TOPIC 10
FREIGHT AND LOGISTICS

ROAD HAULAGE PERFORMANCE IN SMALL VOLUME MARKETS

GARLAND CHOW
Faculty of Commerce
The University of British Columbia
Vancouver, B.C., V6T 1Z2
CANADA

EIJI SHIOMI
Faculty of Economics
Chuo University
Tokyo, JAPAN

JOAN CARAVAN
Faculty of Commerce
The University of British Columbia
Vancouver, B.C., V6T 1Z2
CANADA

Abstract

The relationship between road haulage rates and market characteristics such as market share, concentration and size of market is analysed. Truck transport markets are defined by freight type, commodity and origin-destination points. The empirical results indicate that prices are lower in concentrated markets and for carriers with the largest market shares. This suggests that there are efficiency gains from market concentration when traffic density is low.

INTRODUCTION

The *Motor Carrier Act of 1980* deregulated interstate trucking in the US Extraprovincial trucking deregulation in Canada started with the *Memorandum of Understanding* between the provincial and federal Transport Ministers in 1985 and was completed with the *Motor Vehicle Transportation Act of 1987*. Mexico deregulated its trucking industry in July 1989 as part of the country's overall restructuring plan (Landero, 1989). This deregulation of road haulage in North America has led to many structural changes in the trucking industry. Although the total number of firms in road haulage has increased, most of the new firms are small firms competing in the truckload (TL) market (Glaskowsky, 1987; NTA, 1993). In contrast, the less-than-truckload (LTL) market is perceived to have become more concentrated as bankruptcies and consolidations have resulted in fewer and larger carriers dominating the movement of small shipments (Rakowski, 1988; Kling, 1990; NTA, 1993). This outcome was not expected by many economists as their studies generally found no scale economies in the trucking industry (Friedlaender and Spady, 1978; Klem, 1978). An exception was Chow (1978a) who observed economies of scale in various segments of the LTL trucking industry. "It now appears that the extremely low levels of concentration in the for-hire trucking industry were the result of regulation rather than the lack of economies of scale" (Boyer, 1993). Therefore, an important issue is whether this concentration leads to decreased competition in the market with the traditional negative performance implications.

This analysis provides some insights into the behaviour of motor carriers under various levels of concentration using data representing specific origin-destination markets in Canada. The analysis distinguishes between large and small markets and focuses on the LTL market. The next section reviews the relevant literature and discusses the theory behind our models. The section following describes the model and data utilized. Our empirical findings and observations are then displayed. Finally, we present our conclusions and the implications for trucking policy.

CONCENTRATION EXPECTATIONS AND IMPLICATIONS

Several alternative hypotheses can be made concerning market conduct and its relationship to concentration (Shepherd, 1988). Traditional collusion theory suggests that the degree of effective collusion is positively associated with the degree of concentration. This precept is based on the simple idea that the organization of a cartel and the ability to collude will be easier if a small number of firms account for a large share of the market. Furthermore, the detection of 'price-shading' (slight price reductions by members to capture more sales) is likely to be easier with a smaller number of firms. In contrast, the efficiency hypothesis contends that a high level of concentration is the outcome of superior firm performance. Supranormal profits (prices) accruing to large firms are indicative of their increased efficiency, lower costs, and/or innovations in technology or organization. A variation of the efficiency hypothesis is that firms with larger market shares are more efficient and that these efficiencies are reflected in lower prices. A more highly concentrated market will thus result in cost efficiencies and lower prices.

The economic logic supporting the collusion hypothesis is well-known and generic. However, the efficiency hypothesis needs some elaboration with respect to transport firms such as road haulage. Many studies have identified economies of traffic density as a source of lower costs per unit of output in transport. Tretheway and Oum (1992) state "...(O)nce a set of cities are being served, additional traffic does not require any increases in the fixed operation costs; advertising need not be increased...the fixed operation costs can be spread out over more traffic, allowing unit costs to fall". Traffic density affects the ability to fully utilize the capacity of vehicles (for example, by raising the average load per vehicle trip). Higher levels of traffic density result in lower costs per unit of freight carried since most of the costs of a vehicle trip are constant. Chow (1994) demonstrates how higher traffic density allows a carrier to provide more frequent and reliable service with constant utilization of the capacity on any particular route. Increased traffic density also allows LTL carriers to maximize pickup and delivery (P&D) efficiency since more shipments are picked up or delivered per stop and stops will be closer together (Keaton, 1993). In an LTL system that uses hub (breakbulk) terminals, higher point-to-point traffic density increases the economic viability of direct service, thus avoiding the expenses of rehandling freight at intermediate hub terminals (Chow and Shiomi, 1995). Finally, higher traffic density may allow truckers to use larger, more efficient vehicles in both P&D and linehaul.

Firms that are able to achieve a high level of traffic density need not pass on their productivity gains to their customers unless competitive pressures exist to compel them. The threshold costs of entering the LTL sector of road haulage are not insignificant. The LTL carrier needs to develop a relatively costly and asset-based network of terminals using pickup and delivery and linehaul fleets (Chow, 1978b). However, motor carriers compete in multiple geographic markets. While one origin-destination market may be dominated by carrier A, another market may be dominated by carrier B and each carrier can threaten to expand into the other's market via a simple shift in vehicle capacity. Motor carrier markets, defined by origin-destination (O-D) points, satisfy most of the requirements of being 'contestable'.

The importance of traffic density on the cost and ultimately the price and quality of transport service is accentuated in smaller volume markets since there is less traffic to support multiple competitors. One would expect low volume markets to have fewer competitors or higher concentration levels in order to achieve levels of service and cost comparable to higher volume markets.

In summary, there are alternative expectations concerning how concentration levels in LTL trucking markets, defined by origin and destination points, will affect firm behaviour and performance. We propose that the traditional concentration-price relationship be investigated through the use of spatially differentiated market comparisons. The econometric model is a reduced form price equation where concentration is treated as an exogenous surrogate for quantity as well as an aggregate measure of traffic density for the dominant firms in the specific market. A similar formulation is often used in airline research (Borenstein, 1989).

METHODOLOGY AND DATA

The product of transportation is "...the capability to move certain commodities between specific origins and destinations at an expected service quality level" (Studnicki-Gizbert, 1970). In this study, we focus on LTL truck markets where:

- transported shipments are less than 10,000 lbs per consignment;
- all transported commodities are identified as either fabricated materials (inedible) or end products (inedible), or general or unclassified freight; and
- origin and destination points are metropolitan areas as defined by Statistics Canada.

The basic unit of observation is then the *i*th origin-destination market in the *j*th year. We posit that the average price per unit of transport output in each market is dependent upon:

- the characteristics of the freight movement,
- input costs, and
- the characteristics of the O-D market.

Therefore, the econometric model is a reduced form price equation where concentration is treated as an exogenous surrogate for quantity. The equation takes the form:

$$\ln AVGRATE_{ij} = \alpha_{ij} + \beta_1 \ln AVGWGT_{ij} + \beta_2 \ln AVGDIST_{ij} + \beta_3 \ln COSTPKM_{ij} + \beta_4 \ln CR4(TKM)_{ij} + \beta_5 \ln IMBTONS_{ij} + \beta_6 \ln TNNCAR_{ij} + \sum \delta_y REGION_y + \sum \delta_z YEAR_z \quad (1)$$

where *i* indexes the origin-destination market and *j* indexes the year. We utilize the following definitions to measure the dependent and independent variables in this relationship:

- *AVGRATE* is the average revenue per tonne-kilometre in the market;
- *AVGWGT* is the average weight in kilograms per shipment in the market;
- *AVGDIST* is the average distance in kilometres travelled by the shipments in the market;
- *COSTPKM* is a cost index measured in dollars per vehicle kilometre in the market;
- *CR4(TKM)*, the measure of concentration in each O-D market, is the 4-firm concentration ratio using the firm's share of total tonne-kilometres in the market as the base;
- *IMBTONS*, the measure of the level and direction of imbalance in the market, is calculated as the ratio of backhaul to fronthaul tonnage in the market;
- *TNNCAR* is the tonnes per carrier in the market which is derived from *TONNES*, the total tonnes of freight traffic in the market, and *NCAR*, the number of carriers that compete in the market as indicated by the shipment of at least one shipment in the year of the observation;
- *REGION* is a dummy variable for selected regional market lanes; and
- *YEAR* is a dummy variable for the *j*th year with 1982 as the base year.

The source of shipment level data is the For-Hire Trucking Survey, also called the Truck Origin-Destination Survey (henceforth TOD) conducted annually by Statistics Canada since 1976. The TOD is a random sample of freight shipments by road haulers which includes information concerning the shipment weight, the origin-destination points, the commodity category, a carrier identification, and the sampling ratio. The authors obtained the disaggregated shipment observations for the 45 largest one-way origin-destination markets in Canada and their corresponding return (backhaul) movements. The database thus contained potentially 90 geographic markets over a seven year period from 1982 to 1988. The variables identified above were estimated from this database by aggregating the shipment information to the O-D market level with the exception of the *COSTPKM*, *REGION* and *YEAR* variables. A natural logarithmic transformation of all continuous variables was used while the dummy variables remained untransformed.

ESTIMATION RESULTS AND INTERPRETATION

Market characteristics

The characteristics of the LTL market studied are shown in column 1 of Table 1. The maximum number of markets in any year never exceeds 85 as some markets were too small to be reported for confidentiality reasons and some markets were not represented due to data collection problems. When aggregated, these markets represented about 20 percent of the total Canadian for-hire LTL market. The typical market in the sample has a volume of 52,199 shipments with each shipment weighing about 587 kilograms. Approximately 20 firms competed per market and the average 4-firm concentration ratio was 70 percent over the entire time period.

The standard deviations shown in Table 1 suggest wide variability in market size characteristics. The markets are segmented according to whether or not the annual number of shipments was greater than or equal to, or less than 30,000 shipments per year as suggested by a US study (US Committee on Commerce, Science, and Transportation, 1979) which used 30,000 shipments to define high volume, LTL, interstate routes. The result of this segmentation are shown in columns 2 and 3 of Table 1. Aside from the expected differences in market size (ie volumes in tonnes, shipments and revenues), smaller markets are significantly more concentrated than larger markets. For example, the average CR4 for the smaller markets is 0.77 while it is only 0.62 for the larger markets. Another significant difference is the measure of imbalance which is roughly equal to one for the large markets but significantly imbalanced for the smaller markets. The average shipment and distance characteristics are similar.

Table 1 Canadian LTL trucking: 1982-1988: means and standard deviations for selected characteristics over all O-D markets

Market Characteristic	Annual All Markets (1)	Annual Large Markets (2)	Annual Small Markets (3)
Volume (Tonnes)	18,600	35,229	4,311
	(31,103)	(39,531)	(4,349)
Shipments	52,199	99,329	11,699
	(76,674)	(92,319)	(9,178)
Revenues ($ M)	5.06	9.35	1.37
	(6.58)	(7.60)	(1.23)
Cost per Km ($)	1.15	1.15	1.14
	(0.10)	(0.10)	(0.10)
Imbalance (Tonnes)	2.97	1.12	4.64
	(4.55)	(1.84)	(5.53)
Average Shipment	587	554	616
Weight (Kg)	(270)	(224)	(302)
Average Shipment	1,651	1,586	1,708
Distance (Km)	(1,242)	(1,371)	(1,120)
CR4 (Tonne-Km)	0.70	0.62	0.77
	(0.17)	(0.15)	(0.15)
Herfindahl Index	0.22	0.15	0.27
(Tonne-Km)	(0.18)	(0.09)	(0.21)
Tonnes per Carrier	631	1056	277
	(690)	(803)	(247)
# of O-D Markets	77.63	35.43	42.57
	(10.56)	(6.37)	(4.20)
# of Carriers per	19.91	27.90	13.05
O-D Market (NCAR)	(11.63)	(11.48)	(6.06)

A test of homogeneity is used to determine if the large and small market parameter estimates for equation (1) are significantly different. The analysis of covariance test suggested by Johnston (1972) confirms that the slope coefficients and the intercepts for the two populations are different. The F-statistic for the test of overall homogeneity is 3.933; the F-statistic for the test of differential slope vectors is 3.242; and the F-statistic for the test of differential intercepts is 16.882. All three of these values are significant. Therefore, separate estimates of the parameters are calibrated for the large and small markets as well as for the total LTL market. These coefficients are shown in Tables 2 and 3. Standard errors are shown in parentheses. A t-statistic of 2.326 would indicate a significance level of 0.01. Due to the large sample sizes, the following discussion will use that critical value to indicate statistical significance.

We expect market size, as measured by *TONNES*, and the number of competitors in the market, as measured by *NCAR*, to be inversely related to rate levels since larger volume markets allow for greater competition and competitive conduct is encouraged by a larger number of competitors. However, if the available traffic volume cannot support a large number of competitors, then costs are higher and this outcome is reflected in rates. Therefore, we included a traffic per carrier variable, *TNNCAR*, in the model to reflect the combined effect of both market size and the number of competing firms. Multicollinearity could result if all three variables were specified in the equation. For example, in the "all markets" population, the correlation coefficient between ln(*TNNCAR*) and ln(*TONNES*) is 0.9716, the correlation between ln(*TNNCAR*) and ln(*NCAR*) is 0.7551, and the correlation between ln(*TONNES*) and ln(*NCAR*) is 0.8888. Thus only TNNCAR was used in the model. The *TNNCAR* coefficient is significantly negative indicating that increases in *TNNCAR* lead to increased productivity and therefore lower costs and rates.

The *AVGWGT* and *AVGDIST* coefficients are consistently in the same range and of the expected signs in the model specification for large or small volume markets. Shipments shipped in larger lot sizes and over longer distances cost less per tonne-kilometre to produce. The coefficients are also very similar to those produced by McRae and Prescott (1980) based on comparable 1975-1976 data.

Table 2 Canadian LTL truck performance: parameter estimates of continuous variables

Variable	All Markets (N = 534)	Large Market (N = 248)	Small Market (N = 286)
ln *CR4TKM*	-0.374**	-0.294**	-0.453**
	(0.046)	(0.042)	(0.087)
ln *AVGWGT*	-0.275**	-0.289**	-0.128**
	(0.029)	(0.045)	(0.038)
ln *AVGDIST*	-0.537**	-0.573**	-0.527**
	(0.012)	(0.026)	(0.021)
ln *IMBTONS*	0.034**	-0.004	0.038
	(0.008)	(0.023)	(0.042)
ln *COSTPKM*	0.016	-0.476*	-0.876**
	(0.027)	(0.170)	(0.240)
ln *TNNCAR*	-0.164**	-0.219**	-0.253**
	(0.013)	(0.020)	(0.020)
Intercept	5.269	5.850	4.827
	(0.226)	(0.368)	(0.317)
R-Square	0.826	0.929	0.772
Adjusted R-Square	0.822	0.925	0.763

Notes:

* Significant at the 0.01 level
Standard errors in parentheses
** Significant at the 0.001 level

The *IMBTONS* variable is insignificant in both the large and small market estimates but significant in the total market estimate. As noted above, the large and small markets had significantly different mean values of *IMBTONS*. This suggests that the homogeneity of this market characteristic within each of the markets may have produced these insignificant results.

The *COSTPKM* coefficients are insignificant for the pooled market but significantly negative for the large and small volume markets individually. These results are not consistent with the *a priori* expectation that an increase in this aggregate input price would increase total costs and therefore prices. The results observed here also contradict earlier findings where the unit of observation was the individual shipment rather than the origin-destination market (Chow and Caravan, 1991). The *COSTPKM* variable was derived from secondary data at the origin-destination level while all the other variables were aggregated from individual shipment level data to the origin-destination level. Thus the unexpected negative coefficient for *COSTPKM* may be due to an aggregation problem. This possible explanation will be the subject of future research. The estimation of the reduced form price equation without *COSTPKM* did not significantly change the values of any of the remaining variables in the equation, indicating the lack of any significant collinearity between *COSTPKM* and the other variables in the equation. Hence, we retain the estimation results shown in Tables 2 and 3.

The signs and the significance levels of the coefficients of the *REGION* and *YEAR* variables varied across the three markets. No *a priori* expectations with respect to the *REGION* results were made because of the uncertainty regarding the actual level and nature of regulation in each of these markets. The base year for the *YEAR* variable is 1982. Holding the other variables in the equation constant, the following pattern is exhibited in the large market: no change in rates in 1983, increases in rates in the 1984 through 1986 period relative to 1982, and a reduction in rates in 1987 back to 1982 levels. Freight rates appear to have reached a peak in 1985 with rates 16 percent higher than rates in 1982. Rates then dropped slightly in 1986 and further still in 1987 and 1988. The *YEAR* coefficients for the small market indicate that throughout the 1983 to 1988 period, rates did not significantly change from rates in 1982.

In summary, apart from the coefficient estimates for *COSTPKM*, the coefficient estimates are consistent with our *a priori* expectations. Approximately 93 and 76 percent of price variation is explained by the estimates for the large and small volume markets respectively. We now discuss the estimates of the variable of primary interest, *CR4TKM*.

Table 3 Canadian LTL truck performance: parameter estimates of dummy variables—model consistency (large and small markets)

Variable	All Markets (N = 534)	Large Market (N = 248)	Small Market (N = 286)
REGION2	-0.272**	-0.158	-0.267**
	(0.039)	(0.061)	(0.055)
REGION3	0.033	0.336**	-0.058
	(0.022)	(0.053)	(0.038)
REGION5	-0.230**	-0.130*	-0.182*
	(0.038)	(0.047)	(0.055)
REGION6	-0.246**	-0.120	-0.250**
	(0.039)	(0.054)	(0.061)
REGION7	-0.028	-0.002	0.025
	(0.019)	(0.019)	(0.031)
REGION9	-0.037	0.194**	-0.375**
	(0.023)	(0.039)	(0.067)
REGION10	-0.140*	-0.005	-0.310
	(0.050)	(0.024)	(0.121)
REGION11	0.048	0.131*	0.033
	(0.040)	(0.050)	(0.058)
REGION12	-0.009	0.009	-0.017
	(0.022)	(0.026)	(0.034)
YEAR83	-0.011	-0.002	0.016
	(0.019)	(0.021)	(0.031)
YEAR84	0.009	0.116**	0.019
	(0.019)	(0.030)	(0.030)
YEAR85	0.014	0.161**	0.006
	(0.019)	(0.028)	(0.030)
YEAR86	-0.003	0.135**	0.008
	(0.019)	(0.028)	(0.030)
YEAR87	-0.186**	-0.025	-0.101
	(0.029)	(0.020)	(0.044)
YEAR88	-0.155**	0.017	-0.018
	(0.029)	(0.026)	(0.042)

Notes:

* Significant at the 0.01 level
Standard errors in parentheses
** Significant at the 0.001 level

Concentration-collusion-efficiency findings

The effect of concentration as a measure of market power is the focus of this study. In all three markets, the coefficients for *CR4TKM* are significantly negative. Lower rates seem to result from trucking markets being more concentrated. These rate regression results indicate that the collusion hypothesis is not applicable to the domestic Canadian LTL commodity markets examined here. Rather than fostering higher rate levels, higher levels of concentration are associated with lower rate levels. The impact of concentration is significantly higher for small markets than for large markets as indicated by the coefficients for *CR4TKM* of -0.45 and -0.29 respectively. This result is due to carriers in the larger markets having already reached efficient volume thresholds. For example, as shown in columns 2 and 3 of Table 1, the tonnes per carrier in large markets is nearly four times the tonnes per carrier in small markets. Thus the small volume markets have proportionately more competitors than larger volume markets. The net effect is illustrated in Figure 1 where revenue per tonne-kilometre is estimated for each size market as a function of concentration, holding other influences at their mean values across all O-D markets in the market size category. A revenue per tonne-km of $0.35 is achieved in large markets at a concentration level of slightly over 0.25 whereas the same amount is obtained in small markets at a concentration level of about 0.45.

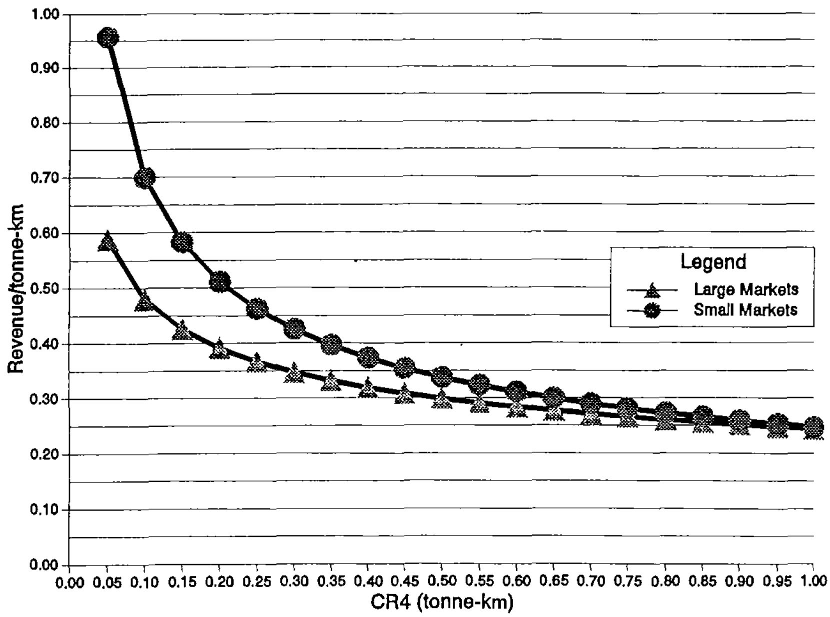

Figure 1 Revenue/tonne-km as a function of CR4 (tonne-km): 1988 (segmented by size of O-D market)

The productivity impact of market volume, concentration and number of competitors can be illustrated with a simple simulation of the potential traffic available to each various groups of carriers. In Tables 4 and 5, we assume a standard load per vehicle trip to be 24,000 pounds and 250 working days in a year. This standard load is slightly less than the average load reported for general freight carriers in the US (see ATA, 1987). The 250 working days per year assumption recognizes the normal business week that most carriers offer to pick up freight. If either of these two factors were to increase (eg higher loads or more working days), the amount of freight available to competing carriers would even be less, and the conclusions even stronger.

The number of potential vehicle trips per day is calculated by dividing total tonnes by both of these numbers. These vehicle trips can be allocated between the larger four firms and the remaining competitors using the CR4 value. Finally, the potential number of vehicle loads per day can be calculated for the four carriers with the largest market share and the remaining carriers. The simulated productivity shows that in large volume markets, the four carriers with the highest market share have from 1.4 to 2.3 loads per day if the traffic is shared equally, which is enough to allow each carrier to provide daily service between the two points in the market. In contrast, the remaining carriers would only have less than one-fifth of a vehicle load if all the remaining firms equally split the remaining traffic. The small market estimates are even more dramatic in terms of the low level of productivity. The top four firms in each small market would transport less than three-tenths of a vehicle load on an average day and the remaining competitors would move practically empty.

Table 4 Canadian LTL trucking productivity: large markets—means and standard deviations for selected characteristics over all O-D markets

Market Characteristic	1982	1984	1986	1988
Tonnes	25,278	32,802	35,096	41,365
	(22,757)	(33,126)	(39,229)	(45,757)
CR4 (Tonne-Km)	0.59	0.62	0.62	0.65
	(0.14)	(0.14)	(0.16)	(0.17)
# of Firms	25.7	28.0	30.2	29.7
	(8.5)	(11.3)	(11.5)	(13.7)
# of Loads @ 12 tons/load	2,317	3,007	3,217	3,792
	(2,086)	(3,037)	(3,596)	(4,194)
# of Trips per Day	9.3	12.0	12.9	15.2
	(8.3)	(12.1)	(14.4)	(16.8)
Volume Share of Top 4 Firms (Tons)	16,885	21,039	23,196	27,201
	(19,149)	(22,333)	(29,184)	(27,859)
# of Loads for Top 4 Firms	1,407	1,753	1,933	2,267
	(1,596)	(1,861)	(2,432)	(2,322)
Trips/Day of Top 4 Firms	5.6	7.0	7.7	9.1
	(6.4)	(7.4)	(9.7)	(9.3)
Trips/Day/Firm (of Top 4 Firms)	1.41	1.75	1.93	2.27
	(1.60)	(1.86)	(2.43)	(2.32)
Volume Share of Remaining Firms (Tons)	10,921	15,043	15,410	18,301
	(9,134)	(19,491)	(20,585)	(26,481)
# of Loads for Remaining Firms	910	1,254	1,284	1,525
	(761)	(1,624)	(1,715)	(2,207)
Trips/Day of Remaining Firms	3.6	5.0	5.1	6.1
	(3.0)	(6.5)	(6.9)	(8.8)
Trips/Day/Firm (of Remaining Firms)	0.15	0.17	0.15	0.17
	(0.08)	(0.12)	(0.12)	(0.15)

Note:
Standard deviation in parentheses

In reality, most carriers will not dispatch a vehicle movement without sufficient freight. Thus, in the case of the small markets, it is likely that most of the carriers offer less than daily service and that service is staggered across the competitors. For example, each of the top four carriers in the typical small market may dispatch a vehicle once a week in each O-D market resulting in frequent service between any two points but the service will be offered by only one competitor on any given day. In addition, many of the small markets may be backhaul routes for a larger market. The vehicles would then move regardless of the load.

These relationships reflect the highly competitive nature of trucking. The negative relationship consistently observed between concentration and rate levels suggests the dynamics that lead to this result. A comparison between the number of loads available on the average day on the average route and the number of potential competitors indicates that there is enough traffic for only a few carriers to fully utilize their vehicles consistently. Carriers with larger market shares are able to utilize their capacity more effectively, and this productivity is passed on to shippers due to the presence of many competitors. In both large and small markets, there are competitors who can easily expand their service offerings if these productivity advantages are not reflected in the prices of the carriers with the highest market shares. Christensen and Huston (1987) reach a similar conclusion in their examination of US specialized trucking markets, observing "There remains, of course, the risk of monopolization occurring in low density routes, where the minimum efficient scale represents a large proportion of the market. Development of such market power is unlikely, however, due to the ease of entry and exit in specialized trucking markets."

Table 5 Canadian LTL trucking productivity: small markets—means and standard deviations for selected characteristics over all O-D markets

Market Characteristic	1982	1984	1986	1988
Tonnes	3,645	4,124	4,213	4,464
	(3,133)	(4,125)	(4,142)	(4,354)
CR4 (Tonne-Km)	0.77	0.78	0.77	0.79
	(0.17)	(0.15)	(0.16)	(0.14)
# of Firms	11.9	12.1	13.8	13.5
	(5.9)	(5.5)	(6.2)	(6.3)
# of Loads @ 12 tons/Load	334	378	386	409
	(287)	(378)	(380)	(399)
# of Trips per Day	1.34	1.51	1.54	1.64
	(1.15)	(1.51)	(1.52)	(1.60)
Volume Share of Top 4 Firms (Tons)	2,797	3,333	3,325	3,576
	(2,433)	(3,853)	(3,550)	(3,569)
# of Loads for Top 4 Firms	233	278	277	298
	(203)	(321)	(296)	(297)
Trips/Day of Top 4 Firms	0.93	1.11	1.11	1.19
	(0.81)	(1.28)	(1.18)	(1.19)
Trips/Day/Firm (of Top 4 Firms)	0.23	0.28	0.28	0.30
	(0.20)	(0.32)	(0.30)	(0.30)
Volume Share of Remaining Firms (Tons)	1,213	1,204	1,309	1,334
	(1,344)	(1,354)	(1,556)	(1,490)
# of Loads for Remaining Firms	101	100	109	111
	(112)	(113)	(130)	(124)
Trips/Day of Remaining Firms	0.40	0.40	0.44	0.44
	(0.45)	(0.45)	(0.52)	(0.50)
Trips/Day/Firm (of Remaining Firms)	0.05	0.04	0.03	0.03
	(0.12)	(0.04)	(0.03)	(0.03)

Note:
Standard deviation in parentheses

CONCLUSIONS AND POLICY IMPLICATIONS

The empirical findings of this study show that higher levels of concentration are related to lower rates for the LTL freight markets examined here. An examination of the dynamics of the LTL truck market suggest that there is a causal relationship in which the concentration of freight volume in a few firms (ie the top four in terms of market share) results in a level of traffic density that allows frequent movement of fully loaded vehicles. In addition, rates decrease with the size of the market relative to the number of competitors in the market as measured by the tonnes of freight available to each competitor. We observed that small volume markets in Canada have more competition relative to the size of the market as measured by the freight tonnage available per competitor. We also observe that carriers in small markets have potentially lower productivity and significantly higher rates.

These observations could be interpreted as supporting the concept of regulated monopoly as adopted by many regulatory jurisdictions in the past and to some degree now. For example, regulators of rural truck markets sought to limit access in specific routes to one carrier on the premise that fragmentation of the available traffic would reduce service and decrease productivity. However, it is generally acknowledged that regulators cannot do as good a job as the market in determining shippers' preferences. Chow (1983) demonstrated that the unregulated Alberta market resulted in higher prices *and* higher service quality than what was produced in the highly regulated trucking market in neighbouring Saskatchewan.

How can unregulated markets result in meeting shippers' preferences for the correct price-service combination, yet avoid unnecessary fragmentation? In unregulated markets, the transportation selection and purchase decisions by each shipper regulate the entry and exit of carriers. Although consumer wants are reflected, a system-wide view of the economies of the market is not taken by an individual shipper which only knows how much freight it offers and not the total freight density available in the market. Individual shippers choosing their freight carriers independently could fragment the market unnecessarily. In contrast, if all decision-making for all the freight in a relevant market were consolidated, the market fragmentation impact would be known readily. This centralization of purchasing could be accomplished through voluntary group purchasing. Chow and Caravan (1995) suggest that "...the shippers in smaller markets could consolidate their transportation purchasing and make choices to encourage equipment utilization, negotiate lower prices, and reflect the cost/service trade-offs desired." Such an arrangement effectively controls entry since the threat to the existing carrier is the possibility of losing a significant amount of business or, conversely, the availability of a significant amount of traffic which would support a potential entrant immediately. Group purchasing is of course not new and has been effectively implemented in the form of non-profit co-operatives or in the form of freight forwarders who consolidate freight of many shippers. If the direction of government is to let markets regulate themselves, there is still a role for public policy. Government programs that educate shippers and facilitate cooperation can lead to consolidated purchasing on a voluntary basis where justified.

In summary, increased concentration, even at the high levels observed here for small truck markets in Canada do not appear to lead to collusive behaviour and monopolistic price levels. Instead, increased concentration leads to carriers achieving higher traffic density and higher productivity in truck markets. The existence of substantial competition, current and potential, appears to be a sufficient incentive to pass these productivity benefits on to the shipping public in the form of lower rates.

ACKNOWLEDGMENTS

The financial support of Transport Canada and the University of British Columbia are gratefully acknowledged.

REFERENCES

American Trucking Associations, Inc. (ATA) (1987) *1986 Motor Carrier Annual Report.* American Trucking Associations, Inc., Alexandria, VA.

Borenstein, S. (1989) Hubs and high fares: dominance and market power in the US airline industry. *Rand J. of Econ.* 20:3, Autumn, 344-365.

Boyer, K.D. (1993) Deregulation of the trucking sector: specialization, concentration, entry, and financial distress. *South. Econ. J.* 59:3, 481-495.

Chow, G. (1978a) The cost of trucking revisited. In: *Motor Carrier Economic Regulation*, 57-98. National Academy of Sciences, Washington, D.C.

Chow, G. (1978b) *The Economics of the Motor Freight Industries.* Division of Research, School of Business, Indiana University, Bloomington, IN.

Chow, G. (1983) An evaluation of LTL transportation to small rural communities in Western Canada, *The Logistics and Transportation Rev.* 19:3, 225-244.

Chow, G. (1994) Transportation in low density markets: a role for public policy? *Papers of the Australasian Transport Research Forum* 19, 501-516. University of Melbourne, Parkville, Aust.

Chow, G. and J. Caravan (1991) Concentration, market share and rates in Canadian LTL trucking. *Working Paper 91-TRA-001*, University of British Columbia, Vancouver, Canada.

Chow, G. and E. Shiomi (forthcoming 1995) Market concentration and efficiency: the case of trucking. *The Annual of the Institute of Economic Research*, Chuo University, Tokyo, Japan.

Christensen, L.R. and J.H. Huston (1987) A reexamination of the cost structure for specialized motor carriers. *The Logistics and Transportation Rev.* 23:4, 339-351.

Friedlaender, A.F. and R.H. Spady (1978) Hedonic cost functions for the regulated trucking industry. *Bell J. of Econ.* 9:1, 159-179.

Glaskowsky, N. (1987) *Effects of Deregulation on Motor Carriers.* Eno Foundation for Transportation Inc., Westport, CT.

Johnston, J. (1972) *Econometric Methods*, 2nd edition. McGraw-Hill Book Company, New York.

Keaton, M.H. (1993) Are there economies of traffic density in the less-than-truckload motor carrier industry?: an operations planning analysis. *Transp. Res.-A* 27A:5, 343-358.

Klem, R. (1978) The cost structure of the regulated trucking industry. *Motor Carrier Economic Regulation*, 141-171. National Academy of Sciences, Wash., D.C.

Kling, R.W. (1990) Deregulation and structural change in the LTL motor freight industry. *Transp. J.*, 29:3, 47-53.

Landero, A.D. (1989) Economic appraisal of the deregulation process in the Mexican load transport market. Paper presented at the *Transportation Research Forum Annual Conference*, Williamsburg, VA, 1-15, October 1989.

McRae, J.J. and D.M. Prescott (1980) An econometric analysis of the effects of regulation on the Canadian common carrier industry. *Studies in Trucking Regulation* II, Working Paper No. 3, Economic Council of Canada, Ottawa.

National Transportation Agency (NTA) (1993) *Annual Review.* Supply and Services Canada, Ottawa.

Rakowski, J.P. (1988) Marketing economies and the results of trucking deregulation in the less-than-truckload sector. *Transp. J.*, 27:3, 11-22.

Shepherd, W.G. (1988) Three 'efficiency school' hypotheses about market power. *The Antitrust Bull.*, Summer, 395-415.

Studnicki-Gizbert, K.W. (1970) A note on the definition and measurement of competition in regulated industries with special reference to transport. *Transp. Law J.*, 2:1, 333-340.

Transport Canada (1982-1990) *Operating Costs of Trucks in Canada.* Prepared by Trimac Consulting Services Ltd., biennial, Ottawa.

Tretheway, M.W. and T.H. Oum (1992) *Airline Economics: Foundations for Strategy and Policy.* Centre for Transportation Studies, University of British Columbia, Vancouver, Canada.

US Committee on Commerce, Science, and Transportation (1979) *Economic Regulation of the Trucking Industry-Part 2.* US Government Printing Office, Washington, D.C.