and system-wide perspective, it is possible to assign each customer to one of nine composite revenue deviation categories and thus, identify key customers for review. The customers whose revenues fall below the norm at both the terminal level and system-wide (Low-Low customers) are the prime candidates for upward rate adjustments (perhaps by reducing their discounts). The customers whose revenues are above the norm at both the terminal level and system-wide (High-High customers) seem to merit special attention to preserve the business relationship.

In the instance of the chosen terminal, the 68 customers whose revenues fall materially below the norm at the terminal, and also below the norm system-wide, should be scrutinized to assess whether there are other factors (such as special cargo type, tendency to ship on lanes where there is heavy competition, lower level of service rendered on some dimension, or better access to other shipping alternatives for some reason) that can account for their negative deviations. Absent such explanations, these customers would seem to be candidates for a downward adjustment to their discounts. In the spirit of value-based pricing, however, it is recognized that the perceived need for expedited service may not be so great for some of these customers, and that the lower rates may have been necessary to capture their business.

TABLE 4
CUSTOMER GROUPINGS BASED ON ANALYSES OF CHOSEN TERMINAL AND SYSTEM-WIDE REVENUES

	Low – System	OK – System	High – System	Terminal Total
Low – terminal	68	7	17	92
OK – terminal	361	385	104	850
High – terminal	11	16	54	81
System Total	440	408	175	1,023

Perhaps the discounts for such value-conscious customers could be continued, but with a softer guarantee of service delivery time. Nonetheless, a managerial review of quoted rates for the Low-Low customers should occur in light of the deviation reports, and experiments should be conducted to determine the effect on revenues of raising their rates (reducing their discounts). It is recommended that the Low-Low customers who, after managerial review, seem still to be appropriately categorized, be split into three balanced sub-groups which will receive differential changes in rates as follows.

- Group 1 to receive a designated change in discount in month 1 of the experiment.

- Group 2 to receive a designated change in discount in month 3 of the experiment if the net effect of change of rates for Group 1 customers appears to be beneficial.

- Group 3 to receive a designated change in discount in month 5 of the experiment if the net effect of changes of rates for Groups 1 and 2 appears to be beneficial.

Increasing rates in a recessionary period may pose some risks. In this case, the experimental program may be designed in connection with some volume incentive scheme to reduce the potentially negative impact.

On the other end of the spectrum are the High-High customers whose actual revenues exceed expected revenues based on both the terminal-level analysis and system-wide analysis. Again, these deviations might be due to traffic on lanes where there is little competition, or due to the provision of additional services. Managerial review should occur with these possibilities in mind and the grouping should be validated by management. Programs designed for retention of this business should be designed and administered with a similar experimental format.

- Group 1 to receive attention in month 1 of the experiment.

- Group 2 to receive attention in month 3 of the experiment if the net effect of change in attention for Group 1 customers appears to be cost-justified.

- Group 3 to receive attention in month 5 of the experiment if the net effect of changes in attention for Groups 1 and 2 appears to be cost-justified.

Similar tactics to those described above may be employed for analysis in connection with origin airport, size of city served by the origin airport, marketing region, and customer type. The "rate deviation" analyses on these broader dimensions will point to areas where the basic rate structure (as opposed to individual customer discounts) might potentially be altered to improve profitability.

CONCLUSION

Tools can be built economically with standard database and statistical software in order to assist freight carriers in determining appropriate rate adjustments. The analytical approach is hierarchical (top-down) in character, proceeding from broad statistical summaries of corporate performance to detailed summary statistics, to formal statistical models, to the search for further information on related factors (guided by deviations from the norms produced by the statistical models). The utility of regression models to produce benchmarks for this purpose was demonstrated, as well as how the benchmarks from such models, like the results of any statistical analysis, can depend upon the segments of business activity (e.g., time frame or portions of the transportation network) chosen for developing them. Finally, it was shown that differences between actual rates and the benchmark rates from the statistical models might be used in systematic programs for periodic rate review and customer relationship management. The system prototypes were developed for a large motor carrier with a distribution network covering major cities throughout the United States and parts of Canada. These same systems could readily be implemented by other carriers using desktop computer systems.

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