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Technical Report No. 23

Regulation and Performance in the Canadian Trucking Industry

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and
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REGULATION AND PERFORMANCE IN THE CANADIAN TRUCKING INDUSTRY

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RÉSUMÉ

Les débats publics au sujet des rôles respectifs de la concurrence et de la réglementation dans l'industrie du camionnage commercial au Canada se sont poursuivis pendant un certain temps, sans pouvoir s'appuyer sur de solides données empiriques. Cependant, plusieurs études effectuées pour le Conseil économique dans le cadre de son Mandat sur la réglementation et pour un Comité de travail interministériel sous la direction de Transports Canada, ont contribué à corriger partiellement cette situation. Malheureusement, dans bien des cas, la base des données empiriques servant à l'analyse des politiques pertinentes reste faible. Nous voulons, dans le présent document, apporter une contribution positive à cette analyse en faisant l'estimation de fonctions de tarifs et de coûts, pour les segments pertinents de l'industrie du camionnage commercial, dans des conditions allant de l'absence de réglementation jusqu'au contrôle des prix et de l'accès au marché. Les données ainsi obtenues, combinées avec une certaine connaissance des institutions et des lois régissant le camionnage, permettront peut-être aux responsables des politiques de prévoir la performance probable de cette industrie advenant l'adoption de mesures législatives qui favoriseraient le jeu de la concurrence.

Plusieurs conclusions se dégagent de notre étude quant à savoir quels seraient, en régime de concurrence ou de réglementation, le

niveau et la structure des tarifs du camionnage. Nous avons constaté, après plusieurs essais, que la nature des données présentement disponibles ne permet pas de traiter adéquatement la question du niveau des tarifs, c'est-à-dire qu'il n'est pas possible d'en arriver à une estimation définitive de l'incidence de la réglementation sur les tarifs. Toutefois, exceptionnellement, un test portant sur la situation en Saskatchewan -- province qui réglemente les tarifs et l'accès à l'industrie -- nous a permis de quantifier les effets de la réglementation sur les tarifs. Nous avons en effet constaté, dans ce cas, que la réglementation tarifaire, sur la période d'observation, a été trop rigoureuse, créant ainsi une taxe implicite pour les transporteurs. Selon nos estimations, au cours de la période 1975-1976, les tarifs en Saskatchewan ont été de 9 à 23 % inférieurs à ce qu'ils auraient été en régime de concurrence équilibrée. Nous présentons d'ailleurs, à l'appui de cette conclusion, des données financières supplémentaires sur les entreprises de camionnage. L'analyse comparative des tarifs provinciaux révèle que, pour l'expédition de charges multiples (CM), ils sont beaucoup plus élevés en Ontario, et même de 50 à 100 % plus élevés qu'en Alberta. D'autre part, les tarifs ontariens applicables aux charges uniques (CU) sont seulement de 5 % supérieurs à ceux de l'Alberta. Nous avons observé que, dans les deux provinces qui réglementent les tarifs (le Manitoba et la Saskatchewan), les tarifs CM sont plus faibles qu'en Alberta, ce qui confirme les résultats de notre analyse pour la Saskatchewan.

Enfin, pour ce qui concerne la Colombie-Britannique, les tarifs CU y semblent particulièrement élevés par rapport à ceux de l'Alberta.

Les estimations de coûts se fondent sur une fonction de coûts de production joints, de type translogarithmique et hédoniste, utilisant des données sur les coûts des entreprises. Les coûts de production marginaux des transporteurs CU et CM sont estimés pour l'Ontario, le Québec et l'Alberta, puis comparés aux renseignements ci-dessus au sujet des structures tarifaires. Nous en concluons, premièrement, qu'ils sont d'un même ordre de grandeur dans chacune des trois provinces. À un niveau donné de production, c'est en Ontario que le coût marginal de production, pour le transport de charges multiples (CM), est le plus élevé, suivie par le Québec, puis par l'Alberta. Cependant, on constate que, dans l'échantillon, les entreprises de transport CM sont en moyenne beaucoup plus grandes en Ontario que dans les deux autres provinces; cela donne d'ailleurs un avantage aux transporteurs ontariens, car les coûts marginaux diminuent à mesure que s'accroît la production des transporteurs CM. Ces résultats, ainsi que ceux que nous avons obtenus au sujet des tarifs, indiquent que le transport de charges multiples en Ontario contribue d'une façon importante aux profits marginaux. L'estimation des fonctions de coûts du transport de charges uniques (CU) montre qu'à un certain niveau de production, c'est au Québec que les coûts marginaux sont les plus élevés; suivent ensuite l'Ontario et l'Alberta. Il faut ajouter cependant que les écarts ne sont pas grands.

Nous avons essayé également d'évaluer la performance relative des entreprises de camionnage, du point de vue des coûts, dans les trois provinces. Pour ce faire, nous avons utilisé d'abord des fonctions de coûts particulières à chaque province, puis une autre fonction ajustée à des données regroupées.

(i) Pour chaque province, nous avons estimé que les coûts correspondaient aux valeurs moyennes de l'échantillon pour cette province, d'après chacune des trois fonctions de coûts. Nous voulions ainsi répondre à la question suivante : quels seraient, par exemple, les coûts au Québec si la fonction de coûts de l'Ontario ou de l'Alberta, y était applicable ? Les résultats indiquent que la production du transport CU est plus élevée en Ontario qu'en Alberta, alors que c'est le contraire dans le cas des expéditions CM.

(ii) Pour arriver à vérifier l'efficacité globale, nous avons groupé les données, c'est à dire appliqué aux trois provinces la même structure de coûts, à l'intérieur de laquelle, toutefois, connaissant les valeurs des variables explicatives, nous avons permis aux coûts de varier d'une province à l'autre, en incluant deux variables auxiliaires dans nos calculs. Il semble que, dans l'ensemble, l'Alberta est la province où l'efficacité des entreprises de camionnage est la plus grande en fonction des coûts, suivie du Québec et de l'Ontario. Nous avons constaté une assez grande différence de coûts, sur le plan statistique, entre l'Ontario et l'Alberta. Nos estimations ponctuelles montrent que les coûts sont, en comparaison avec l'Alberta, plus élevés d'environ 10 % au Québec et de près de 20 % en Ontario.

Nos résultats indiquent aussi que si la production est correctement mesurée, le degré d'utilisation de la capacité de produire ne joue aucun rôle dans la détermination des coûts. Cela vient renforcer l'opinion que l'utilisation de la capacité de production diffère entre les divers transporteurs et, par conséquent, entre les provinces aussi, mais seulement dans la mesure où la composition de la production n'est pas la même d'une entreprise à l'autre.

On voit donc qu'il existe deux explications aux différences résiduelles entre les provinces du point de vue des coûts. Premièrement, les schèmes de trafic peuvent varier d'une province à l'autre à cause, non pas de la réglementation, mais des facteurs qui conditionnent la demande. Deuxièmement, les règlements entraînent une hausse des coûts en restreignant la concurrence par le contrôle de l'accès à l'industrie ou du mouvement des camions, au moyen de restrictions s'appliquant aux permis de camionnage. Dans la présente étude, nous avons calculé des indices de l'état du trafic au niveau de l'entreprise. Nous trouvons, cependant, que cette variable n'explique aucune des différences de coûts qui existent apparemment entre les provinces. Autrement dit, compte tenu de l'état du trafic et du degré d'utilisation de la capacité de production, nos estimations ponctuelles montrent que les coûts des entreprises de camionnage, en Ontario et au Québec, sont respectivement d'environ 20 % et 10 % plus élevés qu'en Alberta, étant donné les prix des facteurs ainsi que les caractéristiques et le niveau de la production. On ne peut dire d'une façon catégorique si ces différences sont attribuables à la réglementation de l'accès à l'industrie et des permis d'exploitation, mais cela est fort possible.

Par ailleurs, nous avons constaté qu'il existe des économies d'échelle au niveau de la moyenne de l'échantillon des transporteurs intraprovinciaux, dans chacune des trois provinces. Toutefois, nous tenons à souligner que ces transporteurs ne sont pas nécessairement les plus importants de l'industrie. Les plus grandes entreprises sont probablement celles qui s'occupent de transport extraprovincial et qui, à cause de leur envergure, peuvent fort bien avoir déjà épuisé les économies d'échelle possibles. C'est donc dire que, à long terme, les difficultés éventuelles de concentration de l'industrie ne seront peut-être pas trop graves.

Enfin, au sujet du problème des petites localités, notre analyse n'est pas aussi détaillée que nous l'aurions souhaité, car elle se fonde uniquement sur une étude des tarifs. Nous en concluons, cependant, que les provinces qui réglementent les tarifs -- soit la Saskatchewan et le Manitoba, ainsi que le Québec qui se borne à les approuver -- modifient les tarifs du transport intraprovincial de façon à favoriser les petites localités. Mais étant donné le manque de données au sujet des coûts, il est malheureusement impossible de mesurer le degré de subventionnement implicite que permet la réglementation des tarifs.

SUMMARY

Public debate in Canada concerning the relative roles of competition and regulation in the For-hire motor carrier industry has continued for some time without the benefit of rigorous empirical evidence. This state of affairs has been partially rectified by several studies done for the Regulation Reference, Economic Council of Canada, and an Interdepartmental Working Committee led by Transport Canada, but in many cases, the empirical evidence available for policy analysis remains weak. This study attempts to contribute positively to this situation by estimating rate and cost functions for relevant segments of the For-hire trucking industry, when operating under various regulatory regimes ranging from no regulation to entry and price controls. This information, when combined with some institutional and legal knowledge, may be used to provide policy makers with a forecast of likely industry performance if legislative changes favouring competitive forces are enacted.

With respect to the level and structure of trucking rates when formed under competitive and regulated conditions, several conclusions emerge from the analysis. Despite several attempts, the nature of the currently available data precludes an adequate treatment of the rate level issue, i.e., it's not possible to come up with a definitive estimate of the impact of regulation on rates. However, a unique test involving the rate and entry regulating province of Saskatchewan is able to quantify the effects of regulation on rates.

Here it is seen that rate regulation over the sample period has been too severe, thus creating an implicit tax on carriers. Our estimates are that over the period 1975/76, Saskatchewan rates were depressed by between 9% and 23% of what they would otherwise have been in competitive equilibrium. Additional carrier financial evidence is presented to support this conclusion. The analysis of rate structures between the provinces reveals that less-than-truckload (LTL) rates are much higher in Ontario, in comparison to the other provinces, being 50% to 100% higher than equivalent rates in Alberta. At the same time, truckload (TL) rates in Ontario are only 5% above equivalent rates in Alberta. Confirming the results of the rate level test for Saskatchewan, is the observation that LTL rates in both of the rate regulating provinces (Manitoba and Saskatchewan) are lower than in Alberta. Finally, TL rates in British Columbia are seen to be particularly high relative to equivalent rates in Alberta.

The cost estimations are based on a two-output, trans-log hedonic cost function fitted to firm level cost data. Marginal costs for TL and LTL output are estimated for the provinces of Ontario, Quebec and Alberta, and compared to the rate structure information discussed above. The first conclusion is that the marginal costs are of the same order of magnitude in each of the three provinces. At a given level of output, the marginal cost of producing LTL shipments is highest in Ontario followed by Quebec and Alberta. However, within the sample, Ontario LTL carriers are much larger on average than in the other two provinces, and this gives an advantage to Ontario carriers since marginal costs fall with increasing LTL output. These results, coupled with the rate results, suggest that LTL freight in Ontario contributes substantially to profit of the margin. The estimated TL cost functions indicate that at a given level of truckload output, marginal costs are lowest in Quebec followed by Ontario and Alberta. However, the estimated differences are not large.

The study also attempted to judge the relative cost performance of trucking firms in the three provinces. The first approach used province-specific cost functions, and the second used a cost function fitted to pooled data.

(i) Costs in a particular province were evaluated at that province's sample mean values according to each of the three cost functions. This procedure was intended to answer the following question: What would, say, Quebec's costs be if the cost function of Ontario or Alberta held in Quebec? The results of this exercise suggested that Ontario is relatively more efficient at producing TL output than is Alberta, while the reverse is true of LTL output.

(ii) In order to judge overall efficiency, the data were pooled. Thus, the same cost structure was imposed on all three provinces, but cost levels, given the values of the explanatory variables, were allowed to vary from province to province through the inclusion of two dummy variables. The results of this exercise suggest that, overall, Alberta is the most efficient province, followed by Quebec, then Ontario. Cost levels in Ontario proved to be statistically significantly different from cost levels in Alberta. The point estimates indicate that costs in Quebec are about 10% above those in Alberta, while costs in Ontario are about 20% above those in Alberta.

Our results show that if output is adequately measured, capacity utilization plays no role in determining costs. This strongly supports the view that capacity utilization differs between carriers, and therefore provinces, only inasmuch as the output mix is different between carriers.

Thus, there are two explanations for the remaining differences in provincial cost levels. The first is that the traffic patterns may differ between provinces due, not to regulation, but to the natural conditions of demand. The second possible explanation is that regulation leads to higher costs by inhibiting competition through control of entry and/or traffic patterns through restrictions that are placed on trucking licenses. In this study, we have attempted to calculate traffic balance indices at the firm level. We find that this variable does not explain any of the cost differences that apparently exist between the provinces. That is to say, after accounting for both traffic balance and capacity utilization, our point estimates indicate that trucking costs in Ontario and Quebec are, respectively, about 20 percent and 10 percent higher than costs in Alberta given factor prices and the level and characteristics of output. One cannot say categorically that such cost differences are due to entry and license restrictions, but this remains a strong possible explanation.

With respect to the economies of scale issue, it is found that scale economies exist at the sample mean for intra-provincial carriers in each of the three provinces. However, it should be emphasized that the intra-provincial carriers are not necessarily the largest in the industry. The larger firms are likely to be extra-provincial carriers who may well be large enough to have exhausted potential scale economies. Thus, potential long run problems of industry concentration are probably not too serious.

Finally, concerning the small communities problem, the analysis is not as detailed as would be desirable as it is based on a study of rates alone. Our conclusion is that the rate regulating provinces of Saskatchewan and Manitoba, along with the rate approval province of Quebec, manipulate the intra-provincial rate structure so as to benefit small communities. Unfortunately, the size of the implicit subsidies effected through the regulated rate structure can not be calibrated due to the lack of cost data.

CHAPTER ONE

POLICY ISSUES IN REGULATED MOTOR TRANSPORT

1.0 INTRODUCTION

With passage of the National Transportation Act (NTA) in 1967, Canadian transportation policy entered a new phase of greater reliance on the forces of competition, as opposed to the forces of legislatively imposed regulation. However, since 1967, and specifically with respect to the motor carrier industry, there has been a continued interest in the question of the relative costs and benefits of both systems of control.

At the provincial level, both the provinces of Ontario and Alberta established select committees of their respective legislatures to investigate the question. The Alberta Select Legislative Committee on Interprovincial Trucking Legislation (1977) recommended that no changes be made in provincial motor carrier legislation as the industry appeared to be operating in an efficient and equitable manner when viewed from both the shippers and the carriers points of view. The Ontario Legislative Select Committee Report (1977), on the other hand, identified several areas where legislative changes were thought to be necessary. Several bills relating to the regulation of the Ontario motor carrier industry were subsequently introduced into the Legislature[1], and the whole issue of Ontario's Public Commercial

Vehicles Act (PCVA) is once again under review by a committee of truckers, shippers and industry officials appointed by Ministry of Transportation and Communications. Finally, after several studies and public hearings, the Saskatchewan Advisory Council on Transportation released a report in August, 1979 which was concerned with the need to rationalize motor carrier operations, especially as they applied to general freight service to rural communities in Saskatchewan.

At the level of the Federal Government, there also has been a continuing interest in the new course set for transportation policy after passage of the NTA. Bills to amend the NTA have been submitted to the House of Commons[2], and several Interdepartmental Working Committees, involving the Canadian Transportation Commission (CTC) and the Departments of Consumer and Corporate Affairs and Transport, have been created to investigate the relative roles which competitive and regulatory forces should play in various transportation modes.

The correct resolution to this problem of control mechanisms is crucial not only for those directly involved in the motor carrier industry, but also for Canadian consumers and producers in aggregate. At the industry level, shippers have the right to expect a mix of cost based rates and service characteristics which sail a middle course between low short run prices and higher longer run prices and profits which are needed for expansion and technological improvement in the industry. With a socially correct set of transportation prices and

and service levels, a healthy motor carrier industry will be able to pay competitive wage rates, and provide continuous employment for existing and new entrants into the labour force. In addition to the importance of the motor carrier industry on its own, there is the indirect importance of the industry as a necessary input into nearly all other sectors of the economy. If transportation costs and service levels are not cost based and responsive to changing market situations, there will occur a whole series of distortions in other industries as firms make sub-optimal location decisions, move too soon into private trucking operations, or make socially incorrect factor input decisions.

1.1. THE ISSUES

Debate on the economic question of the correct balance which should be struck between the competitive and regulatory forces has, after some time, centered on three issues.

The first, and historically the most widely discussed, issue concerns the belief that the industry is potentially "destructively competitive". Economic theorizing [see Kahn (1970)] on the subject of destructive competition has identified the problem as one of excess capacity which will not be self correcting over long periods of time because the industry is composed of firms with high ratios of fixed to total costs. Firms with this type of cost configuration will be willing to continue to operate with short run losses in order to preserve their substantial amount of sunk capital. These low price, negative profit phases may also be characterized by a reduction in safety or service variables as producers attempt to minimize costs to recapture previous profit levels. Thus, the necessary structural requirement for long term existence of a "sick" industry is that firms making up that industry have high ratios of fixed (or sunk) to total costs.

Empirical testing of the destructive competition rationale for legislatively imposed regulation has produced the conclusion that the link between the absence of regulation and the existence of destructive competition is not at all clear. Using different research methodologies, Diamond (1980), McRae and Prescott (1979) and Cooper (1979) all conclude that the existing data will not support a conclusion that regulation by competitive forces results in the existence of destructive competition. This issue will not be dealt with any further in this Report.

The second issue of empirical and policy significance concerns the possibility that the For-hire trucking market, or certain segments of the overall market, may, over long periods of time, be characterized by a concentrated industrial structure due to the operation of scale economies. If it can be demonstrated that long run unit costs fall as firm size increases, then economic regulation of the industry may be needed to prevent shippers from being charged monopoly prices, but at the same time allow them the benefits of cost reductions brought about by firm level expansion.

At this point, an important distinction must be made between technological economies of scale as discussed above, and regulatory economies of scale. This latter concept refers to the hypothesis that large firms may have lower long run unit costs than small firms, not because of some inherent cost advantage of large scale production per se, but because large firms are able to accumulate a more substantial portfolio of operating authorities. With the greater number and diversity of authorities, and the financial resources to acquire more if needed, large firms are able to utilize their fleets more efficiently. Thus, the cost savings arise due to better equipment utilization, and fewer empty backhauls. The relevant point for economic policy in this industry is that if the cost advantages of large firms are simply "regulatory" in nature, i.e., due to their greater number and diversity of operating authorities, then these cost advantages should disappear in a deregulated environment. This question will be dealt with in Chapter Five.

The third issue of policy importance concerns the particular problems which could be faced by shippers on low density, rural traffic corridors if the For-hire trucking industry were regulated only by the forces of competition. It is widely believed that in addition to any (long run) technological economies of scale, unit costs also depend upon the volume of traffic which passes over any carrier's network. Rural routes, with low volumes of traffic density, are more costly to service than high density, urban routes, but it is presumed that under regulation the rate structure does not correctly reflect these inherent cost differences.

Specifically, it is suspected that by using the tools of entry and rate regulation, the regulatory board has created a situation in which the rates charged to shipper on low density, rural traffic corridors are below the marginal costs of providing the service. Thus, if the regulatory system were to be abandoned, and rates became more cost oriented in a competitive equilibrium, it is anticipated that small community shippers are likely to experience steeply rising rates, abandonment of service or both.

Taken together with issue two on the possibility of technological economies of scale, it is argued that the eventual outcome of a For-hire trucking market regulated only by the forces of competition, will be disastrous. Specifically, there will be a few large carriers across the nation charging monopoly prices to shippers who are located in high density, urban areas. Rates to rural customers off of the high density traffic lanes will be even higher, or the service will be non-existent.

FOOTNOTES TO CHAPTER ONE

1. Bill 21, introduced in March, 1978, was allowed to die on the order paper. Bill 78, introduced in May, 1978, was withdrawn in the face of strong opposition from the regulated trucking industry. Bill 89, passed by the Legislature in November, 1978, ammended Ontario's PCVA. The main thrust of this legislation is to tighten up on illegal activity by imposing higher penalties for operating outside the terms of one's license, and making shippers liable for knowingly using unlicensed services.
2. Bill C-33, introduced into the House of Commons in 1977 was allowed to die on the order paper. Bill C-20 was given first reading in November, 1978, and also was allowed to die on the order paper.

CHAPTER TWO

INSTITUTIONAL AND LEGAL FRAMEWORK

2.0 THE DIMENSIONS OF ECONOMIC REGULATION

Because of the absence of any Federal Government initiative in the area of intercity motor carrier regulation, each provincial government in the 1930's began to legislate separately with respect to the economic controls placed on the operation of the highway transport mode within provincial borders. The presumption of provincial jurisdiction was ended in February 1954, when the Judicial Committee of the Privy Council ruled that when a highway transport undertaking connects one province with another, or extends beyond the limits of a province, it comes solely within the jurisdiction of the Federal Government. This ruling was applied to any company with extra-provincial business, regardless of the relative importance of extra-provincial as opposed to intra-provincial movements. Not wishing to divide the jurisdiction over highway transport between that moving solely within provincial boundaries and that moving between provinces, Parliament, in 1954, passed the Motor Vehicle Transport Act (MVTA). This Act provides that the Highway Transport Board of each province is the authority for granting of licenses for extra-provincial undertakings into or through the province. The inconsistencies and lack of uniformity between provincial regulatory legislation which existed previous to the Privy Council decision thus continued unabated.

Despite this delegation of regulatory authority to the provincial boards, federal interest in the area continued, ultimately leading in 1967 to passage of the National Transportation Act (NTA). Part III of this Act imposed upon the Canadian Transportation Commission (CTC) the duty of regulating extra-provincial motor carrier business with a view towards harmonizing the operations of all extra-provincial motor vehicle transport. Federal-Provincial discussions began in 1969, and have continued in various forms since then, but to date, Part III of the NTA has not been implemented. Thus, regulation of both intra- and extra-provincial motor transport continues to be a provincial responsibility, and as such, must be studied province by province.

Provincial regulation of the motor carrier industry uses a broad range of policy tools, all of which to some degree influence the economics of truck transport. However, public debate concerning the correct balance between the forces of government regulation and the forces of competition has resulted in a distinction being made between "economic" and "non-economic" regulations. All participants in the debate appear to realize that the freight motor carrier market is characteristically very heterogeneous, being naturally divided into sub-markets by the nature of the commodity hauled or equipment used (bulk carriers, livestock, etc.), the shipment size and the shipment distance. It is argued, however, that economic regulations further divide the freight motor carrier market by legislatively "franchising" specific commodity/area/route/shipper combinations so that the net result is a cartelized industrial structure over and above the natural level given the heterogeneity in the overall motor carrier market. Although the dividing line between economic and non-economic regulations is somewhat arbitrary, economic regulations for our purposes include the following five criteria:

(a) entry control, i.e., do carriers require an operating authority to enter into business?

(b) service provisions, i.e., are restrictions attached to an operating authority? Examples include: commodities, routes, areas and points of coverage, frequency, named shippers, shipment size, vehicle type, interline possibilities, allowable points of pick-up and delivery.

(c) authority retention, i.e., is the authority to carry on a For-hire trucking business a permanent, saleable right granted to an individual, or is it temporary permission granted and taken away at the pleasure of the Crown?

(d) exit control, i.e., is the firm free to abandon or discontinue service on its own initiative?

(e) pricing, i.e., what control does the Crown have over the level of rates charged for service?

Non-economic regulations, for the purpose of this Report, include regulations pertaining to conditions of carriage and consumer protection, conduct of drivers, issuance of duplicates, maximum vehicle weight, hours of work, inspection of vehicles, etc. Again, it must be stressed that non-economic regulations certainly have an important public purpose, and will definitely have an effect on the economic operation of the industry. However, the control issues identified in the competition/regulation controversy are those concerned with what have here been called economic regulation, and as such, attention is focussed solely on them.[1]

First, with respect to entry control, all provinces have legislation and regulations which allow them to control entry into the For-hire trucking industry. New entrants, or existing firms wishing to extend their authority, must first obtain entry permission in the form of an operating authority, not to be confused with other permits, plates or vehicle registrations whose issuance follows as a matter of course upon receipt of the operating authority. A fundamentally important point is that Alberta, as a matter of policy, approves essentially all applications for intra-provincial authority provided applicants show proof of cargo and vehicle insurance, post a fidelity bond and meet a six-month residency requirement. With respect to the granting of extra-provincial authority, the Alberta Board acts like the other boards across the country. In British Columbia, and the four Atlantic provinces, the provincial legislation setting up the various motor carrier boards contain a list of criteria which the board is to consider when investigating an application. Included are such things as: the transportation capacity by any mode; the effects on these existing services of the proposed new carrier; the quality, permanence and ability of the applicant to provide the service. The fourth criterion is the all-important "backstop" or residual power which these boards have to deny an application not thought to be in the "public interest", or deemed not to serve "public convenience and necessity".[2] In Alberta and Quebec, there is no legislative guidance at all with respect to the criteria the boards should use in approving or denying an application, i.e., these boards have absolute discretionary power. In Ontario, Manitoba and Saskatchewan, no attempt is made at defining criteria,[3] the boards are simply issued backstop powers to approve only those applicants whose entry will promote the public interest. Thus, regardless of how it is legislatively accomplished, all regulatory boards have been granted wide ranging subjective powers to approve entry on a case by case basis. Only the Alberta Board for intra-provincial applicants has chosen not to use this power.

Although institutional details differ between provinces, the provincial regulatory boards are basically unconstrained in terms of the conditions that may be attached to operating authorities. Conditions include the geographic area which may be served, the frequency of service, commodities which may be transported, the type of equipment which may be used, the number and size of vehicles, the shippers who may be serviced, and the type of shipments in terms of size or weight. Reflecting the Alberta Board's desire to not limit entry into the intra-provincial market in that province, is the observation that authorities for carriage within that province are, for all intents and purposes, "open".

The third dimension of economic regulation in this industry concerns the concept of authority retention. There are two issues here - the power to control the transfer or sale of operating authorities, and the power to cancel or revoke authorities.

With respect to the first issue, all boards have the power to control trading in pure authorities without the transfer of real assets. This power reflects the fact that all provinces view authorities as property of the Crown, and hence, incapable of being sold, bought, or transferred without permission. In most cases, the granting of permission depends on the same criteria as if a new authority were being granted. However, when authorities are transferred in the course of the sale or merger of viable trucking firms, the situation between provinces is different. The boards in Ontario, Quebec, Alberta and British Columbia are all reported to be taking an active interest in the effects that the merger or sale of authorities in association with trucking company merger or sales has on effective company control. This process of the board monitoring sale and merger activity is most formally developed in Ontario. The regulatory boards in the other provinces do not monitor, evaluate or investigate sales or mergers of operating authorities when the sale or merger occurs in conjunction with the transfer of real assets. The only other legislative control over these types of activity occurs under Section 27 of the NTA, and the Foreign Investment Review Act (FIRA). Under the NTA, a transportation undertaking within federal jurisdiction must notify the CTC if it proposes to acquire an interest in any tranportation undertaking. Upon receipt of an objection, "the CTC shall investigate and may disallow the proposed acquisition on the grounds that it unduly restricts competition or is otherwise prejudical to the public interest".[4] The FIRA applies to the acquisition of control of a Canadian business by foreign interests, and to the establishment of a new Canadian business by foreign interests who do not already have an existing business in Canada, or by foreign interests whose existing business in Canada is unrelated to the proposed new business. Since the beginning of the FIRA in 1974, there have been 17 cases involving trucking companies, 13 of which were allowed.

The power to cancel or revoke authorities has two primary purposes. The first is an enforcement power to cancel or suspend authorities for failure to abide by the terms and conditions imposed by the provincial board. The institutional mechanism used here is the "show cause" proceedings. The second purpose for the cancelling of authorities is to aid entry control by revoking authorities which are dormant, thus stopping them from being reactivated at some point in the future without the approval of the current board. However, in practice, only the boards in Newfoundland and Alberta actively attempt to cancel authorities.[5] It is concluded by Nix and Clayton (1980, p. 105) that "few if any regulatory boards regularly and systematically check the cumulative stock of authorities issued for the purpose of detecting inactive (or dormant) authorities..."

The fourth issue concerns exit control. The symmetrical power to entry control is the power to approve the abandonment or discontinuance of service. Having satisfied itself that the public interest will be served by the issuance of an operating authority, it stands to reason that the provincial regulatory boards should wish to control exit in order to continue the protection of the public interest. However, the practical importance of this power is very limited. The board in Prince Edward Island does not legislatively have this power, Ontario requires only a 10 day notification of a carrier's intent to discontinue service, and the other boards (except Newfoundland) find it difficult to enforce exit control measures. Only the Newfoundland board seems active in this area.

The fifth and final issue concerns pricing. Here the provinces differ considerably in terms of their statutory and practiced control over intra-provincial rates. The Province of Manitoba can be thought of as being at one end of the regulatory spectrum. Over 90% of the commodities moving intra-provincially within Manitoba move under the Single Price Structure (SPS) which specifies tariffs. Rates different from this SPS must be filed and approved by the board. Saskatchewan can also be considered an active rate regulating province. In this province, instead of an exactly specified rate as in Manitoba, a rate range is set for all items of general merchandise moved intra-provincially by prescribing maximum and minimum rates. Since it is generally believed that only the rate ceiling is binding, one may view this situation as being not too dissimilar from that existing in Manitoba. However, Saskatchewan more than Manitoba, has a much longer list of rate exempt commodities. The other active rate regulating province is Newfoundland. The board in this province has broad powers to fix, approve, investigate and revise rates, and has used its power differently on different segments of the industry. The provinces of Quebec and British Columbia each have broad statuatory authority to fix and approve rates, but it is generally acknowledged that both provinces accept most rates as filed. The provinces of Prince Edward Island, Nova Scotia, New Brunswick and Ontario require only that rates be filed, while Alberta has no requirements with respect to freight rates. Only the provinces of Newfoundland and Quebec show any concern for extra-provincial rates.

In the empirical Chapters of this Report, it will be seen that not all of this institutional detail can be used due to the paucity of data. The essential point is that the continued existence of provincial jurisdiction over the For-hire motor carrier industry has resulted in the creation of a unique "economic laboratory" which may be used to empirically estimate the effects of economic regulation on carrier rates and costs. Intra-provincial For-hire truck movements within the Province of Alberta may be used as a control group because the relevant economic variables are being determined within a purely competitive environment. All other provinces employ entry controls combined with service provisions, so that the effect on rates and costs of this suspected industry cartelization may be investigated. In addition, because the Provinces of Manitoba, Saskatchewan, and, to a lesser extent, Newfoundland, actively attempt to regulate the structure and level of intra-provincial rates, it is also possible to empirically investigate the consequences of this dimension of economic regulation.

2.1 THE TARIFF BUREAUX

Of the various public and private institutions which collectively make up the For-hire trucking industry, the role played by the various tariff bureaux is probably the least understood. A fundamental point concerns the informational problem potentially inherent in a system where there are thousands of For-hire carriers moving many thousands of different commodites over hundreds of different distribution patterns. The result, quite clearly, is the existence of hundreds of thousands of quoted rates. The rational shipper attempting to minimize his transportation costs, and the competitive carrier attempting to provide for interline arrangements would be hopelessly swamped with price information, little of which could be adequately absorbed into the decision making process.

In principle, the institutional response to this legitimate informational externality may take several forms. For example, one could easily imagine that the competitive market place would solve the problem by providing the incentives for independent business interests, not necessarily associated with the trucking industry, to collect, consolidate, publish and distribute rate information in the same way that a credit or bond rating service does in the financial markets. Individual carriers would independently set their own rates, and the private information service would collect and sell this information to all interested parties, also acting as the carrier's agent if rate filing is required. On the basis of this information, carriers whose services compliment one another could make formal and informal inter-line agreements, and shippers could choose the carrier who best meets their demands for low rates and reliable service. At the other end of the spectrum, the same informational problem may be solved by groups of carriers surrendering their independent rate setting powers in order to participate in a collective rate setting cartel. In both arrangements, consolidated rate information is made available to shippers wishing to cost minimize, and carriers wishing to provide for inter-line services, but each varies considerably in terms of its social welfare consequences. Various freight tariff bureaux in Canada lie on a spectrum between these two extremes, with neither the perfectly competitive, nor the cartel models, being adequate to describe current tariff bureaux practices.

With respect to motor carrier freight rates within Canada, there are 6 tariff bureaux whose structure and relative importance must be understood. The Canadian Transport Tariff Bureau (CTTB), the Quebec Tariff Bureau (QTB), the Western Transportation Association (WTA) and the Atlantic Provinces Motor Tariff Bureau (APMCTB) are all member owned, and, with the exception of the APMCTB, all have formalized rate setting procedures which operate with a minimum of shipper participation. The remaining two tariff bureaux are the Pacific Tariff Services (PTS) and the Western Tariff Bureau (WTB). Both are non-member owned, with less formal rate setting procedures, although rates are still discussed with a minimum of shipper representation. It is generally believed that the PTS operates mainly as an agent and publishing agency for any carrier or group of carriers desiring rate changes.

An interesting feature of the major rate setting bureaux which potentially makes policy analysis somewhat difficult is the possibility that carrier specific tariffs can be accepted. For example, if a rate change proposal submitted to the CTTB is turned down by a majority of members at a general meeting, the proposal's originator, who presumably still wishes the rate change, may proceed to charge the desired new rate on his own. Any other carriers who follow his lead are said to be "flagging in". Also, members who disagree with an approved new rate may continue to use the old rate, or any other rate thought appropriate. Such action is called "flagging out". Administrative details differ in the other bureaux, but all allow for the existence of "independent action" with respect to rate setting. However, it is suggested by Boucher (1979) and Transport Canada (1979b) that this power to file carrier specific rates is rarely used.

Whether by historical accident or explicit design, the 5 most important freight tariff bureaux (the PTS is neglected) have evolved in such a fashion that they have effectively divided the country into 10 seperate geographic markets. For freight moving extra-provincially between the 4 Western Provinces, the WTA and WTB share jurisdiction.[6] The WTB has exclusive jurisdiction over freight moving on the intra-Alberta traffic lanes. The CTTB has exclusive jurisdiction over freight moving intra-Ontario, extra-provincially between Ontario and the 4 Western Provinces, extra-provincially between Ontario and Quebec, and extra-provincially between Quebec and the 4 Western Provinces. The QTB has jurisdiction over freight moving intra-Quebec and extra-provincially between Quebec and the 4 Atlantic Provinces. Finally, the APMCTB has jurisdiction over freight moving extra-provincially between Ontario and the 4 Atlantic Provinces, and for freight moving extra-provincially between the 4 Atlantic Provinces.

When this information on market jurisdiction is placed in juxtaposition to earlier information on independent action, and the fact that there is no legal requirement that a carrier become a member of a tariff bureaux prior to soliciting business, it becomes clear how both proponents and opponents of tariff bureaux can continue to argue their cases. Proponents see the doughnut of widely available rate information enabling the construction of complex interlining arrangements, but neglect the hole of social welfare losses due to a potentially cartelized rate structure.

Whether or not the social benefits of tariff bureaux exceed the social costs is an empirical matter, yet, until recently, there has been very little hard evidence available with which to test hypotheses concerning tariff bureaux. The information presented here has been derived from McRae and Prescott (1981), where statistics on the relative importance of membership are presented for all 10 tariff bureau markets.

Table 2.1.1 highlights the relative importance, measured in terms of ton-miles,[7] of tariff bureau members in the intra-Alberta, intra-Ontario and intra-Quebec market jurisdictions. The three markets have been reported here because the rate and cost analysis to be presented in later Chapters of this Report is based on freight movements on traffic lanes solely within each of these regulatory and tariff bureau market jurisdictions. Finally, small shipments, also called less-than-truckload (LTL) shipments, have been defined as those weighing less than 10,000 lbs.

TABLE 2.1.1

PERCENTAGE SHARE OF ESTIMATED MARKET TON-MILES HELD BY TARIFF BUREAU MEMBERS, 1975 AND 1977

MARKET	SMALL SHIPMENTS		LARGE SHIPMENTS	
	1975	1977	1975	1977
Intra-Alberta	38.7	35.4	5.0	6.2
Intra-Ontario	42.7	43.8	22.9	24.6
Intra-Quebec	66.2	62.1	24.4	62.7

Source: McRae and Prescott (1981)

It is easily seen from this Table that tariff bureau members operating on the intra-Alberta traffic lanes have not achieved the same degree of market penetration as members operating within Ontario and Quebec. Also, in all three jurisdictions, tariff bureau membership is relatively more important in the small shipment, in comparison to, the large shipment markets.[8] This observation tends to confirm a long held belief [see Transport Canada (1979b, p. 50)] that the rate control of the various bureaux really rests on their control over class rates, i.e., the rate structure under which most LTL traffic moves.

One of the main purposes of this Section of the Report is to determine whether or not collective rate making is sufficiently powerful to be able to explain the rate structure and level which exists in the various markets for which rate and cost information will be presented. Although it is difficult to state an exact market share after which collective rate setting becomes an important issue for public policy, it would appear that the problem is limited to the small shipment market for intra-Quebec movements.

FOOTNOTES TO CHAPTER TWO

1. This information has been obtained from Nix and Clayton (1980) and Transport Canada (1979a).

2. For an analysis of the specific factors which appear to be constituent elements of "public necessity and convenience" in Ontario, see Manouchehri, McRae and Prescott (1981).

3. Manitoba actually has one other legislatively defined criterion in addition to public convenience.

4. See Transport Canada (1980, p. 2). It is further reported in this study that since 1968, there have been about 444 notifications concerning trucking companies, but only 7 hearings in response to objections, and no acquisitions have been disallowed. The never implemented Part III of the NTA would have given the CTC the power to make legislation prohibiting the transfer, consolidation, merger or lease of a motor vehicle undertaking.

5. Nix and Clayton (1980, p. 107) report that the board in Newfoundland cancelled 272 authorities in 1975, 316 in 1976, and 60 in 1977. Transport Canada (1979) reports that from 1971 to 1977, 6,157 Alberta certificates were cancelled (3,000 of which were in the year 1977) for dormancy or for failure to comply with insurance or registration requirements.

6. It should be stressed that the WTA is composed of 13 large extra-provincial carriers who operate west of Sault Ste. Marie. All 13 are also members of the WTB, but they do not subscribe to WTB tariffs, preferring to set their own through a formalized rate committee structure.

7. The same information is also presented in terms of estimated market revenue, tons, and shipments. See McRae and Prescott (1981).

8. The 1977, large shipment, intra-Quebec market is an exception to this observation. However, the tremendous increase in the number of ton-miles being produced by members of the CTB in this market over the years 1975 to 1977, can be attributed to the fact that the total number of large shipment ton-miles being generated in this market fell by 20.6% over the same period. This relationship that the importance of tariff bureau membership increases in declining markets is confirmed when attention is focused on all 10 tariff bureau jurisdictions.

CHAPTER THREE

THE MARKET STRUCTURE

3.0 INTRA-MODAL MARKET SHARES

As mentioned in Chapter 1, it has been realized by knowledgeable observers of the For-hire trucking business that there is no overall market in which all trucking firms compete, but instead, a collection of sub-markets divided one from the other in terms of the type of commodity being moved, the shipment weight (small or large shipment), the shipment distance (short or long haul) and the geographical area in which the carrier operates. The commodity being hauled, to a large degree, determines the type of equipment employed, and each class of equipment has different operating characteristics and costs. For example, live animal carriers require a different mix of equipment and techniques to produce their ton-miles when compared to (say) carriers of fabricated or bulk materials. Thus, these different types of ton-miles must be displayed separately in any analysis of market structure. The distinction between small and large shipment business arises due to the basic terminal facility which must be provided by the small shipment carrier in order that he may accept shipments from diverse locations, sort, group and consolidate them into truckload or near truckload sized lots, and distribute to a diverse network of destination points. Shipment distance is an important market distinguishing dimension due to the widely held belief that the short haul and the long haul markets are quite separate one from the other in terms of carrier operating techniques and costs. Finally, the geographic dimension is different from the previous three economic criteria in that it is created partially by differing provincial regulations over entry and rates, and partially by any non-regulatory differences between provinces such as climate, topography and industrial structure.

This basic hetrogeneity in the For-hire trucking markets is recognized in Table 3.0.1. This Table shows the relative importance of Class I size carriers in terms of their percentage share of estimated market ton-miles. The numbers in brackets are the total For-hire ton-miles being generated in each market cell, and expressed in millions of ton-miles. This information on For-hire trucking market structure is presented only for the intra-provincial markets of British Columbia east to Quebec. The Atlantic Provinces have been excluded from further study with respect to rates and costs due to the potential economic distortions brought on by the truck and rail subsidies under the Maritime Freight Rate Act (1927) and the Atlantic Regional Assistance Act. (1969)

Examination of Table 3.0.1 produces the conclusion that the intra-provincial markets of British Columbia and Alberta stand alone with respect to the relatively low degree of market activity which is dominated by Class I size carriers. The dominance achieved

TABLE 3.0.1

PERCENTAGE OF (TOTAL) ESTIMATED MARKET

TON-MILES CAPTURED BY CLASS I FIRMS, 1977

COMMODITY GROUPINGS	PROVINCES					
	BC	ALB.	SASK.	MAN.	ONT.	QUE.
Live Animals	3.6(11)	5.4(24)	0.5(11)	1.3(3)	2.2(104)	1.3(8)
Food, Feed & Beverages	43.0(183)	15.1(138)	41.1(38)	68.1(57)	44.6(1058)	69.7(413)
Crude Materials	26.2(245)	19.6(168)	20.6(36)	2.3(57)	38.1(649)	49.3(268)
Fabricated Materials	65.2(540)	61.9(886)	65.7(250)	87.7(141)	73.6(1779)	68.8(1175)
End Products	17.7(444)	36.2(207)	56.2(30)	87.4(65)	79.0(624)	71.3(292)
Miscellaneous Freight	57.6(25)	13.5(42)	33.4(3)	0	71.8(204)	94.3(104)
All Commodities	40.6(1448)	46.7(1465)	55.8(368)	68.2(323)	60.4(4417)	67.9(2261)

Source: McRae and Prescott (1980). Ton-miles are measured in millions.

by the large sized carriers in the other four intra-provincial markets is particularly noticeable in the commodity groupings for fabricated materials, end products and miscellaneous freight.

While Class I carriers are very important in terms of their share of total market ton-miles, it must be remembered that there are a large number of Class I firms operating in most of these markets. In fact, based on 1975 data [see McRae and Prescott (1980)], it may be seen that the degree of dominance achieved by the largest 4 firms in each of the intra-provincial markets exceeds 50% only for some of the commodity groupings in the intra-Saskatchewan and intra-Manitoba markets. Averaged over all commodities, the largest 4 firms in the intra-Ontario and intra-Quebec markets captured just over 14% of the ton-miles being generated in each of these markets. From this, it would appear that with the exception of some of the commodity groupings in the intra-Saskatchewan and intra-Manitoba lanes, there appears to be no undue concentration of activity in the hands of a few carriers.

When this market share information is displayed to highlight the differences in the small shipments (under 10,000 lbs.) and large shipments (10,000 lbs. and over) groupings, two observations emerge from Table 3.0.2. First, with respect to small shipments, the Ontario, and to a lesser degree Quebec markets, are very dominated by Class I carriers. Second, the provincial rankings for large shipment business continue to show lower levels of Class I domination for the intra-British Columbia and intra-Alberta markets as highlighted in the discussion surrounding Table 3.0.1.

TABLE 3.0.2

PERCENTAGE OF (TOTAL) ESTIMATED SMALL AND LARGE SHIPMENT TON-MILES CAPTURED BY CLASS I FIRMS, 1977

PROVINCES	SHIPMENT SIZE	
	SMALL	LARGE
British Columbia	58.8(155)	38.4(1292)
Alberta	42.1(121)	47.1(1344)
Saskatchewan	45.7(50)	57.4(318)
Manitoba	59.3(48)	69.8(275)
Ontario	81.9(473)	57.9(3944)
Quebec	69.5(308)	67.6(1954)

Source: McRae and Prescott (1980). Ton-miles are measured in millions.

In addition to highlighting the concentration information in the various market segments, Tables 3.0.1 and 3.0.2 provide some tentative information on the issue of scale economies in the For-hire trucking industry. If larger firms have lower unit costs, there must exist a long run tendency towards industry concentration as market output levels increase. Simple inspection of these Tables highlights the observation that there appears to be no simple relationship between market output, measured in ton-miles, and the percentage of this output captured by Class I firms. The intra-provincial shipment markets of Ontario and Saskatchewan are almost equally dominated by Class I firms, but the Ontario market is generating over 12 times more ton-miles in comparison to the intra-Saskatchewan market. Also, the influence of entry and rate regulation on the question of economies of scale is equally difficult to determine from these data. Over the most important commodity groupings, the process of industry concentration has generally not evolved as far in the unregulated, intra-Alberta market, especially the small shipment, intra-Alberta market. However, the For-hire carrier industry in British Columbia is also relatively unconcentrated despite the fact that this province practices entry regulation. Obviously, the scale economy question, and the distinction between regulatory and technological economies of scale, will be resolved only be more explicit cost modelling.

3.1 INTER-MODAL MARKET SHARES

3.1.1 THE RAIL MODE

When transportation markets are correctly disaggregated into their various constituent sub-markets, the competitive interaction between the rail and For-hire trucking modes may be measured and discussed.

Table 3.1.1 shows the percentage share of estimated, intra-provincial truck and rail tonnage being captured by the truck mode. In general, the pattern which emerges is that the For-hire truck mode dominates the intra-provincial movement of commodities in the live animals, food, feed and beverage, end products and miscellaneous freight groupings. The truck comparative advantage weakens somewhat for the fabricated materials grouping, and turns into a rail comparative advantage for crude materials.

An important observation concerns the differences in the rail/truck tonnage split in the various intra-provincial markets. For each of the commodity groupings, the relative importance of the trucking mode is smallest in the combined market of intra-Manitoba and Saskatchewan. When the truck/rail modal split information is disaggregated into the shipment size and shipment distance dimensions [see McRae and Prescott (1980)], this observation concerning the relative unimportance of the truck mode in the Manitoba and Saskatchewan markets is further developed. In comparison to the other provinces, the rail mode in Manitoba and Saskatchewan captures the largest share of the

TABLE 3.1.1

PERCENTAGE OF (TOTAL) ESTIMATED INTRA-PROVINCIAL TRUCK AND RAIL TONNAGE BEING CAPTURED BY THE TRUCK MODE, 1975/77 AVERAGE

COMMODITY GROUPING	BC.	ALB.	MAN/SASK	ONT.	QUE.
Live Animals	100(8.1)	100(28.5)	97(16.5)	100(67.2)	100(7.4)
Food, Feed & Beverages	94(141.5)	70(145.5)	46(245.6)	91(928.9)	90(283)
Crude Materials	21(1724.7)	55(360.5)	20(571.8)	34(3692)	50(850.7)
Fabricated Materials	78(633.1)	73(674.8)	71(410.8)	77(2086.9)	75(1264.6)
End Products	98(120.9)	99(145.2)	86(58.5)	92(409.1)	95(150.1)
Miscellaneous Freight	96(45.9)	75(29.4)	63(22.3)	95(362.7)	87(150.6)

Source: McRae and Prescott (1980). Tons are measured in tens of thousands.

intra-provincial small shipment market, and increases its' share in the larger shipment markets faster than does rail in the other intra-provincial traffic lanes. When the For-hire rate structure and level is investigated in the next Chapter, it will be suggested that the system of rate regulation which exists in the intra-provincial markets of Manitoba and Saskatchewan has probably contributed to this state of affairs.

3.1.2 PRIVATE TRUCKING

Discussion in this Chapter on the size distribution of For-hire carriers, and the competitive influence of the rail mode, has sought first to provide an overall discussion of the economic forces operating, and second, to disentangle any effects which the different provincial regulating schemes have on the transportation market structures. Unfortunately, the lack of a unified data base on private trucking permits only the presentation of fragmentary evidence on these two issues.

For estimates of the competitive interaction between the two modes, there have been 5 studies based on the procedure of sampling carriers at weigh stations on primary highways.[2] Comparison of these studies is somewhat difficult because three separate measures of output (tons, vehicles and vehicle trips) have been alternatively employed. Also, all share the common failing that the sampling procedure is never made clear. Never-the-less, the estimates produced by each of the 5 studies, and what it is that they are estimating, is sumarized in Table 3.1.2. The most striking feature of this Table is the difference

TABLE 3.1.2

SUMMARY OF PRIVATE TRUCKING, WEIGH STATION SURVEY REPORTS

STUDY	DATE	SAMPLE LOCATION	% FOR-HIRE	% PRIVATE
Stechishin/Menzie	1972	Ontario	63*	37*
Ontario Ministry of Transportation and Communications	1971	Ontario	62.9*	37.1*
Ontario Ministry of Transportation and Communications	1975	Ontario	57.5* 57**	42.5* 43**
The Western Canada Truck Traffic Survey	1974	British Columbia Alberta, Saskatchewan Manitoba	75.4***	20.9***
Western Canada Origin Destination Survey	1978	British Columbia Alberta, Saskatchewan Manitoba	75.4***	21.3***

* Tonnage

** Vehicles

*** Vehicle trips. These totals do not equal 100% due to the inclusion of contract, government and farm vehicles.

Source: Compiled from Consumer and Corporate Affairs (1980).

in estimated private truck participation between the Province of Ontario in comparison to the 4 Western Provinces.

More fragmentary evidence on how private trucking's share of tonnage and/or revenue changes with shipment type, size, and distance is available from two additional reports on the private trucking mode.[3] With respect to the importance that shipment distance has on the use of the private trucking mode, there seems to be wide agreement amongst the relevant studies that the use of private trucking drops significantly for shipment distances of 100 miles and over. In fact, the study by the Ontario Ministry of Transportation and Communications (1975, Vol. 2, p. 95) suggests that:

> "The principle role of privately owned trucks is for city cartage, according to the respondents to our survey. Of those surveyed with private truck operations, 60.6 percent considered that the main role of their fleet was for city cartage, while a smaller portion, 20.2 percent, viewed the role of private carriage as being for short and long hauls".

In the commodity dimension, the concensus position of the 9 studies on private trucking is that products relatively low on the value added scale are more usually carried by the private mode. The commodities most often carried by private trucking are agricultural products, forest products, stone, primary and fabricated metal, and petroleum.

Finally, evidence on how shipment size influences the split between the modes is practically non-existent in any of the 9 studies. There is some very tentative evidence that shipments moving by the private mode are slightly smaller than those moving by the For-hire mode, but this evidence is so weak that it should only be regarded as suggestive.

On the second question dealing with the effects that different provincial entry and rate regulating schemes have on the modal split between private and For-hire carriage, there exists only the very tentative information contained in the two Western Canada Surveys (see Table 3.1.2). In both of these studies, the estimated share of private trucks relative to the total number of provincial trucks is lowest for the Province of Alberta in comparison to the other 3 Western Provinces. It may be that the lack of entry and rate regulation in Alberta has resulted in the situation where the For-hire mode is better able to serve shipper needs in terms of price and service, but the data presented to date is not sufficient to accept or reject the hypothesis.

In summary, there are very few statistically valid conclusions which can be drawn from all of the studies on private trucking. The most reliable conclusion seems to be that private trucking is more prevalent in the very short haul markets (urban and less than 100 miles). As one moves from primary products into the manufactured groups, the percentage importance of private trucking appears to decrease. There is lack of sufficient evidence to support or deny any hypotheses concerning the effects of regulation on modal shares.

FOOTNOTES TO CHAPTER 3

1. Class I size firms are those with operating revenues exceeding 2 million dollars annually. Class II firms earn between one-half and 2 million dollars, and Class III between one-tenth and one-half million.
2. In addition to the survey studies, there are two further papers on this question which are also discussed in Consumer and Corporate Affairs (1980). The first produces national estimates of For-hire and private trucking activity by industry and commodity group by using data on fuel consumption in an input-output framework. The second uses information on 1974 truck registrations in the Province of Manitoba as the basis for an estimate on the importance of private trucking. In both studies, the estimated importance of private relative to For-hire trucking appears to be very high due to the difficulty of excluding private, non-commercial trucks from the total.
3. See Transport Canada (1975) and the Ontario Ministry of Transportation and Communications (1975, Vol. 2).

CHAPTER FOUR

THE LEVEL AND STRUCTURE OF INTRA-PROVINCIAL RATES

4.0 INTRODUCTION

This Chapter describes the level and structure of intra-provincial, For-hire trucking rates. Section 4.1 will deal specifically with the issue of rate levels between the provinces, and the influence which different regulatory regimes have on these levels. It will be argued here that because estimated rate equations must necessarily reflect a reduced form equation incorporating both demand and cost considerations, the need for a tremendous amount of statistical information has severely inhibited most attempts at measuring the influence of economic regulation on rates. Only for the Province of Saskatchewan, where there exists a large list of commodities which are exempt from entry and rate regulation is it possible to quantify the effects of regulation by using rate equations without specifically introducing factor cost and demand variables. This test will be discussed in Section 4.2. In Section 4.3, attention is focused on the issue of differing rate structures between the 6 Provinces west of Quebec. The purpose here is not to suggest that regulation alone is causing the differences in the provincial rate structures, but to describe the structure of rates over different segments of the market. Chapter 5 will then investigate what proportion of the described rate structure can be explained by cost differences between the provinces. Finally, Section 4.4 will present preliminary evidence on the third issue identified in Section 1.1, i.e., the structure of rates on low density, rural traffic corridors. Unfortunately, this description of the structure of rural rates under different regulatory regimes cannot be pursued in the cost Chapter which follows due to the paucity of data.

4.1 RECENT ECONOMETRIC ANALYSIS AND METHODOLOGICAL ISSUES

Several attempts have been made to estimate the effect that economic regulation of the Canadian trucking industry has had on the price of trucking services. As we have seen, regulatory regimes differ markedly between provinces, varying from no economic regulation to various combinations of (a) entry regulation and b) price regulation. This variety of structure has encouraged economists to measure the impact that these different regimes have had on the price of trucking services. In this section we will discuss the recent Canadian studies that have looked into this issue.

A key problem that emerges from all of these studies is the difficulty of separating the effects on prices of (a) regulation and (b) other supply and demand factors such as the cost of fuel, labour and other inputs. In fact, the nature of the currently available data precludes an adequate treatment of this difficulty.

4.1.1 AGGREGATE-DATA STUDIES

Sloss (1970), McLaughlan (1972) and Palmer (1973) all used essentially the same data base, which covered the period 1957-63, and employed similar approaches to estimating the price effect of regulation. Sloss, for example, regressed revenue per ton-mile (unit price of trucking services) on (i) average length of haul, (ii) average net weight per loaded vehicle, (iii) average fuel tax per gallon, (iv) average annual licence cost per truck or tractor, (v) average annual wage per employee. Sloss ignored the first year's data and used eight observations - one for each province excluding Newfoundland and Price Edward Island - giving a total of forty-eight observations. He then tested for the differences between the mean residuals for the regulated and unregulated provinces. The difference between mean residuals is then attributed to regulation. Of course, the difference in means is actually a measure of the effect on prices of all province-distinguishing variables that have not been included in the model. On the basis of his tests Sloss concluded that the effect of regulation had been to raise intraprovincial rates by 0.68 cents per ton-mile.

McLachlan (1972) modified Sloss' analysis by replacing employee's wages with the average provincial wage rate. The reasoning here is that if regulation has an effect on prices, some of the additional revenue might be channelled into wages rather than profits. One would tend to underestimate the effect of regulation on prices if the regulation effect is measured by comparing prices in regulated and unregulated provinces once they have been adjusted for employee wages and other costs. McLachlan found that the coefficient on the dummy variable was statistically significantly different from zero, and he concluded that regulation had raised intraprovincial rates by 2.6 cents per ton-mile.

Palmer's (1973) major contribution was to replace the average length of haul by its inverse which he argued is more appropriate on theoretical grounds. He also introduced a time trend and a provincial miles per gallon variable which he hoped would account for additional provincial cost differences. Palmer examined various specifications of his basic model, and concluded that regulation had raised intraprovincial trucking rates by between one and two cents per ton-mile.

Maister (1978a) has criticized these three papers in detail. He points to three key issues:

1. First, he discusses the definition of regulation. All three studies grouped each province into either a regulated or unregulated group. This obscures the distinction between entry and rate regulation, and led Sloss to classify Ontario as being unregulated, while McLachlan decided to omit Ontario from the analysis. However, one could reasonably argue, as Maister does, that entry regulation alone is likely to lead to higher rates than the combination of entry and

rate regulation, since the former can lead to the creation of essentially unregulated monopolies.

2. The second is concerned with model misspecification. The most serious problem here is the use of aggregate data which obscures the different product mixes within the provinces. As an example, take the category Live Animals which can be split into Cattle, Poultry, Swine and Other Live Animals. We have estimated that over the period 1975/76 in Ontario and Alberta, for a given shipment weight and distance, it costs about 35% more to ship poultry than to ship cattle. To the extent that the category Live Animals comprises different proportions of the sub-categories Cattle, Poultry etc. across provinces, comparisons between revenue per ton-mile between provinces based on the grouped data could be very misleading.

3. Finally, Maister questions the quality of data. The key variables (revenue per ton-mile, average length of haul and average net weight per loaded vehicle) were taken from the D.B.S. publication Motor Traffic Transport. It was recognised that these data were of questionable quality. This ultimately led to the discontinuation of the publication.

4.1.2 MAISTER'S ANALYSIS OF THE 1973 DATA

In 1976, Statistics Canada published the For-Hire Trucking Survey - 1975 which was the result of several years work to improve the data on truck transportation. Maister (1978a) used the information in this document to revisit the issues that Sloss, McLachlan and Palmer had addressed. Maister hoped the improved data, the inclusion of more explanatory variables and a more careful treatment of regulation would yield more meaningful results. The latter two improvements are clearly aimed at achieving a more precise separation of the effects on revenue per ton-mile of (a) regulations and (b) other factors, such as factor costs. It is worthwhile to consider this problem in some detail since it essentially reduces to the question of the information content of the available data with respect to the central issue - can the effects of regulation and other factors be separated? First, let's look at the nature of the data.

The basic unit is a single record of information on a particular shipment. The information relates to such characteristics as revenue, origin, destination, origin-destination mileage, weight of shipment, commodity name and three digit standard commodity classification (SCC) code. The information is taken from a sample of shipments which are selected randomly according to a two-tier design. First, a sample of carriers is selected, and then, for each carrier, a sample of shipments is chosen. Statistics Canada publishes the information in aggregate form. Thus Maister used information on (i) revenue per ton-mile, (ii) average length of haul, and (iii) average shipment size in tons. Such information is available in the publication for all ten provinces, and up to a detail of six broad commodity groups: live animals; food feed, beverages and tobacco; crude materials, inedible; fabricated materials, inedible; end products, inedible; and general or unclassified freight.

Maister's expanded list of explanatory variables comprised the following: X_1 = inverse of average length of haul; X_2 = average shipment size in tons; X_3 = index of provincial wages; X_4 = licence fee per vehicle; X_5 = maximum weight limitation on provincial highways; X_6 = fuel tax per gallon of diesel; X_7 = provincial sales tax; X_8 = a unit variable if rates are prescribed by any regulatory agency, zero otherwise; X_9 = a unit variable if rate increases are subject to approval, zero otherwise; X_{10} = a unit variable if filing is required by any regulatory agency, zero otherwise.

Note that Maister's list of explantory variables has reached ten, but there are only six provinces. Consequently, there are only six different values for each of the ten variables if attention is limited to intra-provincial movements. To increase the effective number of observations, Maister is forced to consider interprovincial shipments if his full list of explanatory variables is to be retained (this point is developed more fully below). This, however, raises new problems. Is it reasonable to assume that the effect of regulation on prices is exactly the same for interprovincial shipments as it is for intraprovincial shipments? The specification problems do not end here. What is the appropriate wage rate, fuel tax, etc. for interprovincial movements? Maister does deal with these issues, but one cant't help thinking that too much is being asked of the data. Indeed, none of the province-distinguishing variables have statistically significant coefficients in any of the single commodity group regressions, and many have implausible signs. We conclude that the introduction of interprovincial movements into the analysis is a questionable way of expanding the information content of the data with respect to the issue of isolating the effect of regulation on trucking rates.

An alternative approach, examined by Maister, is to pool all six commodity groups and fit a single regression. When attention is confined to intra-provincial movements, there are 36 observations (six provinces and six commodity groups). Augmenting the ten original variables and a constant term by five dummy variables seems to impley 36-16=20 degrees of freedom. Apparently, Maister believed that these data can yield estimates of the effects on prices of four regulatory regimes and five other province-distinguishing variables. This is not so. Each province-distinguishing variable has the property that its numerical value varies only across provinces, but for all observations within a province its numberical value is constant. With only six provinces, at most six province-distinguishing variables including a constant term can be introduced into the regression. The introduction of more than six such variables will result in exact multicollinearities, and thus, a breakdown of the least squares estimation procedure. Note that Maister used a step-wise regression method and that some coefficients were estimated to be zero. This is a direct result of the exact multi-collinearities that exist in his data.

The following example is intended to clarify the point that is being made in the previous paragraph. Suppose there are just two provinces, one of which is regulated and the other unregulated. Information is available on six commodities which are trucked within each of the two provinces, so that twelve observations are available on average revenue per ton-mile; average weight of shipments; average distance shipments are transported, where all averages are computed over each province's sample of individual shipment records. The researcher wants to estimate the affect that regulation has on revenue per ton-mile. However, he knows that fuel costs are quite different in the two provinces. To separate the effects of regulation and fuel cost differences, the researcher plans to regress average revenue per ton-mile on (i) X_1, a constant term, (ii) X_2, average weight, (iii) X_3, average distance, (iv) X_4, a dummy variable which represents the presence of regulation, (v) X_5, provincial fuel costs. Since the presence or absence of commodity dummy variables is not relevant to the current issue, they are ignored. The researcher plans to interpret the coefficient of the dummy variable as representing the additional revenue per ton-mile that would be earned in the regulated province for transporting a shipment of given weight and given distance if fuel costs were the same in the two provinces.

Unfortunately, the data described do not contain sufficient information to yield an answer to the researcher's question. The use of ordinary least squares will fail to produce coefficient estimates. If the researcher turns to a step-wise regression procedure one of the three varibles X_1, X_4 or X_6 will not be introduced into the regression, i.e., it will be given a zero coefficient. This is precisely what Maister found. To see why this is so, let's examine the data matrix. It will have 12 rows and five columns.

Obs. No.	X_1	X_2	X_3	X_4	X_5
1	1	w_{11}	d_{11}	1	f_1
2	1	w_{12}	d_{12}	1	f_1
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
6	1	w_{16}	d_{16}	1	f_1
7	1	w_{21}	d_{21}	0	f_2
8	1	w_{22}	d_{22}	0	f_2
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
12	1	w_{26}	d_{26}	0	f_2

The first six observations are from the regulated province where the cost of fuel is f_1. Observations 7 through 12 are from the unregulated province where the cost of fuel is f_2. The exact linear relationship between X_1, X_4 and X_5 is now obvious. In particular,

$$f_2 \cdot X_1 + (f_1 - f_2) \cdot X_4 = X_5 .$$

If the intercept were omitted, then the researcher could fit his regression model and his interepretation of the coefficient of the dummy variable would be correct. However, he would not be able to introduce further province-distinguishing variables into his regression. Thus, if he had data on wage rates, licence costs, maximum weight, etc., these could not be introduced separately into the regression. The argument generalizes. With cross-section data collected from six provinces, it is not possible to include more than six variables (including the constant term) of the type that do not vary within a given province. Consequently, it is asking the impossible to demand that the data separate the effects of four types of regulatory regimes and five other province-distinguishing variables.

Finally, we should note an interesting result that Maister found. He estimated a model very similar to the ones investigated by Sloss (1970), McLachlan (1972) and Palmer (1973). That is, the data were aggregated over commodities to the provincial level. A commodity mix variable was introduced along with a single dummy variable to distinguish regulated from unregulated provinces. Since there is only one observation per province, interprovincial movements had to be introduced. This specification yielded a statistically significant negative coefficient on the regulation variable Maister is certainly correct in suggesting that this result is due to the process of aggregation, since such an effect was not found in his more disaggregated analysis. This serves to underscore the danger of basing statistical analysis on aggregate traffic flows.

4.1.3 A TIME-SERIES CROSS SECTION ANALYSIS

One way to enrich the data is to pool cross-section and time-series observations. This was done in Maister (1978b) where separate equations are fitted to each of the six commodity groups to avoid as far as possible the problem of commodity mix. At the time of this study, only three years of data were available (1973-1975) giving a total of 3 x 6 = 18 observations on intraprovincial traffic flows. Since this is not sufficient to estimate all the separate factors that one would like to isolate, Maister again incorporated interprovincial traffic flows into the analysis. As we pointed out above, this greatly increases the number of observations (to 108), but at the cost of having to make additional assumptions.

However, the results of the exercise are interesting in that for three commodity groups, the set of regulatory coefficients are statistically significant. Entry control and rate filing (intra-Ontario) seems to raise rates for food, fabricated materials and end products by 1.44, 1.31 and 6.05 cents per ton-mile respectively above rates in an unregulated market (intra-Alberta). The rates on fabricated materials and end products are also significantly lower in the rate prescribing environments (Manitoba and Saskatchewan) than in Ontario. A surprising result is that rate approval, when added to entry control, appears to raise rates rather than lower them. Maister offers the suggestion that "the mechanics of rate control might provide the forum for collective rate making that would not exist when no rate control existed" (Maister, 1978b, p. 55).

The author warns that these results are to be treated with caution since the usual qualifying comments apply. For example, the model is a poor representation of the true cost structure which is refelcted in the fact that "very surprising coefficients (both of sign and statistical significance) continue to plague efforts of this kind" (op. cit., p. 60). However, for all their shortcomings, these results must be considered the best available estimates of the impact of regulation on trucking rates.

4.1.4 CONCLUDING REMARKS

The first group of studies that looked into the question of the impact of economic regulation on trucking rates did find statistically significant effects. These studies, Sloss (1970), McLachlan (1972) and Palmer (1973) have been thoroughly examined in Maister (1978a) where it is concluded that the results should be considered tentative at best. The most serious problems concern the quality of the early data and its aggregate nature which obscures important differences in the mix of commodities transported in each province. In addition, Maister criticized the oversimplified categorization of provinces as being either regulated or unregulated and he felt important explanatory variables which could explain differences in provincial trucking rates had been omitted.

In 1976, improved data became available and Maister, in a series of papers, attempted to correct some of the defects of the earlier work. Unfortunately, a major stumbling block which plagued all the earlier studies was not overcome. This is the nature of the available data and its information content regarding the key issue of the separation of provincial regulatory effects from the effects of supply and demand factors that together cause the observed differences in average provincial trucking rates. As long as the variables which measure the supply and demand characteristics within a province do not vary within a province, but merely vary between provinces, then it will be virtually impossible to isolate the regulatory effects on trucking rates.

At the time that the present study was undertaken the available data comprised the micro-data (referred to as the TOD data) that forms the basis of Statistics Canada's estimates of traffic flows carried by Canada's for-hire trucking industry. Two years of micro-data (1975 and 1976) were made available to us, consisting of over two-hundred thousand individual shipment records. As we indicated earlier, each record indicates such individual shipment information as the revenue earned, the weight of shipment, the origin and destination names including mileage and the commodity name and the three-digit standard commodity classification code. Unfortunately, no information is given concerning the costs associated with transporting the shipment, or concerning the demand conditions within the relevant market. Regarding the key question of estimating the effects of regulation on trucking rates, we faced similar problems to earlier investigators, namely that of obtaining intra-provincial variation in the variables which account for supply and demand conditions within each province.

Consider, for example, fuel prices. While a measure of fuel prices at the provincial level can easily be obtained, it is not so easy to obtain intra-provincial variation in fuel prices that can be usefully combined with the shipment information. Ideally, one would like to know the fuel price etc. relevant to each shipment in the TOD data set. Unfortunately, this was not possible. An alternative source of intra-provincial variation in fuel prices could be obtained by pooling time-series and cross-section data. But with only two years of cross-section data, this possibility was not available to us.

In an earlier study (McRae and Prescott, 1980b) we compared trucking rates under different regulatory regimes. In this study we use the vast amount of data made available to us which has allowed us to describe the level and structure of trucking rates under the different regulatory regimes that exist in Canada. Given the enormous number of individual trucking rates in each jurisdiction, it is not a simple matter to compare like trucking rates between provinces. Using regression analysis to estimate rate structures, we have been able to make valid comparisons between rate levels across provinces. As far as we are aware, no previous study has attempted to systematically compare rate levels across provinces. In addition, we have compared the structure of rates within each province to the structure of rates in the unregulated markets of Alberta. In this regard, ratios of less-than-truckload to truckload rates have been computed and the association between the population size of origin and destination towns and trucking rates have been estimated.

In one particular case, however, we have been able to estimate the effect of rate regulation on the level of trucking rates. In the province of Saskatchewan a large number of commodities are free from rate regulations. We have, in this particular case, been able to use this fact to estimate the average effect or rate regulation on the regulated commodities. This is the topic which is dealt with in the next section, to which we now turn.

4.2 A SASKATCHEWAN/ALBERTA CASE STUDY[1]

As discussed in Section 4.1, there exists a fundamental difficulty in attempting to quantify the effects of economic regulation by fitting rate equations to a cross sectional, intra-provincial data base. However, the existence in Saskatchewan, of 19 commodities, each described in terms of a 3-digit Standard Commodity Code (SCC) number, which are exempt from entry and rate regulation when moved intra-provincially provides the basis for a unique test.[2]

Specifically, three groups of 19 commodities were randomly chosen from the set of regulated commodities moving intra-provincially within Saskatchewan. This produces a total of three sets of 38 commodities, all being transported entirely within Saskatchewan. One-half of any set of 38 is the 19 unregulated goods, and the other 19 are the randomly selected regulated ones. These 38 commodities are matched, when there is a sufficient number of observations on each commodity, to the identical group of 38 which move entirely within the unregulated market in Alberta. If the existence of economic regulation in the Province of Saskatchewan is having an effect on rates, it is expected that this will be reflected in regulated and non-regulated average provincial rate differentials. The specific introduction of provincial cost and demand variables is not required. For this approach, it must only be assumed that the cost and demand factors equally effect all 38 commodities moving entirely within Saskatchewan. This is not a strong assumption. It only says that wage costs, fuel costs, road conditions, maximum allowable gross vehicle weights etc., apply equally to all goods, both regulated and exempt, transported within Saskatchewan. A similar assumption is made for the 38 goods moving within Alberta, but of course, there is no distinction between regulated and unregulated categories.

Since the work of Palmer (1973), the inverse of distance rather than distance itself has been introduced into equations which explain revenue per ton-mile, but apart from this variable, the specifications appearing in the literature are linear. One would expect that revenue per ton-mile (unit price) would also exhibit a nonlinear relationship with weight simply because of the huge range over which shipment weights vary. For example, one would not expect the difference in the unit prices of 1,000 and 2,000 pound shipments to be the same as the difference between 39,000 and 40,000 pound shipments. Experimentation with a double-logarithmic specification produced the conclusion that this specification is far superior to the linear model.

The basic equation estimated and reported in this Section is formally derived in Appendix A.3 and displayed here as equation 4.2.1.

4.2.1 $$y = W^a H^b e^Z$$

where

$$Z = \sum_{j=2}^{NC} e_j C_j + e D_1 + (e - d_u) D_2 + (d_u - d_r) D_3$$

$$+ d_4 D_4 + t_1 \cdot (T^*D_1) + t_2 \cdot (T^*D_2) + t_3 \cdot (T^*D_3) + u$$

and y is revenue per ton-mile

W is shipment weight

H is shipment distance

C_j is a commodity dummy

D_1 is an Alberta dummy

D_2 is a Saskatchewan dummy

D_3 is a Saskatchewan dummy for regulated commodities

D_4 is dummy variable set equal to unity if a transportation surcharge is included in revenue per ton-mile, and zero otherwise

T is a time interaction variable set equal to unity for 1976 and zero for 1975

u is a random error term with the usual classical properties.

When equation 4.2.1 is fitted to this data set, the dummy variables will provide an estimate of the average provincial differentials between the price of trucking services which are regulated in Sasaktchewan, the group which are unregulated in Saskatchewan, and the group of equivalent commodities when shipped entirely within Alberta. By repeating the experiment three times, with the three randomly selected groups of regulated commodities, we believe we have covered a sufficient number of commodities to give a high degree of confidence in the measured effects of regulation on trucking rates in Saskatchewan over the period 1975-76.

Table 4.2.1 reports the results of fitting equation 4.2.1 to each of the three sets of data. Note that this Table does not report the 37 estimated commodity coefficients. There are at most 37 commodity dummies because the base commodity has no dummy variable. A number of indicators suggest that the regression results are sound. First, the overall fit as measured by the $\bar{R}^2$ statistics is good in all

TABLE 4.2.1

REVENUE PER TON-MILE REGRESSIONS FOR

THE ALBERTA/SASKATCHEWAN RATE LEVEL TEST[1]

Variable	Regression 1	Regression 2	Regression 3
Weight (W)	-.426* (.004)	-.420* (.004)	-.397* (.004)
Distance (H)	-.556* (.007)	-.593* (.008)	-.549* (.006)
Alberta (D_1)	4.28* (0.49)	4.37* (.053)	3.95* (.051)
Saskatchewan (D_2)	4.24* (.051)	4.34* (.054)	3.93* (.052)
Reg. Dummy (D_3)	-.301* (.031)	-.173* (.040)	-.050 (.029)
T*Alberta (T^*D_1)	.200* (.011)	.235* (.012)	.210* (.011)
T*Saskatchewan (T^*D_2)	.310* (.027)	.311* (.027)	.310* (.024)
T*Reg. Dummy (T^*D_3)	.057 (.035)	-.203* (.051)	-.144* (.034)
$\bar{R}^2$	0.751	0.810	0.791
Number of Obs.	14,939	11,439	12,699

[1]Commodity dummies (37) are not reported. Standard errors are in brackets, and the asterisk (*) notation denotes a coefficient estimate with a t-statistic greater than 3 in absolute value.

three cases. Second, the weight and distance parameters are stable across regressions. This indicates that forcing the same parameters on all commodities in a given regression is probably reasonable. Third, the coefficient on T^*D_2 is essentially unchanged from one regression to another. This is as it should be, since this coefficient represents the percentage increase in unit prices between 1975 and 1976 in Saskatchewan for the unregulated commodities. Of course, this group is unchanged from one regression to the other.

In order to interpret any of the coefficients presented in Table 4.2.1, one needs to exponentiate the estimated coefficient value and subtract unity to give the percentage increase in revenue per ton-mile. For example, the estimated coefficient on T^*D_2 in percentage terms is exp. (.310)-1, or 36%. Thus, on average the price of unregulated commodities moving intra-provincially within Saskatchewan increased by 36% over the years 1975 to 1976.

When attention is focused on the issue of the effect of economic regulation on revenue per ton-mile, several interesting conclusions emerge. The nearly identical coefficients on D_1 and D_2 in all three regressions show that unregulated commodities in both provinces have, on average, nearly identical rate levels. From the estimated coefficient on D_3 in the first regression, it may be seen that in 1975 regulation in Saskatchewan kept the price of trucking services 35% below the level they would have been in the absence of regulation. This holding down of the intra-Saskatchewan rates by legislation is even more remarkable when it is recalled that the unit price of unregulated commodities in Saskatchewan rose, over the sample period, by 36% as mentioned above. The regression results for the second and third group of regulated commodities also show a large and statistically significant regulation effect which, in 1975, depressed rates by 19% and 5% respectively.

Table 4.2.2 presents a clearer picture of the same information by computing the relationship between rates in the 3 markets averaged over the years 1975 and 1976. Recall that

TABLE 4.2.2

SASKATCHEWAN RATES AS A PERCENTAGE

OF COMPARABLE ALBERTA RATES: 1975/76 AVERAGE

MARKET	REGRESSION 1	REGRESSION 2	REGRESSION 3
Alberta	100.0%	100.0%	100.0%
Saskatchewan - Unregulated	101.5%	101.2%	103.0%
Saskatchewan - Regulated	77.3%	76.8%	91.2%

in each regression, the set of unregulated commodities is the same so the three regressions should produce similar estimates of the ratio of rates in Alberta and Saskatchewan for those commodities which are unregulated in Saskatchewan. This is indeed the case. Our estimates suggest that for this group of commidities, rates in Saskatchewan are between one and three percent higher than in Alberta. With respect to the regulated commodities, the situation is quite different. It is clear that, on average over 1975 and 1976, rates in Saskatchewan were substantially below those in Alberta for the same commodities. Specifically, it may be stated rate regulation in Saskatchewan depressed rates by between 9% and 23% of what they would otherwise have been.

The conclusion that economic regulation of the For-hire carrier industry in the Province of Saskatchewan has resulted in a lower rate structure than expected in a competitive equilibrium is, at first glance, somewhat surprising. The resolution of this apparent dilemma is really quite straight forward when it is recalled that Saskatchewan is one of the two provinces in our sample which regulates entry, and specifies rates for the approved service. It would appear on the basis of these results that rate specification as practiced in Saskatchewan has been too severe, and has totally dominated any tendency towards cartel pricing which may have emerged from the process of creating freight franchises through entry control.

This program of maximum allowable For-hire rates appears to have resulted in predictable effects on carrier supply decisions over the period. Evidence on the phenomenon is supplied in Table 4.2.3.

This Table shows some indicators of the growth of trucking firms in the provinces of Alberta and Saskatchewan over the period 1975/76. Statistics Canada has defined three classes of firms according to their size. Because of confidentiality requirements, no financial information is available on the largest firms in Saskatchewan (Class 1 firms, i.e. those with annual operating revenues in excess of $2 million). Consequently, the figures in Table 4.2.3 refer to firms that earn less that $2 million per annum. In Alberta, the total

TABLE 4.2.3

GROWTH OF ALBERTA AND

SASKATCHEWAN BASED FIRMS[1] 1975/76

	Alberta (%)	Saskatchewan (%)
Number of Firms	- 0.9	0
Revenue Equipment[2]	+11.1	-17.9
Total Equity	+11.7	-51.2
Total Assets	+18.7	-17.7

[1]Confined to firms earning less than $2m revenue, i.e. Statistics Canada's Classes II and III. In Alberta such firms numbered 347 and 344 in 1975 and 1976 respectively. Thus three firms became Class I firms over that interval. Due to confidentiality requirements the number of Class I firms in Saskatchewan and Manitoba are never separated. However, their number did not change between 1975 and 1976. Also, the number of Class II and III firms in Saskatchewan remained unchanged over this period.

[2]Value of equipment less depreciation.

Source: Compiled from Statistics Canada, Motor Carriers, Freight and Household Goods, Cat. 53-222.

number of firms did not change between 1975 and 1976, but three firms did become members of the Class I category, so that the number of smaller firms dropped from 347 to 344. Despite this, the value of revenue equipment, total equity and total assets of this group of firms rose. In Saskatchewan, no smaller firms became Class I firms over this interval, so that their number remained constant at 84. In contrast to the performance of the Alberta firms, the smaller firms in Saskatchewan had a very poor financial performance. The conclusion which emerges from joint examination of the various pieces of financial information which are presented here is that carriers in

Saskatchewan are reducing their commitment to the For-hire trucking industry, while those in the neighbouring, competitive rate Province of Alberta show significant increases in revenue equipment, owners equity and total assets.

Also, as discussed in Section 3.1.1, the relative unimportance of the trucking mode in the intra-Saskatchewan and Manitoba markets may be due to the effects of severe trucking rate regulation. The net result is that the For-hire trucking mode has voluntarily abandoned a large amount of intra-provincial traffic, which in the normal course of competitive equilibrium, would be carried by truck. However, since detailed modelling of the rail and For-hire truck markets in those two provinces has not been attempted, this observation must be regarded as suggestive[3].

To understand how the administrative regulatory machinery in Saskatchewan allowed this situation to develop would require a more detailed analysis of the rate setting process in the province. One possibility is simply the regulatory lags involved in having industry rate submissions investigated and verified by the Board's staff.

A second possibility is more structurally based. Revenues in Saskatchewan are based upon direct one-way distances, and not on the actual route mileage. Thus, it stands to reason, that certain franchises will be more profitable than others. For example, consider two straight line franchises each involving 100 miles of line haul, but in one, the carrier drops 2 tons of freight at the 50 mile mark, and the remaining 18 tons at the 100 mile mark. The carrier on the second franchise drops 18 tons at the 50 mile mark, and 2 tons at 100 miles. The carriers on both franchises experience similar line haul costs[4], but the first one has considerably more revenue producing ton-miles. Other franchise shapes, for example, circuitous routes, and overlapping franchises caused by historical events, will produce the same conclusion. If the rate schedule is set so that the first carrier just earns a normal rate of return on invested capital, the second carrier will be forced into a short run loss situation. When this information is combined with the observation that the Saskatchewan Board also imposes and enforces minimum acceptable service standards, it follows the carrier withdrawal from the industry may be a loss minimizing decision.

4.3 A DESCRIPTION OF RATE STRUCTURES

This Section extends and generalizes rate information produced by the Ontario Ministry of Transportation and Communications (1975) and Maister (1977). It must be again stressed that the purpose is not to quantify the effects of regulation on rates, but simply to describe the structure of intra-provincial rates using the 1975 and 1976 Trucking Origin and Destination (TOD) data tapes.

The analysis of this Section is based on 36 regressions, i.e., 6 regressions for each of the 6 provinces. Within each province, rate regressions for intra-provincial freight shipments are fitted separately to the commodity groupings , food, feed and beverages, (22 products); fabricated materials (20 products), and end products (20 products) which are well represented in all sample provinces. Also, in order to further account for differences in production technology, the data are split into two weight groups. Small, or less-than-truckload (LTL), shipments are defined to be less than 5,000 lbs., while large, or truckload (TL) shipments, are defined to be those weighing in excess of 35,000 lbs.[5] All shipments weighing between these two limits are excluded from the analysis.

The functional form for all 36 regressions is the same, and is described in equation 4.2.2.

4.2.2 $$y = W^a H^b e^Z$$

where $$Z = \sum_{i=1}^{9} m_i M_i + \sum_{i=1}^{NC} c_i C_i + t.\ T + u$$

and y = revenue per ton-mile

W = shipment weight

H = shipment distance

C_i = unity for the $i^{\underline{th}}$ commodity, and zero otherwise.

M_i = the $i^{\underline{th}}$ member of a set of 9 dummy variables which describe various characteristics of the shipment[6].

T = unity for 1976, and zero for 1975.

u = a random error term with the usual classical properties.

With this specification, the weight and distance elasticities for each product within a commodity grouping are constrained to be equal, but the inclusion of the commodity dummies allows for the fact that unit prices may differ between commodities. Thus, when we speak of unit price, or revenue per ton-mile, for any one of the commodity aggregates, we mean the unweighted average of the revenues per ton-mile for each of the 3-digit products included in the regression. The time variable, T, allows for changes in unit prices over the 1975/76 period, and the dummy variables M_i allow for the price effects of the 9 transportation characteristics listed in footnote 6.

The results of fitting equation 4.2.2 to the 36 data sets are reported in summary form in Tables 4.3.1 through 4.3.3. Note that there is a complete set of LTL regressions, but in some cases there were insufficient observations to estimate TL regressions. Comparing the fit of the LTL to the comparable TL regressions by means of the reported values of $\bar{R}^2$, it is seen that generally the LTL regressions have higher $\bar{R}^2$ values.

Looking first at the LTL regressions as a group, it may be seen that the weight and distance elasticities are fairly stable across both provinces and commodity groups. The weight elasticities range between -0.302 to -0.546, and the distance elasticities fall between -0.563 to -0.776. Thus, with respect to a 10% increase in LTL shipment weight, holding everything else constant, it is estimated that depending upon the province and commodity in question, revenue per-ton-mile (unit price) will decrease between 3% and 5.5%. For a 10% increase in LTL shipment distance, unit price is estimated to fall between 5.6% and 7.8% depending upon the province and commodity in question. In all regressions, the weight and distance coefficients have very large t' statistics (no smaller than 13.5 in absolute value).

When attention is focused specifically on the Alberta LTL regressions, it is seen that for the 3 sets of LTL regressions, the Alberta distance elasticity is the smallest in absolute value. The Alberta weight elasticities, on the other hand, do not take on extreme values. Finally, for 2 of the 3 sets of LTL regressions, the reported

TABLE 4.3.1

LTL AND TL REVENUE PER TON-MILE REGRESSIONS FOR THE FOOD, FEED & BEVERAGE GROUPING[1]

LTL SHIPMENTS

VARIABLE	PROVINCE					
	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.302 (-30.9)	-.469 (-43.8)	-.418 (-33.5)	-.546 (-64.4)	-.435 (-49.4)	-.409 (-34.4)
Distance (H)	-.776 (-59.8)	-.584 (-25.5)	-.726 (-29.8)	-.687 (-69.4)	-.693 (-61.1)	-.775 (-55.2)
Time (T)	.289 (10.7)	.194 (7.25)	.223 (8.62)	.211 (11.6)	.216 (10.3)	-.029 (-.937)
Number of Obs.	2,192	1,432	869	1,180	3,926	2,205
$\bar{R}^2$	.746	.685	.727	.885	.705	.721

TL SHIPMENTS

VARIABLE	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.402 (-2.70)	.219 (1.42)			-.983 (-28.1)	1.26 (-11.9)
Distance (H)	-.525 (-26.5)	-.443 (-9.07)			-.628 (-55.5)	-.718 (-31.2)
Time (T)	.445 (7.97)	.099 (1.13)			.093 (4.89)	-.006 (-.102)
Number of Obs.	640	181			1,760	881
$\bar{R}^2$	.669	.689			.739	.699

1. T-Statistics in brackets. Commodity and shipment characteristic dummies are not reported.

TABLE 4.3.2

LTL AND TL REVENUE PER TON-MILE REGRESSIONS FOR THE FABRICATED MATERIALS GROUPING[1]

LTL SHIPMENTS

VARIABLE	PROVINCE					
	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.432 (-38.2)	-.469 (-53.2)	-.469 (-27.5)	-.544 (-46.7)	-.432 (-62.4)	-.418 (-56.8)
Distance (H)	-.702 (-46.9)	-.563 (-25.5)	-.662 (-13.5)	-.662 (-40.6)	-.731 (-75.9)	-.649 (-59.0)
Time (T)	.153 (5.01)	.153 (6.16)	.189 (4.03)	.117 (3.80)	.086 (4.93)	.081 (4.00)
Number of Obs.	1,378	1,779	591	694	3,507	2,704
$\bar{R}^2$	.735	.673	.643	.839	.704	.699

TL SHIPMENTS

VARIABLE	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.846 (17.3)	-.566 (-14.1)	-.665 (-11.1)	-1.16 (-6.72)	-.628 (-32.6)	-.231 (-6.75)
Distance (H)	-.472 (-40.0)	-.491 (-46.7)	-.379 (-28.1)	-.442 (-15.8)	-.489 (-91.5)	-.568 (-53.9)
Time (T)	.308 (14.0)	-.009 (-.553)	.271 (16.9)	.455 (7.70)	.092 (9.69)	.148 (8.80)
Number of Obs.	3,471	4,277	2,588	477	8,072	4,684
$\bar{R}^2$	.446	.424	.503	.552	.604	.521

1. T-statistics in brackets. Commodity and shipment characteristic dummies are not reported.

TABLE 4.3.3

LTL AND TL REVENUE PER TON-MILE REGRESSIONS FOR THE END PRODUCTS GROUPING[1]

LTL SHIPMENTS

VARIABLE	PROVINCE					
	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.385 (-45.4)	-.446 (-54.9)	-.453 (-36.5)	-.451 (-40.4)	-.373 (-79.7)	-.373 (-81.0)
Distance (H)	-.654 (-58.5)	-.594 (-36.0)	-.708 (-28.0)	-.675 (-44.1)	-.647 (-108.3)	-.626 (-99.3)
Time (T)	.129 (5.94)	.310 (15.3)	.266 (8.74)	.246 (9.01)	.053 (4.73)	.127 (11.4)
Number of Obs.	3,062	3,271	1,505	1,670	8,936	7,585
$\bar{R}^2$	.662	.655	.695	.708	.777	.723

TL SHIPMENTS

VARIABLE	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.308 (-18.8)	.778 (19.0)	.284 (11.1)	-1.97 (-1.83)	-.668 (-6.34)	-.291 (-2.11)
Distance (H)	-.482 (-30.7)	-.093 (-4.98)	-1.17 (-21.3)	-.465 (-3.86)	-.568 (-19.9)	-.352 (-9.39)
Time (T)	.043 (.491)	.229 (4.84)	-.351 (-2.00)	-.751 (-1.21)	.002 (.047)	.115 (1.21)
Number of Obs.	1,504	2,475	145	37	459	361
$\bar{R}^2$	.545	.153	.779	.618	.570	.490

1. T-statistics in brackets. Commodity and shipment characteristic dummies are not reported.

$\bar{R}^2$ values for the Alberta regressions are lower than for the other provinces. These observations agree with our expectations. In Alberta, where there is no regulation of rates, one would expect rates to vary according to cost, but in Manitoba rates are prescribed, and do not vary from route to route or carrier to carrier. Consequently, our simple specification is very successful in describing the prescribed Manitoba rate structure, but does less well in describing the more complex set of rates which emerges in the free market place of Alberta.

Turning now to the TL regressions, it may be observed that the weight elasticities are very unstable in all provinces except Ontario, varying from -3.08 to 0.778. Unlike the LTL regressions, the TL regressions show that weight is not as statistically significant in explaining revenue per ton-mile as is distance. Also, with an $\bar{R}^2$ value of 0.153, the Alberta End Products regression stands out as being a particularly poor fit. However, detailed examination of the commodities contained in the End Products grouping reveals that, in Alberta, the vast majority of the observations are from the Drilling, Excavating and Mining Machinery commodity class. Apparently, in this particular market, there are some unique features which are relevant to the pricing of the For-hire trucking services. The omission of those variables has resulted in the poor fit, as measured by the value of the $\bar{R}^2$, and the positive weight elasticity estimate.

In the following subsections, the description of the different rate structures between the provinces is further refined by including in the computations only those 3-digit commodities for which there are observations in all relevant regressions. For example, if the commodity Meat (SCC number 011) is to be included in the data set, it must be represented in all of the 12 regressions concerned with explaining revenue per ton-mile in the Food, Feed and Beverage grouping. That there are 12 such regressions is easily verified by noting the existence of an LTL and a TL regression in each of 6 provinces. The result of this restriction is to reduce the number of commodities included in the Food, Feed and Beverage and End Products groupings to 5 and 4 respectively. However, all 20 commodities in the Fabricated Materials group were represented in all 12 Fabricated Materials regressions, so that the conclusions drawn from this group are based on a far greater volume of traffic than is the case for either Food, Feed and Beverages or End Products.

Equation 4.2.2 is fitted to the restricted data sets, and the results for the 3 commodity groupings are discussed in Sections 4.3.1 through 4.3.3. As with the discussion of the results in the present Section, revenue per ton-mile for (say) the End Products grouping is the average of the revenues per ton-mile for each of the commodities included in the regression. The averages are unweighted, but in most cases, the commodity dummy coefficients from any given regression have such a small variance that it is unlikely that any reasonable weighting scheme would materially affect the results.

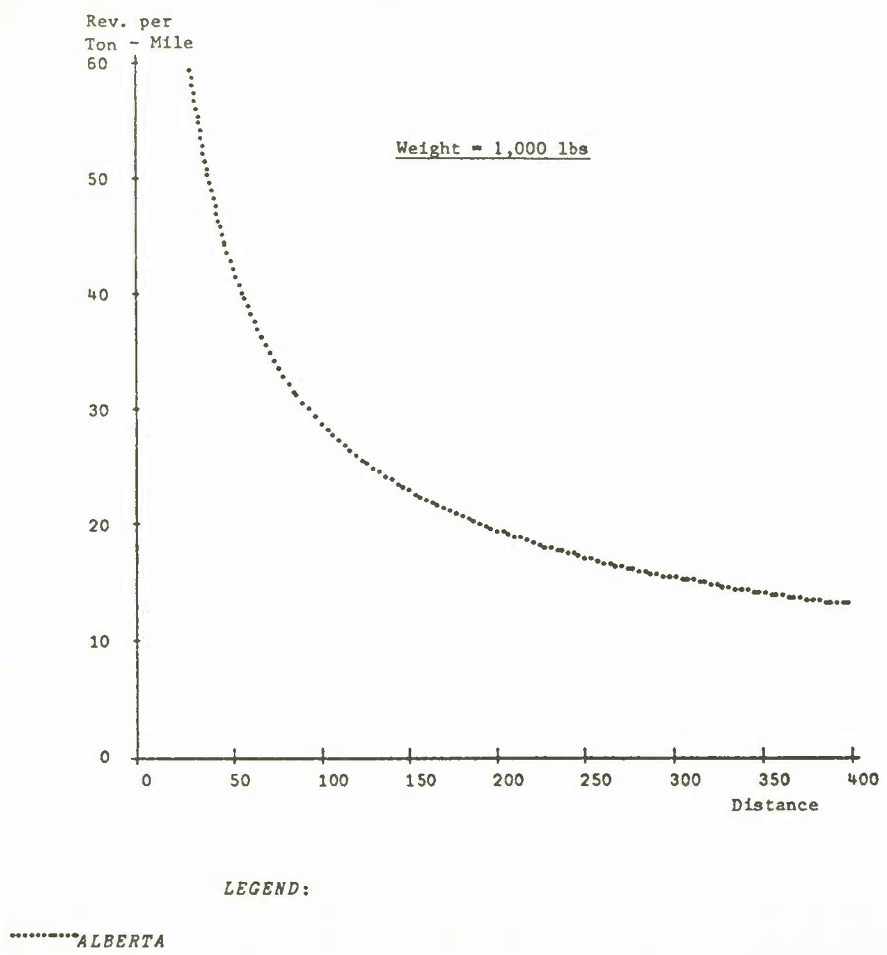
4.3.1 RATES FOR FOOD, FEED AND BEVERAGE GROUPING[7]

In this and the following subsections, instead of reporting the estimated coefficients for the rate regressions as was done in Tables 4.3.1 through 4.3.3, it was thought to be more instructive to

CHART 4.3.1

LTL RATES FOR FOOD PRODUCTS

(5 Commodities)



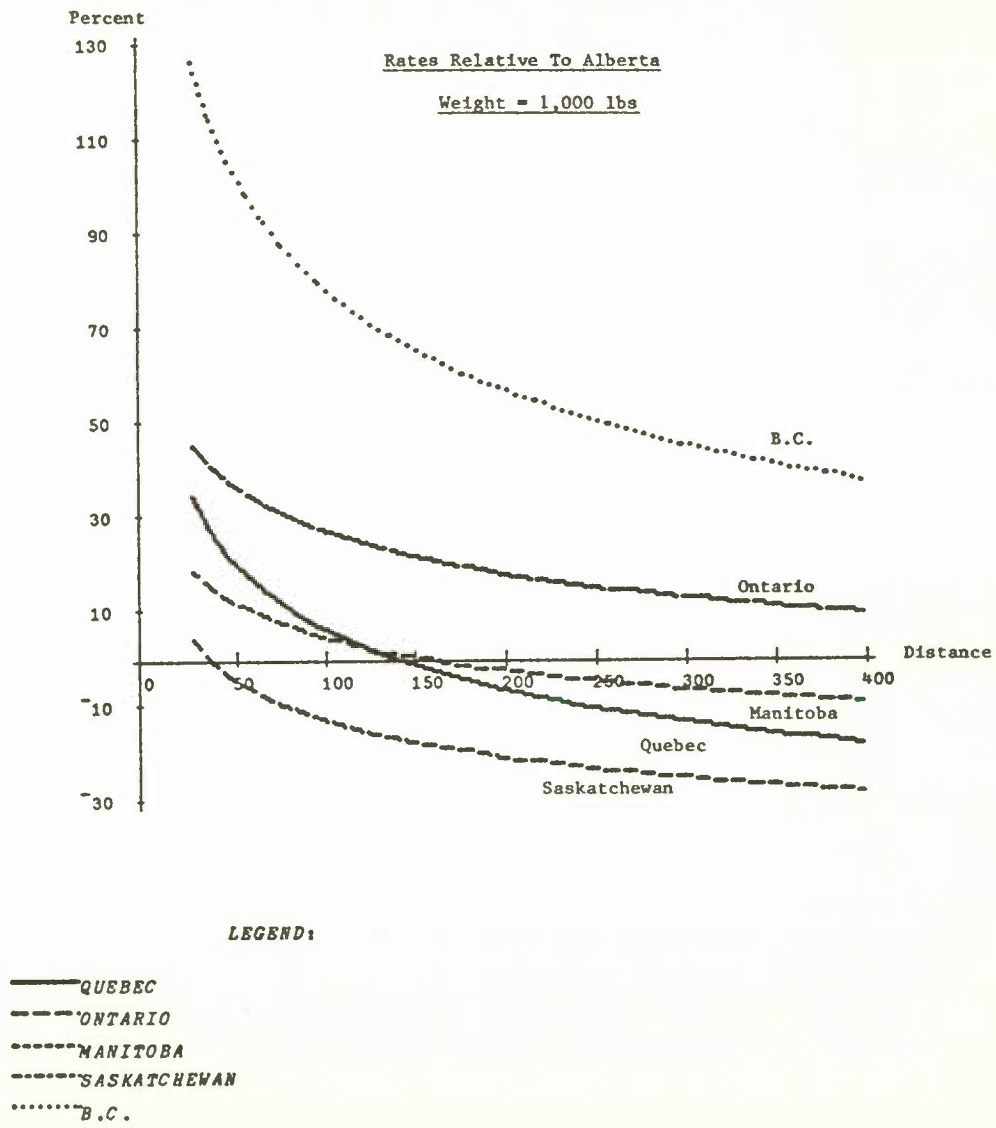
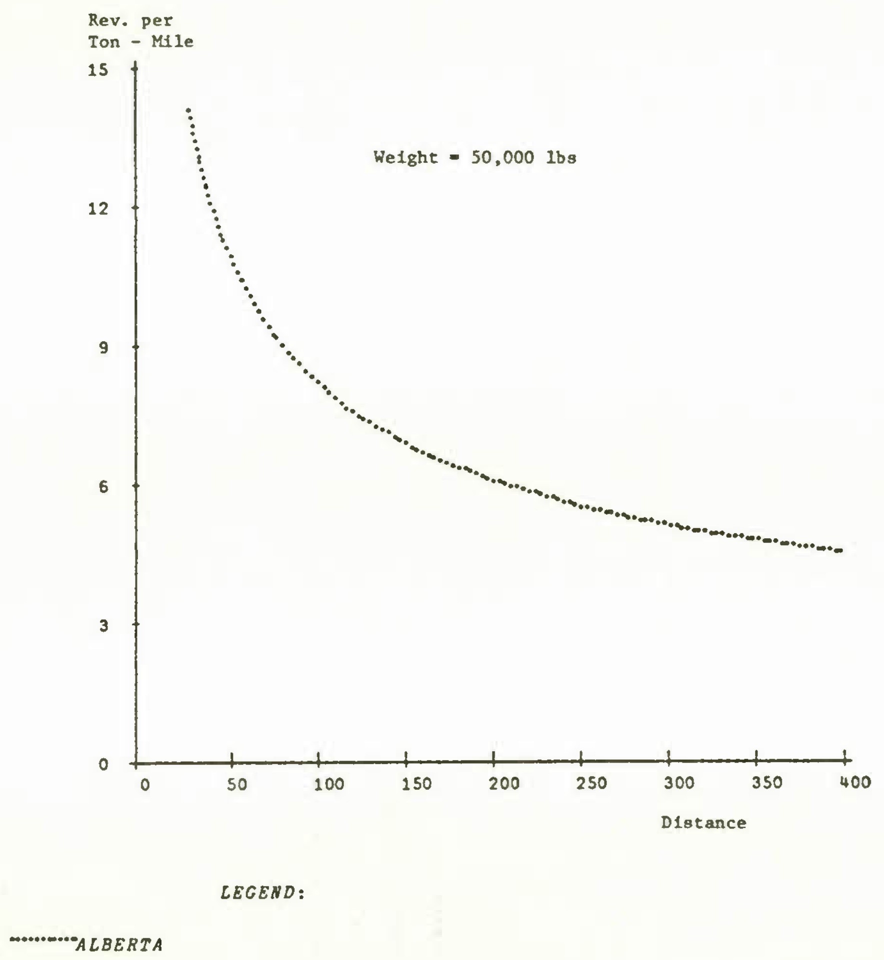


CHART 4.3.2

TL RATES FOR FOOD PRODUCTS

(5 Commodities)



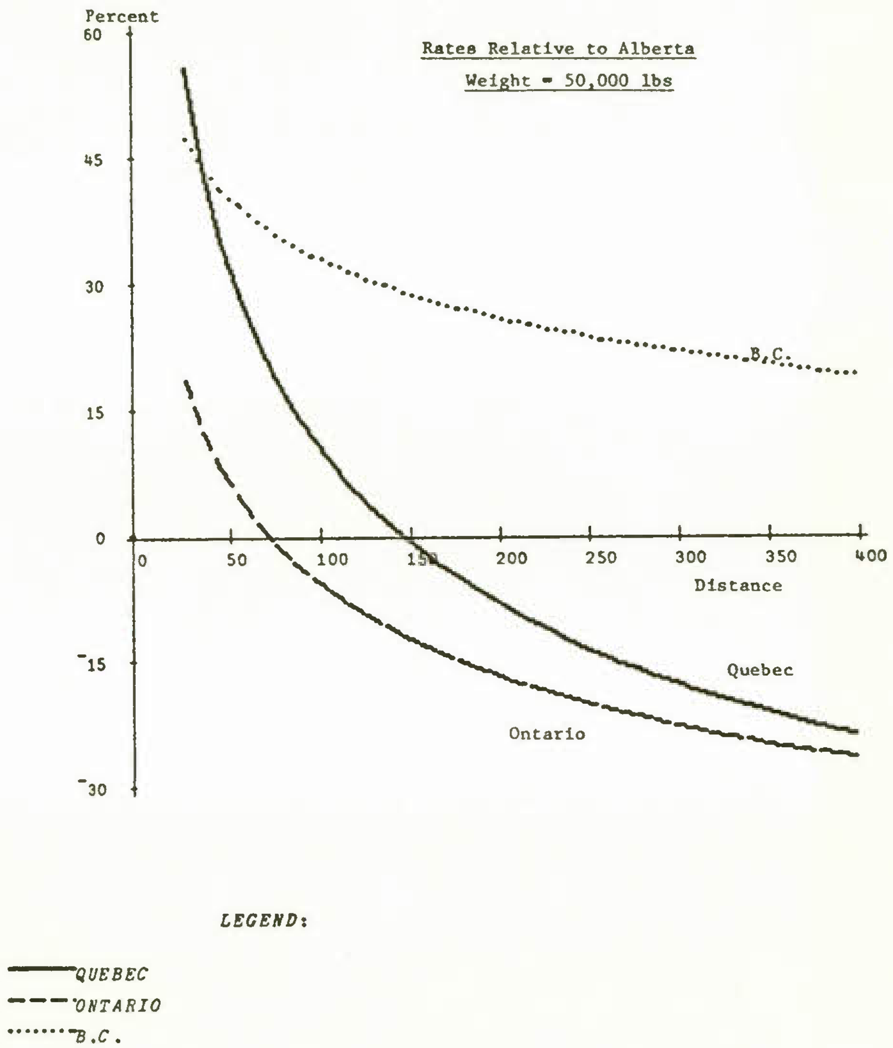
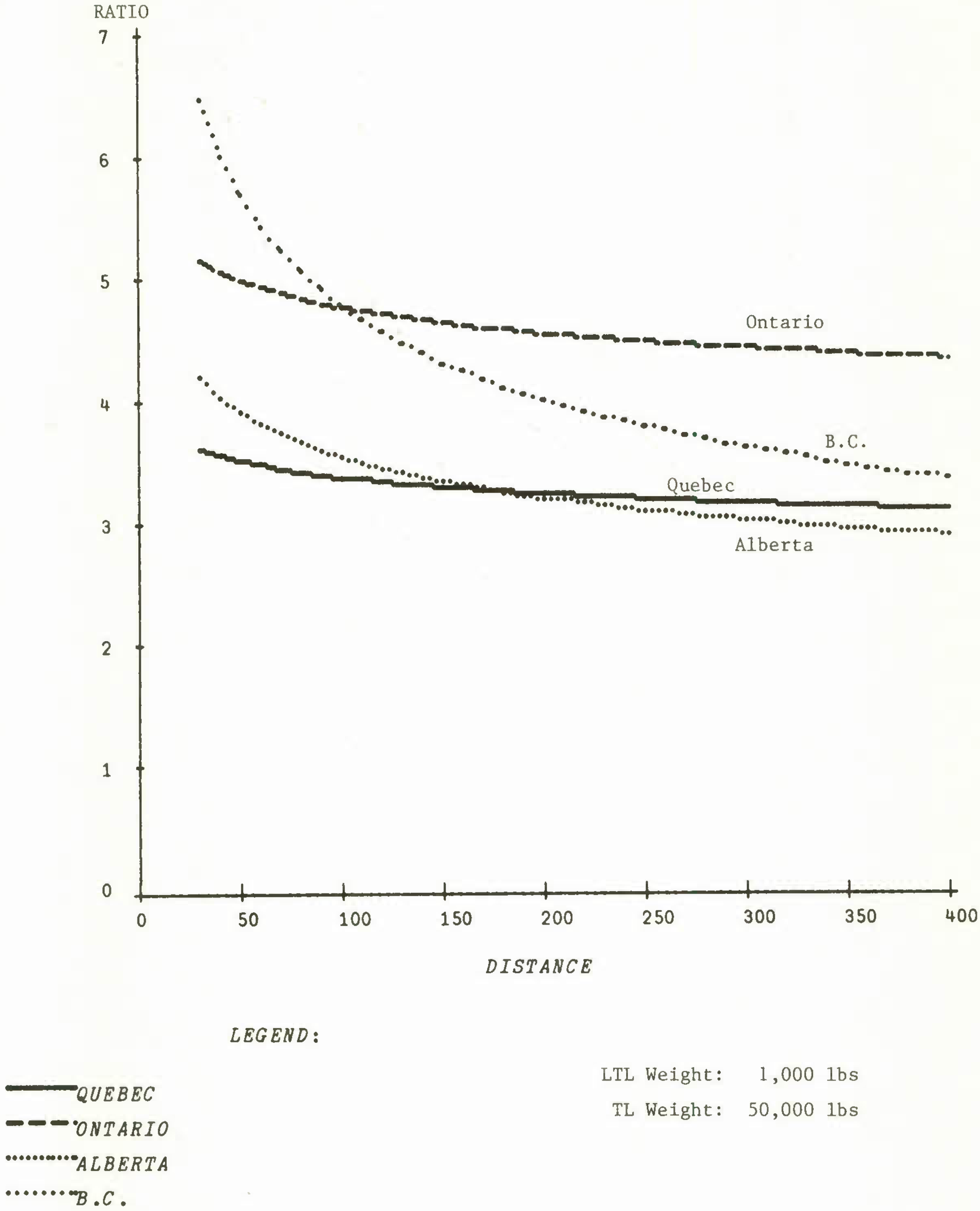


CHART 4.3.3

RATIOS OF LTL TO TL RATES

(Food Products - 5 Commodities)



display the results graphically. Thus, the left hand panel of Chart 4.3.1 shows the fitted relationship between revenue per ton-mile and distance for LTL shipments in Alberta which weigh 1,000 lbs. The right hand panel of the same chart shows the ratio of rates in each of the other 5 provinces relative to those in Alberta. It is clear that rates in British Columbia and Ontario are well above these in Alberta, but the percentage difference decreases as the length of haul increases. This is a reflection of the smaller distance elasticity in Alberta which was discussed in Section 4.3. In Manitoba and Quebec, LTL Food, Feed and Beverage rates are higher than those in Alberta for distances up to 150 miles, but are lower for longer distances. LTL rates are lowest of all in Saskatchewan.

Chart 4.3.2 shows similar information for TL shipments, except that TL rates for Manitoba and Saskatchewan are not reported due to the paucity of data. Again, rates in British Columbia are well above those in Alberta for all distances. Quebec rates are higher than those in Alberta for all distances. Quebec rates are higher than those in Alberta for distances up to 150 miles, but decline below for longer hauls. Ontario rates are lower than Alberta's rates for distances in excess of about 75 miles.

Chart 4.3.3 shows the ratio of rates for LTL and TL shipments for the four provinces for which TL regressions were computed. The LTL weight is fixed at 1,000 pounds and the TL weight is fixed at 50,000 pounds. The four provinces fall into two groups. Over the length of haul range of 50 miles to 200 miles, Ontario and British Columbia have a high ratio of LTL rates to TL rates (between 4 and 5) whereas the ratios for Quebec and Alberta are about 3.5.

The results of this analysis may be summarized in point form. For the 5 commodities included in the Food, Feed and Beverage commodity aggregate, it may be concluded that:

1. Rates in B.C. are well above those in Alberta for both TL and LTL shipments.
2. LTL rates in Ontario are higher than in Alberta, but the reverse is true of TL rates.
3. LTL rates are lowest in Saskatchewan.
4. The ratio of LTL to TL rates is largest in Ontario and British Columbia being in the range 4 to 5 compared to a comparable figure of 3.5 in Quebec and Alberta.

4.3.2 RATES FOR FABRICATED MATERIALS[8]

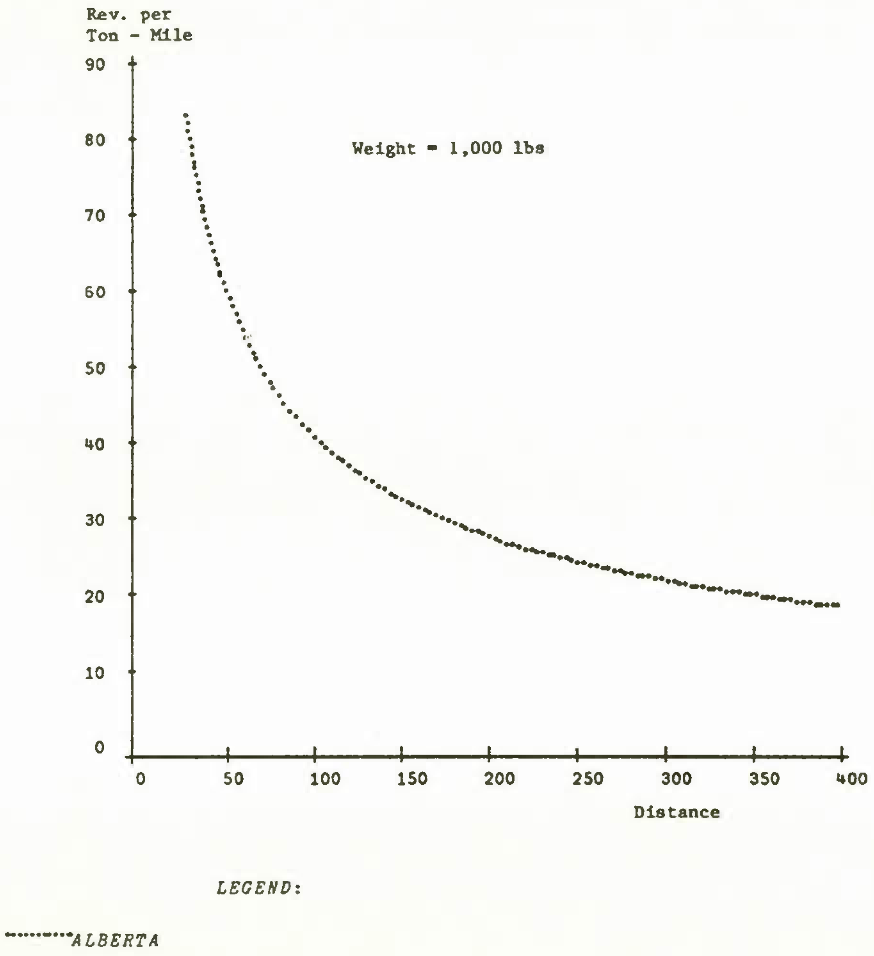
As mentioned above, all 20 commodities in the Fabricated Materials grouping are included in the current analysis. This results in a very robust set of conclusions which are best illustrated by Charts 4.3.4 through 4.3.6.

The left hand panel of Chart 4.3.4 shows the relationship between revenue per ton-mile and distance in Alberta for an LTL shipment weighing 1,000 pounds. The right hand panel shows LTL rates in the five other provinces as proportions of comparable rates in Alberta. Rates in Ontario are almost double those in Alberta for hauls of 50 miles and about 50% higher for hauls of 300 miles. Rates in Quebec and British Columbia are also higher than in Alberta. Both Manitoba and Saskatchewan have LTL rates which are lower than those in Alberta, and again Saskatchewan has the lowest LTL rates.

CHART 4.3.4

LTL RATES FOR FABRICATED MATERIALS

(20 Commodities)



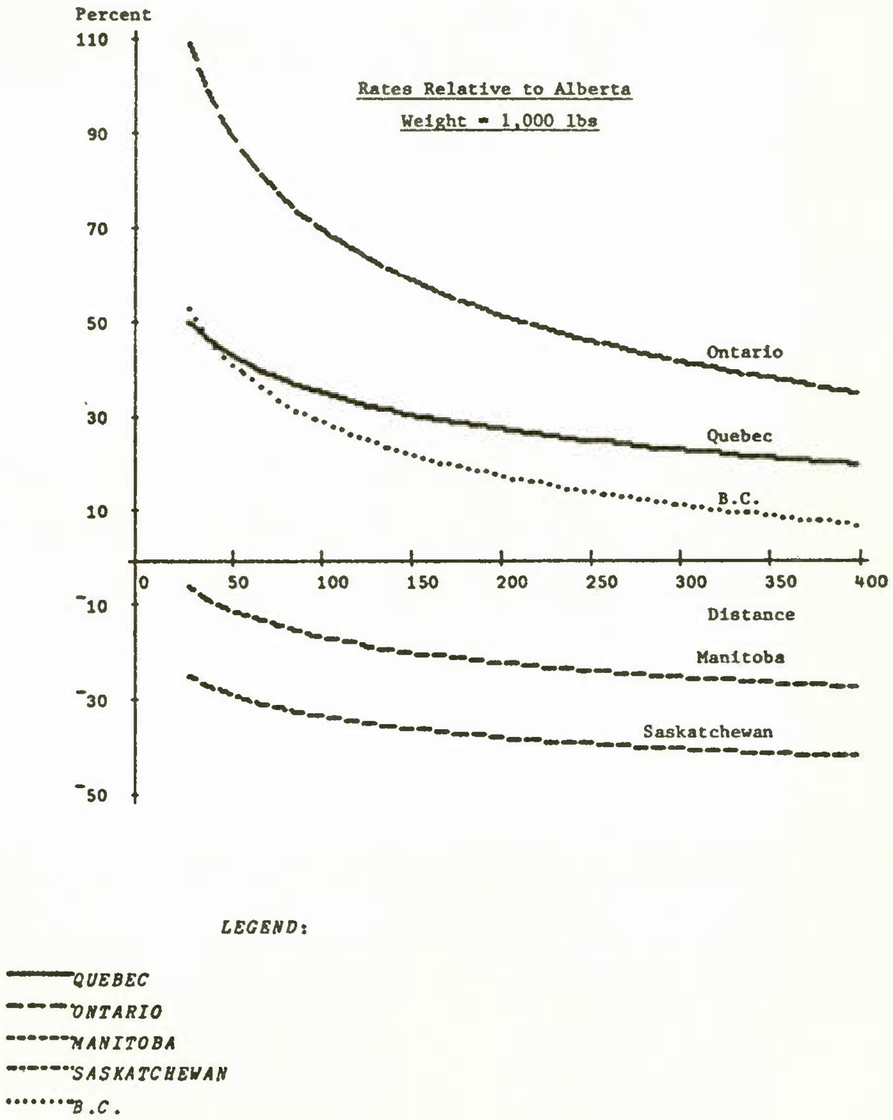
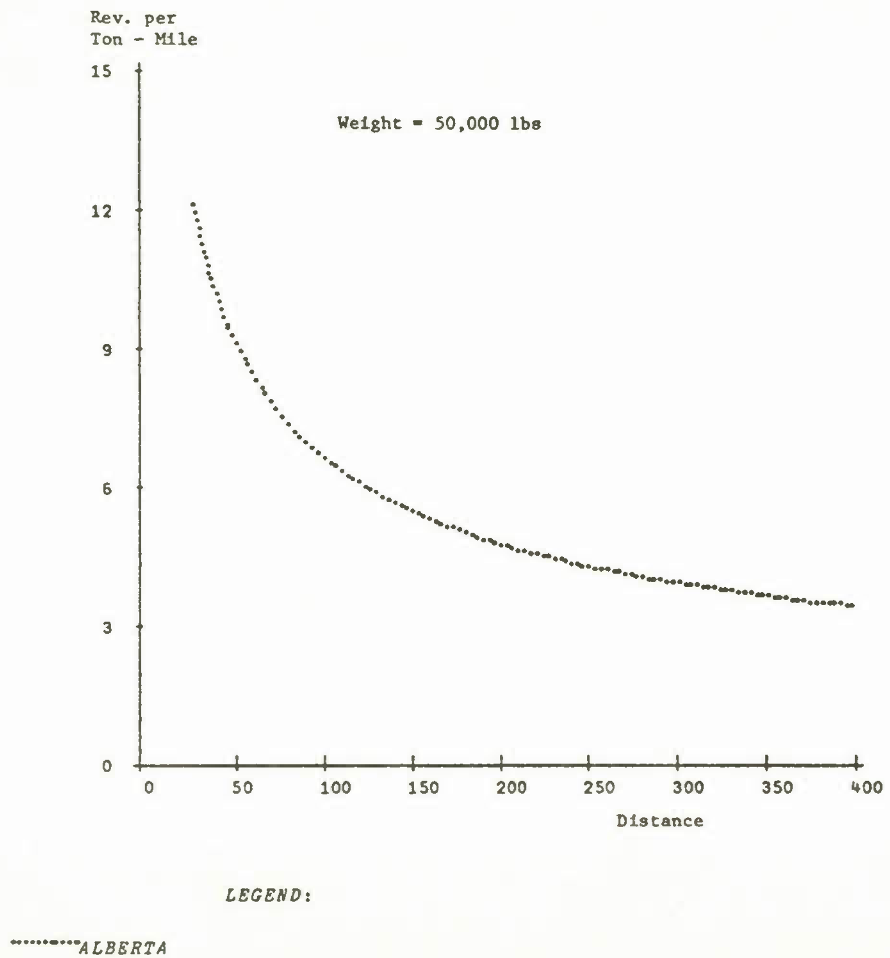


CHART 4.3.5

TL RATES FOR FABRICATED MATERIALS

(20 Commodities)



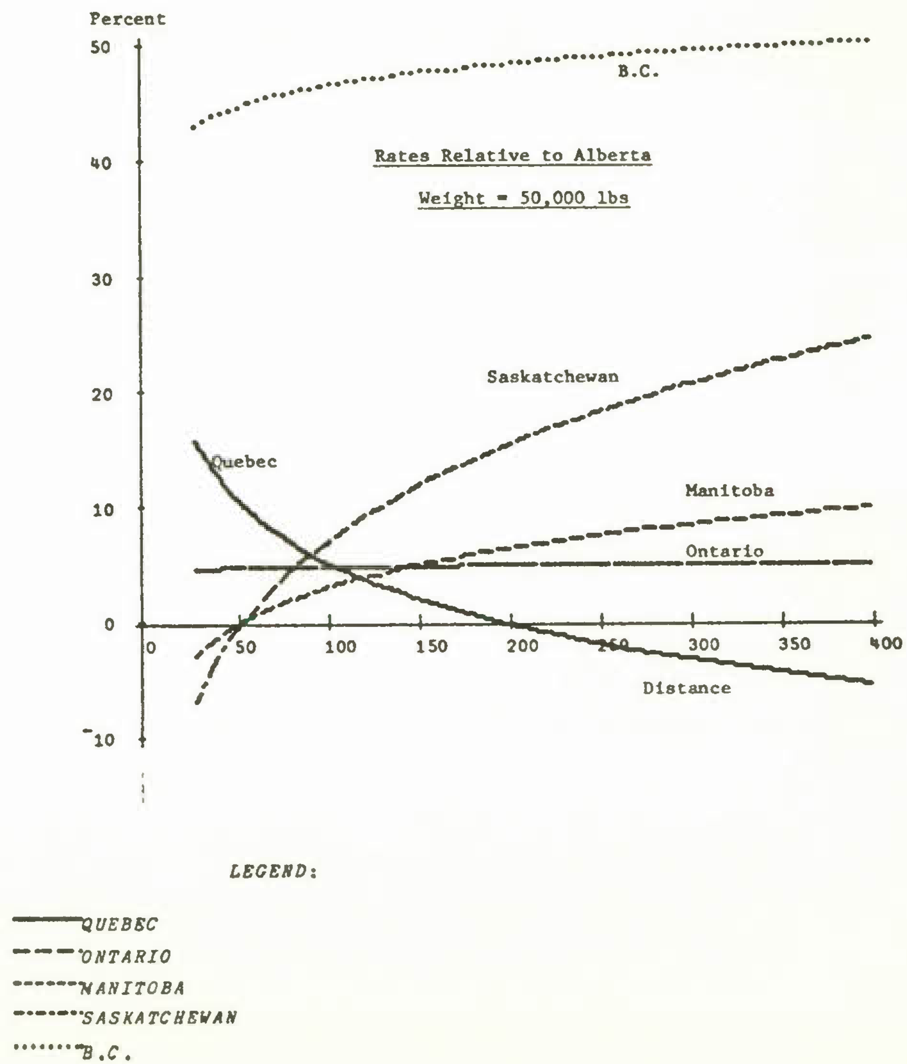
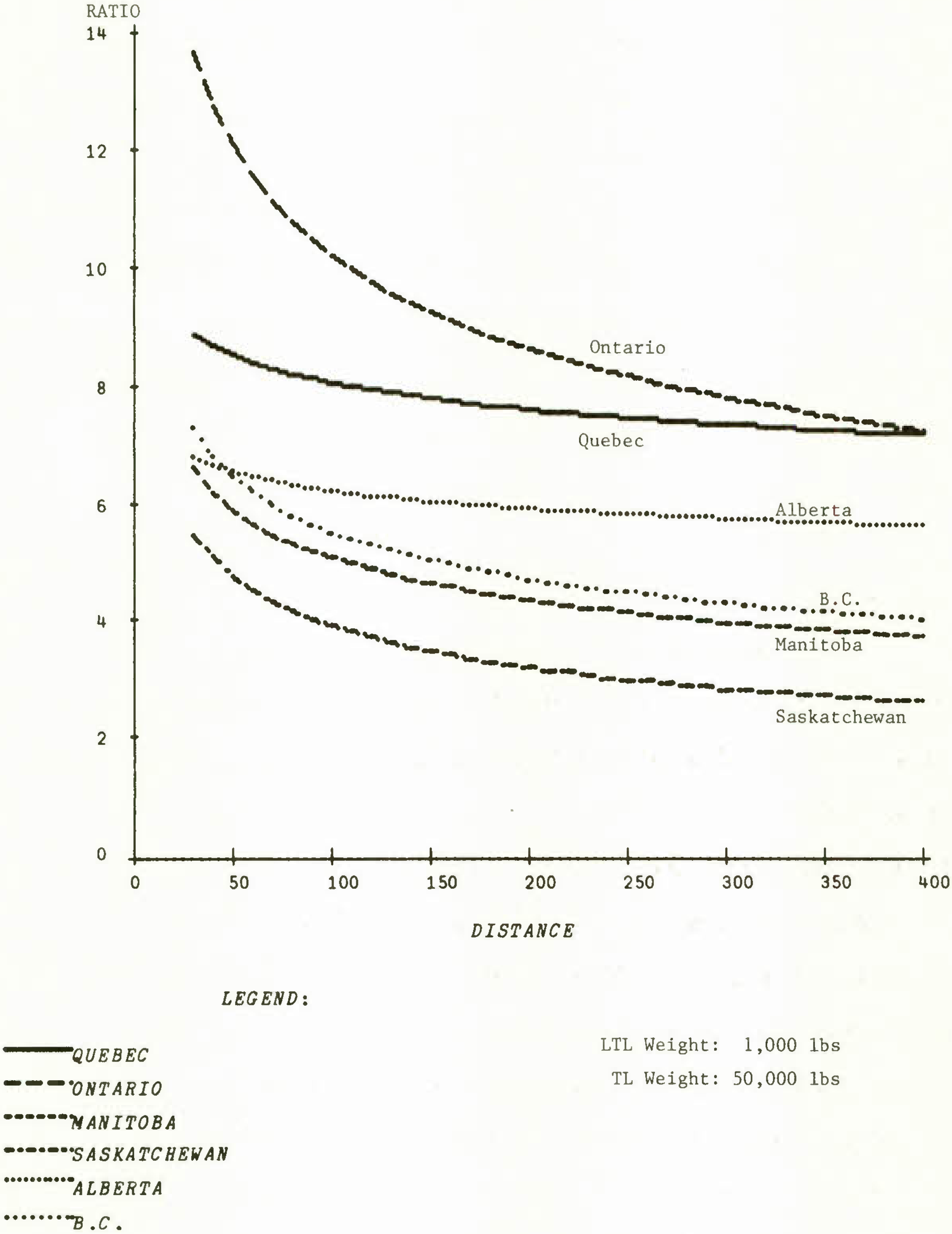


CHART 4.3.6

RATIOS OF LTL TO TL RATES

(Fabricated Materials - 20 Commodities)



LTL Weight: 1,000 lbs

TL Weight: 50,000 lbs

Chart 4.3.5 shows similar information for TL shipments of 50,000 pounds. Rates in British Columbia are by far the highest being about 45% above rates in Alberta. Rates in Saskatchewan, Manitoba and Ontario are also higher than rates in Alberta, but Quebec rates are lower for distances in excess of 200 miles. It is interesting that Ontario TL rates are only about 5% higher than TL rates in Alberta, but as we noted above LTL rates in Ontario are between 50% and 100% higher than LTL rates in Alberta. This is reflected in Chart 4.3.6 which shows ratios of LTL to TL rates for the six provinces. For distances up to 100 miles, this ratio exceeds 10 in Ontario and declines towards 8 as the length of haul increases to 400 miles. Saskatchewan has the lowest ratios which lie between 3 and 5. The ratio in Alberta is fairly constant at just over 6 for all lengths of haul up to 400 miles.

The main conclusions which emerge from this Section can again be summarized in point form. Based on evidence obtained from the 20 commodities included in the Fabricated Materials regressions, it may be concluded that:

1. LTL rates in Ontario are much higher than in other provinces, being double equivalent rates in Alberta for hauls of 50 miles, and about 50% higher for hauls of about 300 miles.
2. TL rates in British Columbia are much higher than in other provinces, being over 40% greater than equivalent rates in Alberta.
3. Saskatchewan has very low LTL rates, being only 40% of equivalent rates in Ontario.
4. TL rates in Ontario are only 5% above TL rates in Alberta and lower

than TL rates in Saskatchewan.

5. Ontario has the highest ratio of LTL to TL rates, and particularly so for short hauls.

4.3.3 RATES FOR END PRODUCTS[9]

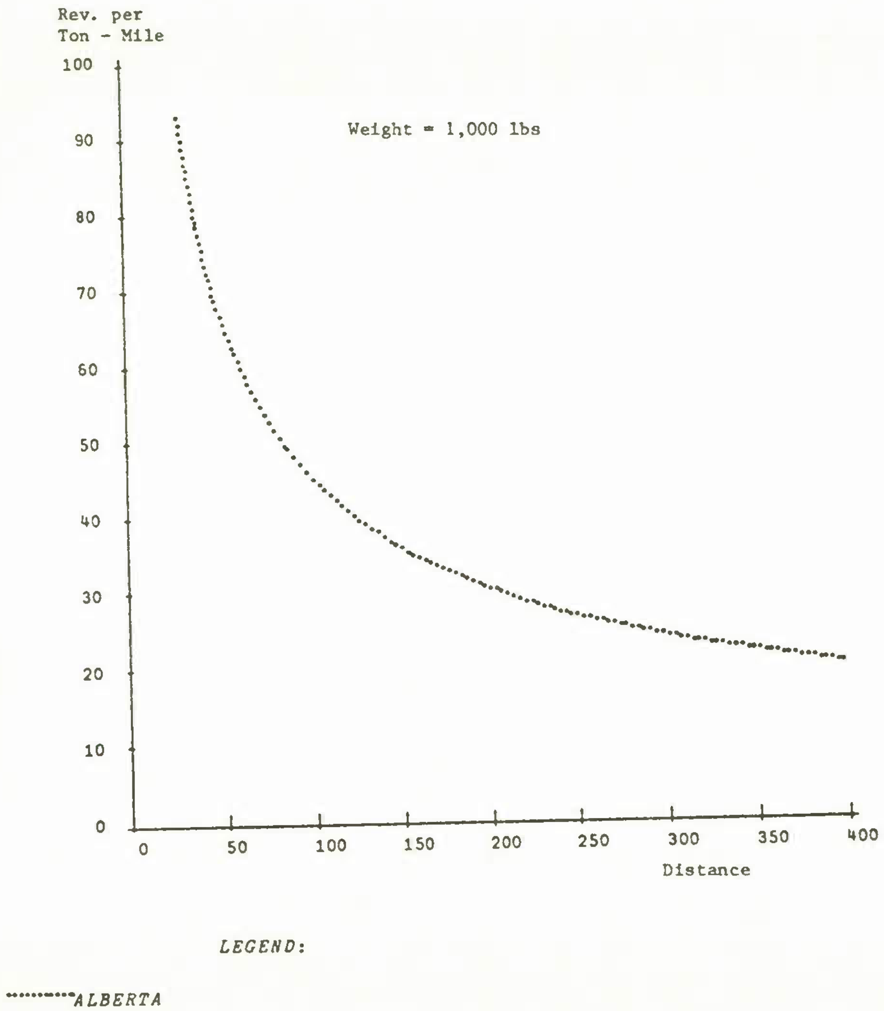
Unfortunately, only 4 commodities in the End Products group were represented in all 12 End Products regressions. As before, the left hand panel of Chart 4.3.7 shows the relationship between revenue per ton-mile in Alberta for LTL shipments weighing 1,000 pounds. The right hand panel shows the rates in the other provinces as proportions of rates in Alberta. Quebec and Ontario have markedly higher LTL rates than Alberta (revenue per ton-mile being at least 35% higher for shipments of 1,000 pounds). Rates in British Columbia are also higher than equivalent rates in Alberta by between 12% and 25%. LTL rates in Saskatchewan are lower for lengths of haul in excess of about 130 miles. Manitoba rates are lowest of all.

Chart 4.3.8 shows similar information for TL shipments. Recall from Table 4.3.3 that the Alberta regression has a very poor fit so that the curve shown in the left hand panel may be a very poor representation of TL rates in Alberta for these four End Products commodities. Consequently, the deviations of the other provinces rates from Alberta's rates may not be accurate. However, we can have reasonable confidence in the ranking of the other four provinces' TL rates. The right hand panel shows rates are highest in Quebec, followed by Ontario, British Columbia and Manitoba, in that order. Chart 4.3.9 gives an indication of the ratio of LTL rates to TL rates in four

CHART 4.3.7

LTL RATES FOR END PRODUCTS

(4 Commodities)



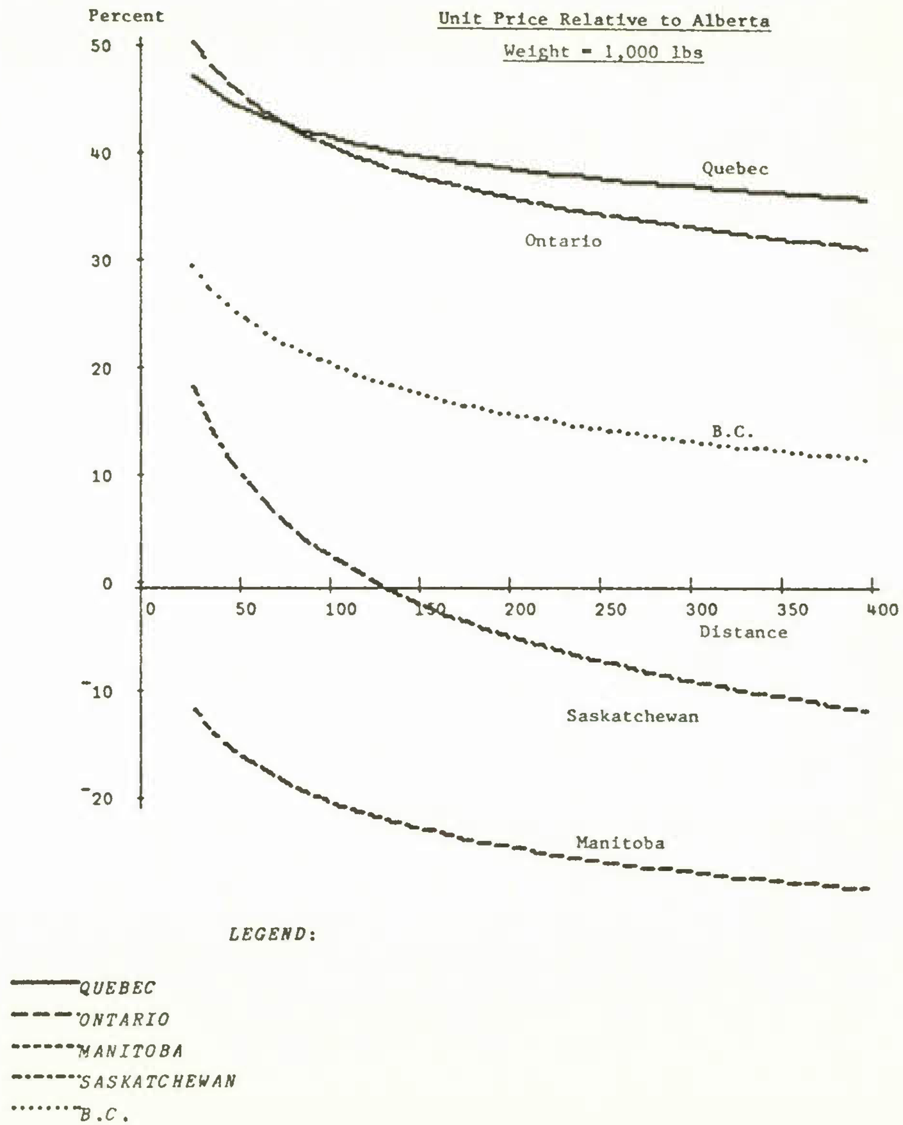
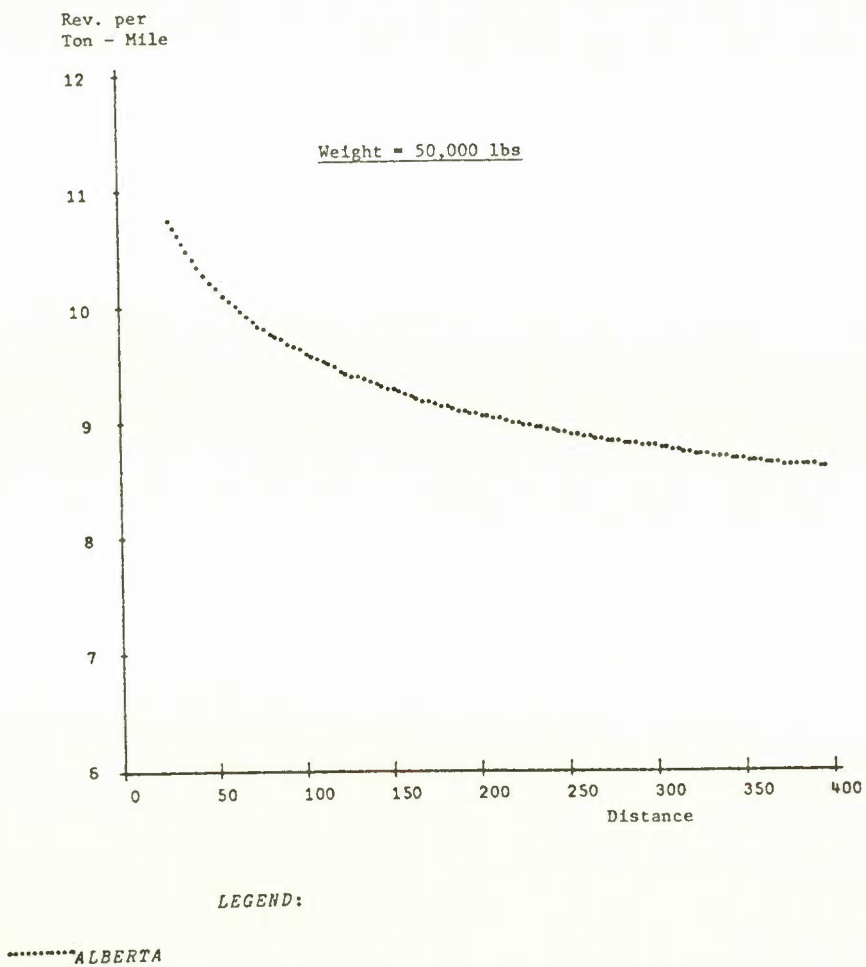


CHART 4.3.8

TL RATES FOR END PRODUCTS

(4 Commodities)



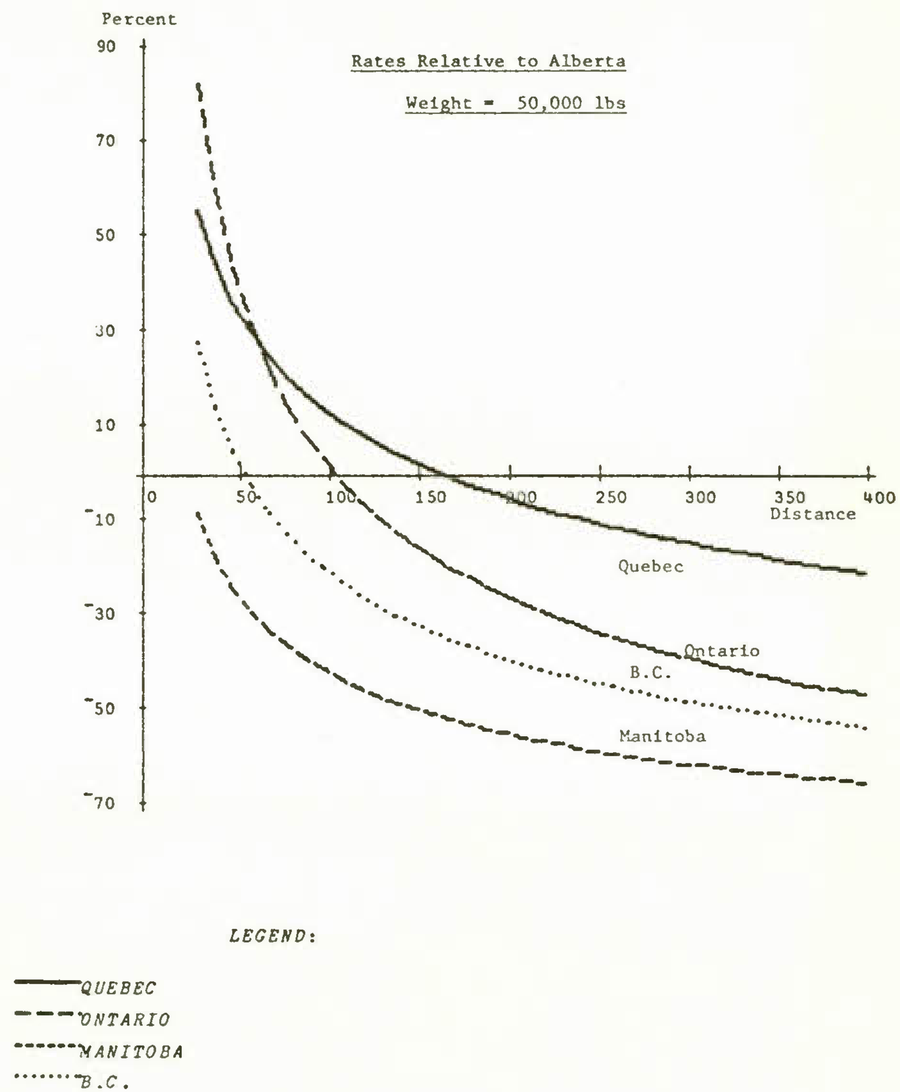
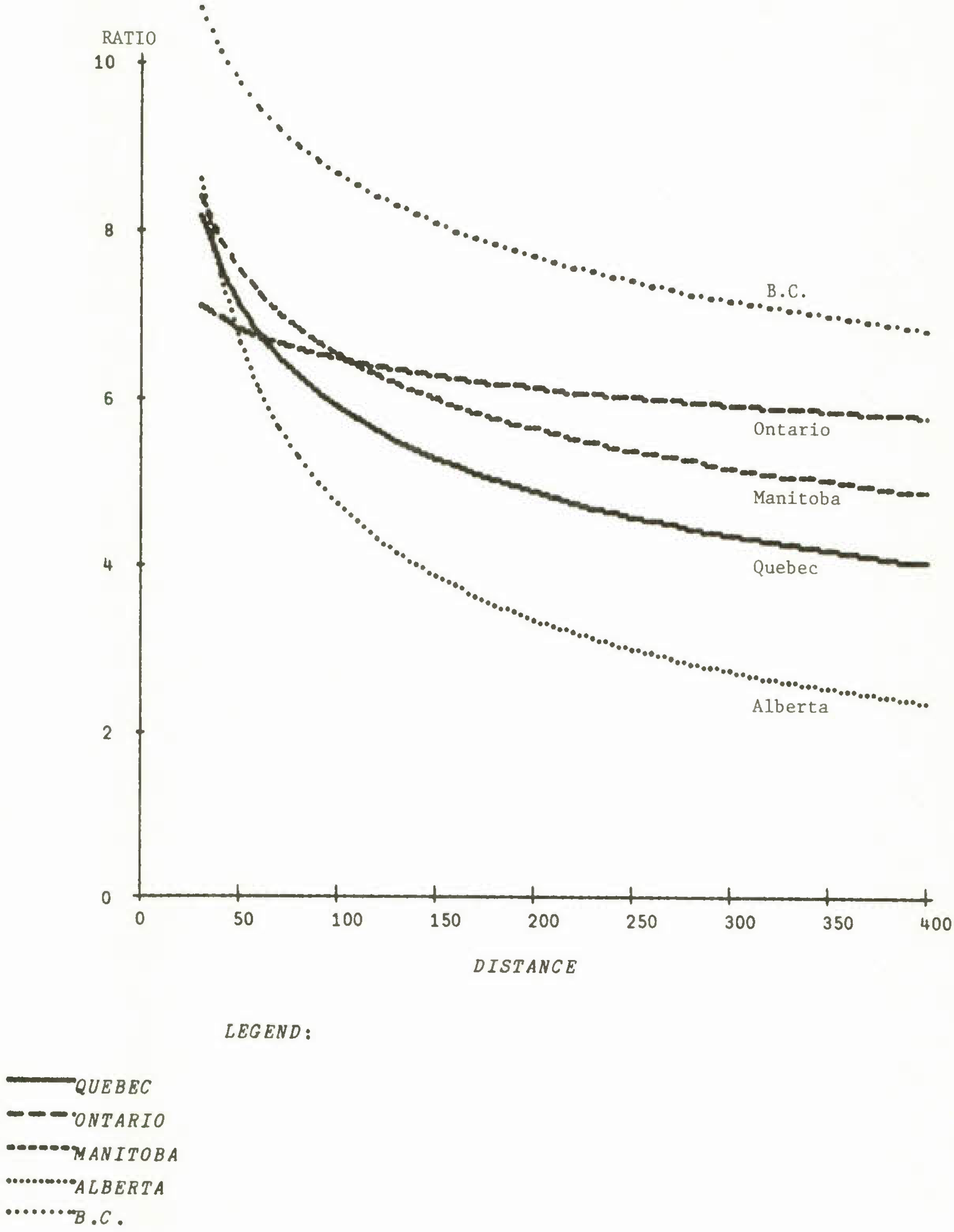


CHART 4.3.9

RATIOS OF LTL TO TL RATES

(End Products - 4 Commodities)



provinces (for the reasons given above, the Alberta curve has a low degree of confidence). This ratio is highest for British Columbia at all lengths of haul. For short hauls, there seems to be little difference between provinces with respect to this measure. However, for hauls in excess of 150 miles, Ontario emerges with the second highest ratio of LTL to TL rates behind British Columbia.

Based on the information presented in this Section, the various observations can be summarized in point form:

1. LTL rates in Quebec and Ontario are high, being at least 35% above comparable rates in Alberta.
2. LTL rates are lowest in Manitoba.
3. Of the four provinces for which meaningful TL regressions we obtained (Quebec, Ontario, Manitoba and British Columbia) Quebec has the highest TL rates, followed by Ontario.
4. The ratio of LTL to TL rates is highest in British Columbia, followed by Ontario.

4.3.4 CONCLUSIONS ON RATE STRUCTURES

Since the results obtained in Section 4.3.2 for the Fabricated Materials group are based upon 20 commodities which are transported intra-provincially in both the TL and LTL markets of all 6 sample provinces, the conclusions obtained are more significant than those for either of the other 2 commodity groupings. A principal finding is that LTL rates are much higher in Ontario than in other provinces, being between 50% and 100% higher than equivalent rates in Alberta. At the same time TL rates in Ontario are only 5% above equivalent rates in Alberta, and lower than equivalent rates in Saskatchewan, which is generally a low-rate province. Consequently, the ratio of LTL to TL rates in Ontario is exceptionally high in comparison to the other five provinces, especially for short hauls. This conclusion is confirmed by the results of the analysis of Food, Feed and Beverage rates and supported by the analysis of End Products rates. This result is in agreement with findings of the study conducted by the Ontario Ministry of Transportation and Communications (1975) and those of Maister (1977). Until the next Chapter reports estimates of the costs of transporting LTL and TL shipments, it will be impossible to say categorically that LTL traffic contributes proportionately more to profits than TL traffic in Ontario, but the evidence gained so far points in that direction.

As might have been expected, given the strong results reported in Section 4.2 concerning the direct measure of regulation in the Province of Saskatchewan, rates in this province are very different from equivalent rates in the other provinces. Evidence exists only for the Fabricated Materials group, but in this case, the ratio of LTL to TL rates is lower than in any other province. It would seem that the structure of prescribed rates in Saskatchewan favours shippers of LTL shipments.

The final major conclusion concerns rates in the Province of British Columbia. It was demonstrated that TL rates in British Columbia seem to be particularly high for both Fabricated Materials and Food, Feed and Beverages. Unfortunately, it is not possible to further investigate this observation through an analysis of British

Columbia For-hire carrier costs due to the lack of data as explained in the next Chapter.

4.4 A DESCRIPTION OF THE GEOGRAPHIC PATTERN OF INTRA-PROVINCIAL RATES

The third issue of policy importance discussed in Section 1.1 concerns the problem of trucking rate, cost and service levels to rural communities in regulated and deregulated environments. The concern of the present Section is rather constrained, being limited to only a description of the structure of rates for shipments destined to, and originating from, various sized areas within each of the 6 sample provinces. No attempt will be made at investigating the level of service in small communities, or the marginal or average costs of providing these services.

It is instructive, before discussing the rate regression results of this Section, or the cost analysis of the next Chapter, to understand the geographic pattern of intra-provincial, For-hire traffic flows. Table 4.4.1 shows the ratio of outbound to inbound For-hire truck traffic within the various Standard Geographic Code (SGC) areas. For the purposes of this Table, traffic volume is measured by the transportation revenue earned by For-hire trucking firms, and the SGC areas are arranged in terms of population size[10]. Over all provinces and commodity groups, the pattern is basically the same. Regions with 100,000 people or less have inshipments exceeding outshipments, while regions with more than 100,000 people have more outshipments than inshipments. When the data are disaggregated into provincial and commodity groupings, it would appear that, with the

TABLE 4.4.1

RATIO OF OUTGOING TO INCOMING FOR-HIRE TRUCK TRAFFIC

BY POPULATION SIZE OF STANDARD GEOGRAPHIC CODE AREAS[1]

Pop. Size ('000's)	B.C.	Alb.	Sask.	Man.	Ont.	Que.	Total
			FOOD, FEED & BEVERAGES				
< 5	0.45	0.95	1.47	0.43	0.83	0.75	0.75
5 - 25	0.42	0.20	0.34	0.32	0.79	0.38	0.52
25 - 100	0.59	0.93	1.16	0.70	0.72	0.38	0.61
100 - 250	22.57	xxxx	1.00	2.49	0.91	0.85	1.04
250+	4.82	1.33	xxxx	3.21	1.67	6.21	2.42
			FABRICATED MATERIALS				
< 5	0.46	0.36	0.08	0.26	0.74	0.71	0.50
5 - 25	0.43	0.12	0.04	0.33	0.56	0.57	0.48
25 - 100	1.38	0.20	0.63	1.36	1.00	0.64	0.88
100 - 250	6.96	xxxx	9.59	3.55	1.05	0.88	1.50
250+	4.02	5.12	xxxx	8.97	1.65	3.91	3.04
			END PRODUCTS				
< 5	0.34	0.45	0.37	0.38	0.46	0.81	0.54
5 - 25	0.54	0.25	0.74	0.33	0.98	0.75	0.74
25 - 100	1.16	0.75	0.27	0.21	0.97	0.62	0.85
100 - 250	0.98	xxxx	2.58	8.66	0.98	1.01	1.12
250+	3.26	3.38	xxxx	2.24	1.42	2.30	2.09

[1]Measured by transportation revenue earned by For-hire trucking firms.

xxxx - indicates no observations

Source: Compiled by the authors using Statistics Canada, For-Hire Trucking Survey data 1975 and 1976.

possible exception of Food, Feed and Beverages in British Columbia, distribution patterns within provinces are not unduly different one from the other.

As in Section 4.3, these data are sorted into 6 intra-provincial categories, 2 weight classes (TL and LTL) and 3 commodity groupings. The functional form for all of the potentially available 36 regressions is given by equation 4.4.1.

4.4.1 $$y = W^a H^b D^c O^d e^Z$$

where Z, y, W, H, c, M, T and u are the same as defined earlier, and

D is the population of the destination SGC area

O is the population of the origin SGC area.

The 3 commodity groupings contain the same products as before except that 2 commodities from the Food, Feed and Beverage group with the fewest number of observations were dropped so that each group now contains 20 products. Also, the list of 20 products for each commodity group has been modified slightly to ensure that in each case the 20 products included are the ones with the largest number of shipment records. One consequence of this slight change in the list of included products is that a complete set of TL regressions is now available. Finally, LTL shipments continue to be defined as those weighing 5,000 lbs. and less, while TL shipments weigh 35,000 lbs. and more up to a maximum of 100,000 lbs.

The results of fitting equation 4.3 to the 36 data sets are reported in summary form in Tables 4.4.2 through 4.4.4. As measured by the reported $\overline{R}^2$ values, the LTL regressions are again superior to

TABLE 4.4.2

LTL AND TL REVENUE PER TON-MILE REGRESSIONS WITH ORIGIN AND DESTINATION POPULATION[1] FOR THE FOOD, FEED & BEVERAGE GROUPING.

LTL SHIPMENTS

VARIABLE	PROVINCE					
	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.369 (-32.0)	-.481 (-47.4)	-.443 (-36.4)	-.552 (-64.1)	-.452 (-42.8)	-.498 (-42.9)
Distance (H)	-.802 (-52.4)	-.583 (-27.3)	-.722 (-29.4)	-.718 (-61.5)	-.727 (-52.2)	-.875 (-58.8)
Time (T)	.348 (10.9)	.173 (6.6)	.209 (7.96)	.228 (10.6)	.330 (8.73)	-.046 (-1.43)
Origin Population (O)	.078 (7.52)	-.027 (-2.01)	.003 (.250)	-.025 (- 2.65)	.054 (6.42)	.096 (14.7)
Destination Population (D)	-.037 (- 3.94)	-.053 (-9.01)	.021 (2.47)	-.005 (-.710)	-.012 (-1.92)	.057 (6.58)
Number of Observations	1688	1571	946	1480	2704	2141
$\bar{R}^2$	.766	.746	.736	.872	.746	.767

TL SHIPMENTS

VARIABLE	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	.203 (1.30)	-.706 (-8.26)	.075 (8.12)	-.230 (-1.23)	-.733 (-17.0)	-.595 (-7.09)
Distance (H)	-.475 (-21.5)	-.582 (-31.8)	-.853 (-51.9)	-.945 (-19.5)	-.689 (- 61.1)	-.584 (-29.3)
Time (T)	.164 (3.26)	.286 (9.23)	.361 (17.0)	.100 (2.51)	.119 (5.48)	.080 (2.00)
Origin Population (O)	.152 (10.7)	.010 (1.64)	.045 (7.16)	.046 (3.26)	.011 (2.06)	.009 (1.30)
Destination Population (D)	-.014 (-1.28)	-.011 (-1.92)	-.047 (-7.02)	-.096 (-4.04)	-.003 (-.600)	.042 (5.31)
Number of Observations	508	1553	722	313	1976	1038
$\bar{R}^2$	.736	.540	.834	.654	.741	.680

1. T-Statistics in brackets. Commodity and shipment characteristic dummies are not reported.

TABLE 4.4.3

LTL AND TL REVENUE PER TON-MILE REGRESSIONS WITH ORIGIN AND DESTINATION POPULATION FOR THE FABRICATED MATERIALS GROUPING.[1]

LTL SHIPMENTS

VARIABLE	PROVINCE					
	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.557 (45.4)	-.544 (-55.0)	-.553 (-35.4)	-.651 (-58.3)	-.540 (-76.4)	-.569 (-95.3)
Distance (H)	-.696 (-37.0)	-.679 (-26.2)	-.731 (-16.4)	-.723 (-41.9)	-.816 (-70.7)	-.749 (-72.2)
Time (T)	.226 (6.10)	.230 (7.81)	.244 (5.36)	.120 (3.48)	.045 (1.68)	.112 (5.98)
Origin Population (O)	-.019 (-1.63)	-.118 (-12.1)	-.002 (-.110)	.027 (2.02)	-.001 (-.180)	.010 (2.35)
Destination Population (D)	.267 (2.41)	-.033 (-4.87)	.020 (1.50)	.023 (2.22)	-.029 (-4.96)	.004 (.930)
Number of Observations	1372	1935	739	856	2892	3941
$\bar{R}^2$	.742	.699	.719	.871	.794	.792

TL SHIPMENTS

VARIABLE	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.963 (-16.9)	-.603 (-15.0)	-.579 (-8.50)	-1.07 (-6.69)	-.641 (-26.4)	-.314 (-8.12)
Distance (H)	-.500 (-35.2)	-.483 (-44.0)	-.422 (-28.0)	-.474 (-17.9)	-.484 (-71.2)	-.601 (-50.2)
Time (T)	.348 (13.4)	-.015 (-.950)	.309 (17.3)	.361 (6.24)	.059 (4.61)	.074 (3.72)
Origin Population (O)	.033 (4.16)	.001 (.280)	.098 (7.57)	-.084 (-5.52)	.015 (4.33)	.004 (.930)
Destination Population (D)	-.038 (-4.96)	-.056 (-15.7)	.022 (4.81)	-.081 (-6.50)	-.010 (-2.96)	-.012 (-2.51)
Number of Observations	2838	3952	2594	489	5793	4237
$\bar{R}^2$	.460	.473	.494	.631	.571	.506

1. T-Statistics in brackets. Commodity and shipment characteristic dummies are not reported.

TABLE 4.4.4

LTL AND TL REVENUE PER TON-MILE REGRESSIONS WITH ORIGIN AND DESTINATION POPULATION FOR THE END PRODUCTS GROUPING.[1]

LTL SHIPMENTS

VARIABLE	PROVINCE					
	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-.535 (-56.5)	-.562 (-61.6)	-.525 (-41.6)	-.569 (-53.0)	-.520 (-96.1)	-.523 (-109.)
Distance (H)	-.748 (-52.1)	-.635 (-31.2)	-.755 (-27.2)	-.756 (-45.7)	-.806 (-98.7)	-.724 (-99.2)
Time (T)	.071 (2.53)	.418 (16.7)	.257 (7.72)	.240 (7.64)	.061 (3.56)	.131 (9.79)
Origin Population (O)	-.004 (-.460)	-.060 (-7.33)	-.065 (-5.15)	.040 (3.49)	-.013 (-2.42)	.006 (1.85)
Destination Population (D)	.020 (2.53)	-.047 (-7.70)	.006 (.660)	.048 (5.08)	-.027 (-6.23)	.014 (4.28)
Number of Observations	3044	3471	1547	1895	7283	7568
$\bar{R}^2$	.713	.676	.710	.767	.805	.781

TL SHIPMENTS

VARIABLE	B.C.	ALB.	SASK.	MAN.	ONT.	QUE.
Weight (W)	-3.45 (-18.1)	.760 (22.5)	.183 (4.77)	-1.56 (-1.09)	-.609 (-6.73)	-.201 (-1.35)
Distance (H)	-.488 (-25.8)	-.378 (-22.3)	-1.22 (-19.3)	-.451 (-3.52)	-.599 (-22.0)	-.409 (-10.1)
Time (T)	.356 (3.64)	.026 (.680)	.005 (.020)	-.863 (-1.27)	.043 (.970)	.065 (.640)
Origin Population (O)	.025 (1.08)	.183 (37.1)	.106 (3.58)	.055 (.540)	.003 (.210)	-.008 (-.510)
Destination Population (D)	-.017 (-1.11)	.028 (3.48)	.035 (1.69)	.034 (.400)	-.026 (-1.86)	.017 (1.06)
Number of Observations	1387	2426	145	37	315	317
$\bar{R}^2$	.508	.460	.799	.587	.726	.519

1. T-Statistics in brackets. Commodity and shipment characteristic dummies are not reported.

the TL ones. Also, in 6 of the 18 TL regressions,[11] the available data sets are dominated by a single product, thus making the modelling efforts more difficult as discussed in Section 4.3.

The LTL regressions continue to display stable weight and distance elasticities in approximately the same range as before. Again, the reported t-values on these coefficients continues to be very high.

With respect to the origin and destination variables in the LTL regressions, particular interest is attached to the Alberta results due to the unregulated nature of this province. Estimated Alberta origin coefficients have t-scores over 2 in absolute value, and are negative for all 3 commodity groups, ranging between -.118 and -.060. Thus, a 10% decrease in the size of the originating shipment point, as measured by population, is estimated to raise the unit price of For-hire trucking service by between 1.2% and 0.6%. This observation is consistent with the belief that the prices observed in this competitive market reflect the higher costs inherent in servicing low density, rural traffic corridors. For the Provinces of British Columbia, Saskatchewan, Manitoba and Ontario, the signs on the origin coefficient estimates, over the various commodity groups, alternate between positive and negative, and statistical significance and insignificance. The Province of Quebec alone shows a consistent pattern of positive origin population elasticities, two of which have t-values over 2 in value. When attention is shifted to the sign and size of the destination population coefficients, a roughly similar pattern emerges. All the

Alberta regressions have negative destination coefficients with t-scores well over 2 in absolute value. Thus, it is estimated that a 10% decrease in the population size of an Alberta destination will raise rates by approximately 0.3% to 0.5%. As with the origin population variable, Quebec has the most consistently different geographic rate pattern with 3 positive destination elasticity estimates, two of which have t-scores over 2. The Province of Ontario appears to have a rate pattern similar to Alberta's, while Saskatchewan and Manitoba are closer to Quebec's. For British Columbia, significant but inconsistent signs were obtained over the different commodity groups.

The geographic pattern of TL rates is considerably more difficult to interpret because for both the End Products and Food, Feed and Beverage groupings, the Alberta regression is dominated by a single product. The TL regressions for Fabricated Materials show that Saskatchewan and not Quebec is the province whose geographic rate structure is most different from the competitively determined one in Alberta.

This econometric evidence presented in Tables 4.4.2 through 4.4.4 will support several broad conclusions regarding the so-called small communities problem. In the competitive rate Province of Alberta, the unit price of For-hire trucking services for outbound and especially inbound shipments increases as community size decreases. For the LTL markets, the geographic structure of rates within Quebec, and to a lesser degree Saskatchewan and Manitoba, is dissimilar to the competitive rate pattern in that rates decrease with decreasing community size. Ontario has a pattern of rates very similar to Alberta's, and British Columbia demonstrates differing results depending upon the commodity group in question. For TL shipments, the evidence is considerably more restricted, but it would appear that Saskatchewan is the province with the most dissimilar pattern of rates when compared to equivalent rates in Alberta.

These results for Quebec, Saskatchewan and Manitoba suggest that the motor carrier boards in these provinces are controlling the intra-provincial rate structure so as to benefit small communities. Since Saskatchewan and Manitoba prescribe rates as well as control entry, and Quebec has rate approval authority in addition to entry control, it is clear that the administrative machinery for this type of rate manipulation certainly exists. This implicit taxation/subsidization arrangement has been dubbed "taxation by regulation" by R.A. Posner (1971), but, unfortunately, it is not possible to pursue the topic by estimating cost functions for service to small communities. The next Chapter makes clear the nature of the data problems involved.

FOOTNOTES TO CHAPTER FOUR

1. An earlier version of the results presented in this Section appeared in the volume by Bonsor et. al. (1980).
2. These 19 commodities for the two sample years 1975/76 were compiled from a study by R.K. House and Associates (1977). They are presented in Appendix A2.
3. Annedotal evidence on Saskatchewan For-hire carrier dissatisfaction during this period is also available. In January, 1976, Canadian Pacific Transport, one of the trucking divisions of Canadian Pacific Railways, announced its intention to abandon service on 31 rural Saskatchewan routes. At approximately the same time, the Saskatchewan based trucking subsidiary of Canadian National Railways announced that it would no longer rate traffic according to the prescribed intra-provincial tariff, substituting instead its own higher rate structure. The result of both of these moves was a protracted set of strained negotiations between the Provincial Regulatory Board and these two carriers.
4. It could be argued that the carrier on the first franchise may have slightly higher line haul costs due to the fact that he has further to go while nearly fully loaded.
5. This definition of small and large shipments is different from the ones used in Chapter 3 on model shares. This more restrictive classification scheme has been used to ensure that the data are placed into categories which are highly likely to reflect the differences in LTL and TL production technologies.

6. The 9 shipment characteristics described by the dummy variables M_i are: use of a heated or refrigerated truck; ferry, roundtrip or other surcharge; piggyback; fishyback; interline shipment; use of container.

7. The commodities, and their 3-digit SCC numbers in brackets, are: Other Food Preparations (146); Meat (011); Dairy Products (051); Vegetables, fresh or chilled (091); and Farinaceous Substances (069).

8. The commodities, and their 3-digit SCC numbers in brackets, are: Other non-metallic mineral based products (479); Other Chemical Specialties (429); Cement and Concrete (475); Petroleum and Coal Products (439); Fuel Oil (432); Primary Iron and Steel (442); Lumber and Sawn Timber (331); Pipes and Tubes (448); Bolts, Nuts, Nails and Screws (465); Other Metal Fabricated Products (469); Gasoline (431); Castings or Forgings (443); Paints and Paint Products (428); Wire and Wire Rope, Steel (449); Plate, Sheet and Strip Steel (445); Structural or Architectural Metal Products (461); Valves and Pipe Fittings (468); Insulated Wire and Cable (464); Glass Basic Products (473); Aluminum and Aluminum Alloy (451).

9. The commodities, and their 3-digit SCC numbers in brackets are: Motor Vehicle Engines, Accessories and Parts (588); Shipping Containers (951); Drilling, Excavating, and Mining Machinery (521); Other Machinery (509).

10. Population information was obtained from the 1972 Census, and updated to the sample years 1975 and 1976.

11. Alberta, Saskatchewan and Manitoba in the Food, Feed and Beverage group, and British Columbia, Alberta and Saskatchewan in the End Products grouping.

CHAPTER FIVE

THE COST STRUCTURE OF THE FOR-HIRE TRUCKING INDUSTRY

5.0 INTRODUCTION

In the previous Chapter, micro-data on individual shipments were used to examine the structure of rates in the six provinces west of and including Quebec. As made clear several times, these data cannot be used to explain the differences in rate levels, but the micro-data do provide a very secure foundation for describing the actual structure of rates.

The purpose of this Chapter is to introduce firm level cost data in order to determine the extent to which the observed differences in rate levels can be explained by differences in the level of carrier costs. There are three specific purposes to the Chapter. The first is to estimate the marginal costs of LTL and TL traffic in provinces where the carrier cost data is sufficient. This will cast light on whether or not the rate levels observed in the previous Chapter, e.g., the high LTL rates in Ontario, are based on cost considerations. The second main purpose is to examine the relative efficiencies of trucking firms in the sample provinces. As discussed in Chapter One, particular attention will be given to role which capacity utilization plays in cost determination. The final purpose is to examine the size of scale economies in trucking operations.

The approach is to estimate a two-output, trans-log cost function using a sample of firms which are primarily concerned with intra-provincial shipments. The specification of a joint-output production function allows for the estimation of marginal costs for both LTL and TL output (the null hypothesis that there is just one output is rejected).

Since the objective of the Report is to examine the role of economic regulation on provincial trucking markets, it is necessary to focus on firms that primarily supply intra-provincial trucking services. This requirement, along with others, has the effect of reducing the sample size available for this cost estimation towards minimally acceptable levels. Instead of estimating cost functions for the same six intra-provincial markets for which rate functions were estimated, we are forced to deal with only the Alberta, Ontario and Quebec markets. A second consequence is that it is not possible to estimate the effect of community size on carrier costs. Thus, the size of the implicit subsidies effected through the intra-provincial rate structures cannot be calibrated, and we must rely on the incomplete but suggestive rate information of the previous Chapter.

The next Section of this Chapter summarizes the research methodology and findings of two other recent studies of Canadian For-hire cost functions which are based on essentially the same data sources as this Report. The first of these is by G. Chow (1980), and the second by M.B. Cairns and B.D. Kirk (1980). Section 5.2 provides the background information required in order to understand the trans-log cost function. Section 5.3 explains how the data were prepared, and the following Section provides the results of the estimating procedure. Section 5.5 summarizes and concludes the Chapter.

5.1 RECENT ESTIMATES OF CANADIAN FOR-HIRE TRUCKING COSTS

5.1.1 CHOW'S PERFORMANCE STUDY

The objective of this study is to assess the performance of trucking firms that operate under different regulatory regimes. Three performance measures are examined: revenue, costs and profits. Chow argues that regulation may cause rates to be higher than they would be in the absence of regulation either because entry regulation inhibits competition, or because regulated firms are less efficient than unregulated firms. However, these factors are not mutually exclusive. The purpose of the econometric work is to quantify these effects by estimating revenue, cost and profit functions for several provinces.

The first step of the analysis is to select the sample of firms. The guiding principle here is that the study group should comprise a homogeneous set of firms. Chow points out that the population of for-hire trucking firms is far from homogeneous. Firms not only differ with respect to the commodities they haul (and therefore the equipment they use), but also with respect to the proportion of their business which is LTL freight, and whether or not they have common carrier obligations. Indeed, Chow shows that these last two distinctions are important for the cost structure of the firms. However, the more stringent are the criteria used to obtain a homogeneous sample, the smaller will be the size of the sample, and the less reliable will be the statistical inferences which will be made on the basis of the sample information. In short, there is a trade-off between the homogeneity of the sample and the sample size. Chow argues that the most suitable division of the data given the objectives of the study is to be found by isolating the intra-provincial general freight carriers which are predominantly[1] common carriers of LTL freight.

The concept of using only carriers reporting that they are general freight carriers is to focus attention on the industry segment which is thought to use a common production technology for shipment sorting and consolidation as well as straight line haul. However, subsequent investigation of Chow's sample shows that 29 of the 131 sample carriers report no terminal expenses. It is suspected that these are contract carriers, and carriers that specialize in specific types of TL freight. Also, while all carriers in the sample report themselves to be purely intra-provincial carriers, the random sample of waybills from these firms done for the 1975 For-Hire Trucking Origin and Destination Survey (TOD) shows that many are engaged in extra-provincial carriage to some degree.

Because of the paucity of the data, the number of provinces that can be studied is reduced to three: Alberta (28 firms), Ontario (52 firms), and Quebec (51 firms). Recall that Alberta does not impose economic regulations on its intra-provincial carriers, while both Ontario and Quebec regulate entry. In addition, rates in Ontario have to be filed with the Ontario Highway Transport Board, while in Quebec rates are approved by the Quebec Transport Commission. However, the approval of rates in Quebec is little more than a formality so that the comparisons to be made between Alberta on the one hand, and Ontario and Quebec on the other, are essentially comparisons between an unregulated environment and an environment where entry alone is controlled.

The methodology Chow uses to examine performance is to estimate revenue, cost and profit functions for each of the three provinces. The explanatory variables include: the level of output (measured by the number of shipments), factor prices and quality measures of output such as average length of haul, average shipment weight and the proportion of shipments that are LTL shipments. Since the profit function was not satisfactorily estimated, it was not further investigated and the analysis focussed on the revenue and cost functions. Chow found that the data could be pooled, i.e., an F-test failed to reject the null hypothesis of common slope coefficients for the pairs of provinces--Alberta/Ontario and Alberta/Quebec. Thus, the structures of the revenue and cost functions are not different between the three provinces, but the levels of revenue and cost, given the values of the explanatory variables, differ between the three provinces. This was revealed by large and statistically significant coefficients on provincial dummy variables. By examining different subsamples, Chow estimated that costs in Ontario are between 66% and 100% higher than in Alverta, given the level of output, factor prices and output characteristics. Costs in Quebec were found to be between 37% and 47% higher than in Alberta. The higher costs in Ontario and Quebec are reflected in higher rates. Again, holding constant all the explanatory variables, revenue in Ontario was found to be between 64% and 96% higher than in Alberta, while revenue earned by Quebec firms was found to be between 35% and 41% higher than firms in Alberta.

The conclusion that Ontario firms have high costs relative to firms in Alberta is especially true of LTL carriers. Chow summarized his findings by saying:

> "It appears then that Ontario and Quebec carriers are less efficient and charge higher rates overall (compared to Alberta carriers)...and it appears that LTL carriers (as opposed to TL carriers) in Ontario are at the greatest disadvantage relative to unregulated trucking".[2]

The estimated differences in costs and revenues between the provinces may not be due exclusively to regulation. The coefficients on the provincial dummy variables pick up the effects of all factors which are not included in the model. Chow suggests that there are two major factors. The first is the pattern of traffic flows. Costs and revenues will differ between provinces to the extent that the geographical pattern of demand influences the efficiency of trucking operations. Such an effect should be captured by a measure of capacity utilization.[3] By including such a variable in the cost and revenue equations, Chow argues that the remaining provincial differences can be attributed to the effects of entry restrictions. However, Chow warns that if the levels of capacity utilization are affected by regulation itself, e.g., licence restrictions reduce back-haul possibilities, the inclusion of the capacity utilization variable will bias downwards the measured effect of entry regulation on costs.

The complexity of the role of equipment utilization rates is illustrated by a number of facts. First, in Chow's sample, the average utilization rate is higher in regulated Ontario than in unregulated Alberta, while utilization rates in Quebec are on average considerably lower than in the other two provinces. Clearly, the presence of entry and licence restrictions are not the only factors that influence equipment utilization rates. Second, utilization rates are positively correlated with output (number of shipments) in Ontario and Quebec, but negatively correlated with output in Alberta. Finally, while the coefficients of the utilization variable are all negative in the three provincial cost equations they differ considerably in size. Despite these difficulties, Chow estimates pooled Alberta/Ontario and Alberta/Quebec cost equations that include the utilization variable. Again provincial dummy variables were used to estimate differences in levels of costs between provinces. Costs in Ontario were found to be 42% higher than in Alberta, while costs in Quebec were found to be 33% higher than in Alberta. These results are qualitatively the same as those obtained when capacity utilization was ignored.

In summary, Chow concludes:

> "This study has confirmed previous observations of the superior rate performance of carriers operating in the unregulated environment of Alberta vis a vis carriers operating in the entry restricted environments of Ontario and Quebec. Further, the study finds that relative cost performance follows an identical pattern. There is no information available in this study to conclude whether the performance differences can be

attributed to regulatory policies that can be controlled or to demand factors that are out of direct reach of public policy. One can unequivocally state that economic regulations differ between provinces while the extent of demand and traffic differences is largely unexplained. The inefficiencies of economic regulation are clearly large if policymakers perceive exogenous demand patterns to be equally burdensome between provinces or are more burdensome in Alberta. The fact that measured utilization of capacity is higher in Ontario than Alberta and that differences in performance are still observed in models accounting for the impact of utilization support this view".[4]

5.1.2 CAIRNS' AND KIRK'S COST STUDY

The purpose of this study is twofold: to determine the effect of economic regulation on the costs of for-hire trucking firms, and to determine the extent of scale economies in the for-hire trucking industry. The conclusions of the research are that:

"The observed differences in the unit costs between the regulated and unregulated provinces cannot be attributed to regulation. The trucking activity examined in Alberta involved a much higher proportion of truckload shipments than was the case in Quebec and Ontario, where less-than-truckload shipments predominated. Capacity utilization is measurably higher

> where truckload traffic predominates and this accounted for much of the observed differences in unit costs.
>
> While significant economies of scale were observed in both regulated and unregulated provinces, most of these economies of scale were attributable to the ability of larger carriers to achieve higher rates of capacity utilization".[5]

These conclusions were reached through a cost analysis that involved the estimation of a trans-log cost function in conjunction with factor share equations. The selection of firms to be included in their sample was based on a number of criteria. Firms were rejected if:

1. the traffic information from the TOD survey was judged to be unreliable;
2. the information reported in the Motor Carrier Freight Survey (MCF) was judged to be unreliable;
3. the firm had significant local or intra-urban business;
4. the firm had significant international business;
5. the firm was an "outlier" according to a principal components analysis of firm characteristics.

Cairns and Kirk found that these criteria eliminated a sufficiently large number of firms that cost functions could be estimated only for the Provinces of Alberta (35 firms), Quebec (32 firms), and Ontario (36 firms). Despite rigorous attempts to ensure sample homogeneity, further analysis of the Cairns and Kirk sample reveals some potential problems. With respect to commodity homogeneity, only 40% of their sample is composed of carriers who reported more than one-half of their operating revenue was derived from hauling general freight, and 25% of the sampled carriers report that the majority of their operating revenue is derived from a mix of specific commodities, or no dominant product group. Also, not all sample carriers are purely intra-provincial. This point is not too important for sample carriers based in Quebec and Ontario because a large majority report little extra-provincial revenue on the MCF tape, but in Alberta, it can be seen that 24 out of the 35 sample carriers are engaged in extra-provincial movements to some degree. In fact, 8 of these 24 carriers earn 30% or more of their estimating operating revenue from extra-provincial sources. Finally, a higher percentage of Alberta-based carriers report some operating revenue from international movements than do carriers based in the other two sample provinces.

The first set of estimates were based on the estimation of a single-output cost function. Ton-miles was used as the measure of output. The heterogeneity of output between firms was recognized by the inclusion of three dummy variables which indicated whether or not the firm carried LTL shipments, TL short-haul shipments, or TL long-haul shipments. The resulting estimates indicated the presence of scale economies in all three provinces, although in Alberta the scale economies were exhausted at the level of output produced by the largest firms. Regarding the level of costs, the results showed that Quebec firms had the highest level of costs at all levels of output. Costs in Ontario were found to be higher than costs in Alberta for all output levels except those produced by the very largest firms.

These results were dramatically affected by the inclusion of a utilization variable defined by Cairns and Kirk as ton-miles per power unit. Once utilization rates were accounted for, Quebec carriers were found to have the lowest unit costs of all three provinces, while the unit costs of Alberta carriers were highest for a very large range of output. This turnabout is explained by the following table which shows the shares of different types of output produced by carriers in each of the three provinces.

TABLE 5.1.1

SHARES OF OUTPUT BY PROVINCE

(%)

	Quebec	Ontario	Alberta
LTL	80.2%	66.3%	12.5%
TL-Short-Haul	14.8	26.6	52.8
TL-Long Haul	5.0	7.1	34.7

The fact that the Quebec firms are predominantly carriers of LTL freight, while firms in Alberta produce an output bundle which is relatively intensive in TL long-haul shipments leads one to expect that costs per ton-mile will be lowest in Alberta and highest in Quebec. No meaningful cost comparisons can be made until the heterogeneity of output is accounted for in the cost estimates.

In order to account for different types of output, Cairns and Kirk estimated a joint-product cost function. Unfortunately, this resulted in a further diminution of the sample as firms are required to produce all three types of output. Consequently the Alberta sample was reduced to 21 firms. The Ontario and Quebec samples were reduced to 16 and 14 firms respectively, and so these two provinces had to be combined. For the purposes of the joint-output cost functions, output was measured in shipment-miles, and no other output-qualifying variables were included.

Regarding scale economies, again it was found that firms in Alberta showed positive scale economies up to the largest level of output where scale economies were exhausted. The Quebec/Ontario sample of firms exhibited significant scale economies at all levels of output.

Average cost is not well-defined in a multiple-output context, and cost comparisons between Alberta and Quebec/Ontario were based on estimates of marginal costs of the three types of output. The results of this exercise were that the marginal costs of LTL shipments were found to be much higher in Alberta than in Quebec and Ontario at all levels of output. Indeed, the marginal costs in Alberta seem (from visual inspection of their Figure 8.10) to be many times the levels of marginal costs in Quebec and Alberta. On the other hand, marginal costs of long-haul truckload traffic were found to be lowest in Alberta. These findings suggest that Alberta carriers have a comparative advantage in producing truckload shipments, while eastern firms have a comparative advantage in producing LTL shipments. This is quite opposite to Chow's findings and other evidence which suggests that LTL rates in Ontario are high relative to other provinces.

While this study does provide estimates of the size of scale economies in the Canadian for-hire trucking industry, it does not provide estimates of the relative efficiency of comparable firms that operate in different provinces. The only attempt to provide inter-provincial comparisons of the efficiency of trucking firms is based on the estimates of the single-output cost functions. Unfortunately, the samples of firms differ so greatly across the provinces with respect to the typical mix of output that these comparisons are unreliable. The multiple-output cost functions were not used to make interprovincial efficiency comparisons.

5.2 THE THEORY OF COST

The major difficulty in modelling the cost structure of trucking firms is that of adequately defining the output that trucking firms produce. The heterogeneity of output has many dimensions. In particular, the products that are hauled cover the spectrum from live animals to finished products to crude materials. Moreover, shipments of a given commodity vary according to both weight and length of haul. Shipment weight in particular is an important distinguishing feature since small shipment operations are more likely to use terminal facilities. It could be argued that the technologies for producing these different output are themselves different, but because firms tend to produce more than one output it is not possible to segment the sample into reasonably-sized subsamples of specialized firms that produce a single well-defined output. A more reasonable approach is to treat firms as multi-produce enterprises. The duality relationships between transformation functions and multi-product cost functions has been developed in, for example, McFadden (1978).

The total cost of production for a firm can be expressed as C(Y,W;T), where Y is an I-dimensional vector of outputs Y_i, W is a J-dimensional vector of factor prices w_j, and T is a K-dimensional vector of "technological factors" t_k. The cost function

5.2.1 $$C\ (Y,\ W;\ T)$$

is such that it minimizes total cost

5.2.2 $$\sum_{j=1}^{n-J} w_j x_j ,$$

subject to

5.2.3 $$F\ (Y,\ X;\ T) = 0,$$

where F $(\cdot)$ = 0 in equation 5.2.3, expressed the transformation function between the inputs x_j, j = 1 ... J and outputs Y_i, i = 1 ... I.

In the present context, a technological factor might represent the route structure of the carrier. Two carriers of which produce the same level of outputs are likely to have different unit costs if one operates on light density routes while the other operates on heavy density routes. Higher costs in the former case could result from lighter average loads and fewer possibilities of back-hauls. In order to capture the effect of "traffic balance" at the firm level, we have computed a firm-specific traffic balance index. More details are given below, and in Appendix A4.

5.2.1 THE TRANSLOG COST FUNCTION

In order to investigate the structure of costs empirically, one needs to specify an explicit functional form. Caves, Christensen and Tretheway (1979) have pointed out that it is desirable to select a functional form that is (a) flexible in that it imposes few restrictions on the derivatives of the cost function with respect to its arguments; (b) parsimonious in parameters and (c) consistent with duality theory. Based on these criteria, Caves, Christensen and Tretheway argue that in the case of multi-product cost functions, the trans-log functional form is superior to both the generalized Leonitief form of Diewert (1971) and Hall (1973), and the quadratic form suggested by Lau (1974). However, because the trans-log form involves the logarithms of the explanatory variables it does have the drawback that it is not defined for forms that produce none of one or more of the possible outputs. Consequently, the sample has to be restricted to those firms that produce non-zero quantities of all the outputs.[6]

The translog representation of the cost equation is

$$5.2.4 \quad \ln C = a_o + \sum_{i=1}^{I} a_i \ln Y_i + \sum_{j=1}^{J} b_j \ln w_j + \sum_{k=1}^{K} c_k \ln t_k$$

$$+ \frac{1}{2} \sum_{i=1}^{I} \sum_{\ell=1}^{I} a_{i\ell} \ln Y_i \ln Y_\ell + \sum_{i=1}^{I} \sum_{j=1}^{J} d_{ij} \ln Y_i \ln w_j$$

$$+ \sum_{i=1}^{I} \sum_{k=1}^{K} e_{ik} \ln Y_i \ln t_k + \frac{1}{2} \sum_{j=1}^{J} \sum_{m=1}^{J} b_{jm} \ln w_j \ln w_m$$

$$+ \sum_{j=1}^{J} \sum_{k=1}^{K} f_{jk} \ln w_j \ln t_k + \frac{1}{2} \sum_{k=1}^{K} \sum_{n=1}^{K} c_{kn} \ln t_k \ln t_n + u$$

where u is a random disturbance term.

One interpretation of the translog cost function is that it represents a second-order Taylor series approximation to the actual cost function at the sample mean. Consider, for example, the function f(x). The second-order Taylor series approximation to this function about the point $\bar{x}$ is

$$f(x) \simeq f(\bar{x}) + f'(\bar{x})\, dx + \frac{1}{2} f''(\bar{x})\, dx^2, \text{ where } x = \bar{x} + dx$$

Now, $dx \simeq \ln(1 + dx)$ for small dx. So if $\bar{x}$ is defined to be unity, we have $dx \simeq \ln(1 + dx) = \ln(\bar{x} + dx)$. But, $x = \bar{x} + dx$ and so $dx \simeq \ln(x)$. Substituting into the Taylor series we have

$$f(x) \simeq a_0 + a_1 \ln(x) + \frac{1}{2} a_2 \ln^2(x),$$

where $a_1 = f'(\bar{x})$ and $a_2 = f''(\bar{x})$ are the first and second derivatives of f (x) evaluated at $\bar{x}$. Note also that since $\ln(\bar{x}) = \ln(1) = 0$, it follows that $f(\bar{x}) = a_0$, i.e., the value of f(x) at point of expansion, $\bar{x}$, is a_0. The implication of this for the cost function given by equation 5.2.4 is that if the data are all scaled so that the sample means are unity then the coefficients have a straightforward interpretation. The coefficients a_1, i = 1 ... I for example, are the first derivatives of cost with respect to the outputs Y_i, i = 1 ... I, all evaluated at the sample means, i.e., derivatives of cost for the representative firm with output levels and factor prices equal to the mean values for all firms in the sample.

5.2.2 THE SHARE EQUATIONS AND PARAMETER RESTRICTIONS

Shephard's Lemma holds for cost minimizing firms, i.e.,

$$\frac{\partial C}{\partial w_j}(Y, W; T) = x_j, \quad j = 1, \ldots, J$$

where x_j is the quantity used of the j^{th} input. From this it follows that

$$\frac{\partial \ln C}{\partial \ln w_j} = \frac{w_j \partial C}{C \partial w_j} = w_j x_j / C, \quad j = 1, \ldots, J.$$

This says that the derivative of the logarithm of cost with respect to the logarithm of the j^{th} factor price is equal to the expense-share of the j^{th} input, say S_j. Taking the derivative equation

5.2.4 with respect to we_i we have

5.2.5 $$S_j = b_j + \sum_{i=1}^{I} d_{ij}\,\ell nY_i + \sum_{m=1}^{J} b_{jn}\,\ell nw_m + \sum_{k=1}^{K} f_{kj}\,\ell nt_k + u_j, \quad j = 1 \ldots J$$

Because the J shares sum to unity without error, it follows that the J disturbance terms u_j sum to zero. The variance-covariance matrix is therefore singular. By specifying that the disturbances are multinormally distributed, the cost and share equations can be estimated jointly using the FIML method described in Berndt, Hall, Hall and Hausman (1974). This can be done by dropping one of the share equations; the estimates are invariant to which share equation is dropped.

The theory of cost minimization implies parameter restrictions. In particular, the following symmetry conditions are implied $a_{i\ell} = a_{\ell i}$, $b_{jm} = b_{mj}$ and $c_{kn} = c_{nk}$ for all i, j, k, 1, m, and n. In addition, the cost function is homogenous degree one in factor prices. This implies the following restrictions:

$$\sum_{i=1}^{n} b_i = 1.$$

$$\sum_{j=1}^{J} b_{jm} = 0, \qquad m = 1, \ldots, J$$

$$\sum_{j=1}^{J} d_{ij} = 0, \qquad i = 1, \ldots, I$$

$$\sum_{j=1}^{J} f_{jk} = 0, \qquad k = 1, \ldots, K$$

where I, J, and K are the number of outputs, inputs and technological factors respectively.

5.2.3 ECONOMIES OF SCALE AND MARGINAL COST

Of significant interest in this study, are the questions of scale economies and the level of rates in relation to the marginal costs of providing service. In the case of a cost-minimizing firm that produces a single output, the elasticity of total cost with respect to output serves as a measure of scale economies at the point where the elasticity is measured. An elasticity which is unity at an output level Y_0 indicates that costs rise proportionately with output in the neighbourhood of the point Y_0, i.e., unit costs are invariant to the level of output around the point Y_0. An elasticity which is less than unity indicates that costs rise less than proportionately with output around the point where the elasticity is measured, i.e., the production process exhibits economies of scale at this point. There is no presumption, of course, that this measure of economies of scale will be the same at all points on the cost curve.

The measurement of scale economies by means of the output elasticity of total cost generalizes to the multi-product case. Suppose, for example, that the sum of the output elasticities of total cost (summed over all outputs) is unity. This means that a one percent increase in all outputs results in a one percent increase in total cost. In this sense, the production process exhibits constant costs at this point. If, on the other hand, the sum of the elasticities is less than unity then the production process can be said to exhibit scale economies at that point. An implication of scale economies is that the firm cannot cover total costs by pricing its output at marginal cost. Consider the sum of elasticities of cost with respect to the outputs:

$$\sum_{i=1}^{I} \frac{\partial \ell nC}{\partial \ell nY_1} = \sum_{i=1}^{I} [\frac{Y_i}{C}] \frac{\partial C}{\partial Y_i}$$

the right-hand term is simply the weighted sum of marginal cost, where the weights are the ratios of output to total cost. If the firm sets the output price p_i equal to the marginal cost of production, then the sum of the elasticities equals

$$\sum_{i=1}^{I} (Y_i \; p_i) \; / \; C$$

which is simply the ratio of total revenue to total cost. Clearly then, economies of scale together with marginal cost pricing leads to losses.

The marginal cost of producing the i^{th} output is $\partial C \; / \; \partial Y_i$. From equation 5.2.4 we see that

$$\frac{\partial \ell nC}{\partial \ell nY_i} = a_i + \sum_{\ell=1}^{I} a_{i\ell} \; \ell nY_\ell + \sum_{j=1}^{J} d_{ij} \; \ell nw_j$$

$$+ \sum_{i=1}^{K} e_{ik} \; \ell nt_k$$

$$= RHS.$$

From this it follows that the marginal cost of producing output Y_i is

$$\frac{\partial C}{\partial Y_i} = \frac{C}{Y_i} \cdot \quad [RHS]$$

Note, however, that when the data are scaled so that all sample means are unity, the marginal cost of the sample mean is simply

$$\frac{\partial C}{\partial Y_i} = a_i .$$

This follows from the fact that the logarithm of unity is zero so that all terms except a_i drop out of RHS at the sample mean. However, the number a_i is the marginal cost of output Y_i where costs and output are measured as proportions of mean cost and mean output. In order to get marginal costs at the sample mean in terms of dollars per unit of output Y_i we take $\bar{C}a_i \,/\, \bar{Y}_i$, where $\bar{C}$ and $\bar{Y}_i$ are the raw data sample means of total cost and the i^{th} output, respectively.

5.2.4 THE NATURE OF OUTPUT AND TECHNOLOGICAL VARIABLES

We mentioned earlier that the output of trucking firms is very heterogeneous, and for this reason, the use of a single output function is likely to prove inadequate. Because of the importance of terminal expenses in the operation of LTL businesses, the approach taken here is to treat LTL shipments and TL shipments as separate outputs, i.e., we specify a two-output cost function. The traditional measure of output is in terms of ton-miles. For example, in the Caves <u>et al.</u> (1979) study of railroad costs, output is measured by ton-miles for freight traffic and passenger-miles for passenger traffic. The approach followed here is similar to that of Friedlaender and Spady (1979) who propose a hedonic measure of output:

$$Y_i = y_i \, F_i \, (q)$$

where y_i is output in ton-miles and q is a vector of output qualities. Ideally, these quality variables would describe the nature of the products that the firm hauls. It would be desirable, for example, to know exactly what the products are, and the technologies used in their transportation. Unfortunately, this kind of detailed information is not readily available. The alternative route to take is to attempt to ensure the firms in the sample are reasonably homogenous. The efforts we have made in this direction are described in the next section. In the present circumstances the firm-specific quality variables that we use are (a) the average weight of shipments for the i^{th} output, and (b) the average length of haul for the i^{th} output. Both of these pieces of information were obtained from each firm's sample of Origin-Destination records, i.e., the TOD tape.

In order to keep the number of parameters appearing in the cost function to a reasonable size, the functions F_i have been taken to be Cobb-Douglas. Hence, for the two outputs (LTL and TL),

5.2.5 $$\ell n Y_i = \ell n y_i + g_{1i} \, \ell n q_1 + g_{2i} \, \ell n q_2, \; i = 1, 2,$$

where q_1 and q_2 are the two quality variables.

We turn now to the technological variables which are the variables other than output and factor prices that affect the level of cost. The first pair of these are concerned with the types of commodities that firms haul. The origin/destination shipment records provide a potentially useful description of the kinds of commodities that a particular firm hauls. Unfortunately, it is not an easy task to properly aggregate the hundreds of fine commodity groupings (3 digit S.C.C.) into a small number of composites which combine homogeneous commodities; homogeneous, that is, with respect to the technology used to transport them. Obviously, the arbitrary collections, End Products, Fabricated Materials and Food Products, are not adequate for this purpose. However, it was felt that the groupings Live Animals and Crude Materials are sufficiently homogenous within themselves, in the sense used above, and different from the other groupings that it is worthwhile calculating the importance of this traffic in each firm's total activity. Accordingly, we computed the share of revenue earned in these two activities for each firm in order to capture as best we could the effect of commodity mix.

The third technological variable is the measure of traffic balance that we introduced earlier. It would seem plausible that a firm which earns half of its revenue by moving freight from A to B, and the other half by moving freight from B to A will have lower costs than a similar firm that earns all its revenue by moving freight from A to B, other things being equal. The first firm can be said to have balanced traffic, which implies few, if any, empty backhauls. On the other hand, the second firm's traffic is not at all balanced, and every trip will require an empty backhaul. In Appendix A4, the nature of our firm-specific measure of traffic balance is described.

How do we interpret the effect of the traffic balance variable on cost? First of all, it is not necessarily the case that large firms have balanced traffic, while small firms have unbalanced traffic. It is more likely that balance is influenced by (a) the type of commodity hauled and the equipment the carrier has, (b) the pattern of demand in the carrier's region, and (c) the effect of regulation to the extent that entry restrictions prevent firms from competing for traffic on routes that would otherwise improve their traffic balance. Thus, while the use of a variable that measures the degree of a firm's traffic balance will help to standardize for the effects of different demand patterns and commodity mix, it could also mask the effect of different provincial regulatory structures on trucking cost to the extent that one effect of entry regulation is to reduce traffic balance.

Finally, our fourth technological variable is one that has been made much of by Cairns and Kirk (1980). This is the degree of capital utilization. We have discussed the use of this variable earlier. It has been included in the present analysis to allow comparisons to be made with the Cairns and Kirk study.

5.2.5 THE SPECIFIC ESTIMATING EQUATION

Because the number of firms in our sample is relatively small, it is important to preserve as many degrees of freedom as possible. This has influenced the manner in which we have introduced the technological variables into the cost function. Rather than following the most general translog model described in equation 5.2.4, we have adopted the following specification:

$$5.2.6 \qquad C\ (Y,\ W;\ T) = C\ (Y,\ W)\ e^{c'T},$$

where c' is a 1 x 4 row vector of parameters that are attached to the four technological variables contained in the 4 x 1 vector T. The technological variables therefore do not interact with any of the other explanatory variables--they simply have a direct influence on cost.

Let us now examine the total number of parameters that appear in the model which is defined by equations 5.2.4, 5.2.5, and 5.2.6, together with the restrictions described in section 5.2.2. Table 5.2.1 summarizes the information. There are two outputs (LTL and TL shipments), but each is qualified by two quality variables. Consequently, there are six parameters associated with the linear output terms. There are four quadratic terms in output, although one of the symmetry restrictions reduces the effective number of parameters to 3.

As we shall see below, the factors of production are combined into four inputs: labour, capital, fuel and purchased transportation. Hence, there are 4 linear terms in the factor prices and 16

TABLE 5.2.1

Number of Parameters in the Estimating Equation

	Variable	Number of Linear Terms	Number of Quadratic Terms
1.	Constant Terms	1	
2.	Output	2 x 3 = 6	2 x 2 = 4
3.	Factor Prices	4	4 x 4 = 16
4.	Technological Vbles	4	0
5.	Interaction (2 and 3)	0	2 x 4 = 8
	TOTAL	15	28

Total Number of Parameters = 15 + 28 = 43

1.	Homogeneity in Prices	1 + I + J	= 1 + 2 + 4 = 7
2.	Symmetry Conditions	(I - 1)/2 + J(J - 1)/2 =	1 + 6 = 7
	TOTAL		14

Effective Number of Parameters = 43 - 14 = 29

N.B.: I is the number of outputs (2) and J is the number of factors of production (4).

quadratic terms. As we mentioned at the beginning of this section, the technological variables enter additively in the translog specification so that only four linear terms appear; there are no interactive terms which involve these parameters. There are, however, the interactive terms involving outputs and factor prices which number 8 (these are, of course, quadratic terms). The total number of parameters is 43.

The theory of cost minimization imposes restrictions on the cost function parameters. The requirement that total cost be homogeneous degree one is factor prices imposes a total of 7 restrictions. Similarly, the symmetry restrictions also number 7. Hence, the effective number of parameters is 29. These restrictions are imposed by the estimation procedure, but the results report the values of 29 + 7 = 36 parameters and their standard errors, i.e., only the symmetry restrictions apply to the reported results since their implication is obvious.

5.3 DATA PREPARATION

This section is concerned with the selection of firms to be included in the cost analysis and the measurement of variables. The two sources of information are the Motor Carrier Freight (MCF) and the For-Hire Trucking Origin and Destination Survey (TOD) tapes produced by Statistics Canada for the year 1976. The MCF data consists of detailed information on individual trucking firms including income expense and balance sheet information as well as data on firm characteristics such as area of operation and types of commodity hauled. A total of 608 of these firms provided the basis for the TOD survey. Table 5.3.1 shows the distribution of these firms by Firm Class and province of domicile. Class I firms are those that earned at least $2 million in revenue during the year 1975. The 1976 survey is designed on the basis of firm information gathered in 1975. Class II firms earn between $500,000 in revenue and $2 million in revenue. The Class III firms are the smallest of the three classes.

The larger firms that specialize in the transportation of household goods are identified separately, and we have deleted these firms from our sample. Table 5.3.1 shows that there are 20 of these firms. Some of the Class III firms may also specialize in the transportation of household goods, but they are included by Statistics Canada in with all the other Class III firms.

TABLE 5.3.1

Distribution of Firms[1] by Class and Province of Domicile

Province	Class I	Class II	Class III	Total
Nfld.	*	*	7	*
P.E.I.	*	*	6	*
N.S.	*	10	11	*
N.B.	*	9	13	*
Que.	37	50	46	133
Ont.	71	50	42	163
Man.	14	7	9	30
Sask.	*	13	11	*
Alta.	23	48	24	95
B.C.	20	29	23	72
Yukon	*	*	*	*
N.W.T.	*	*	*	*
Total	174	221	193	588
			Household Goods I, II	20
			Grand Total	608

[1]Information in some cells (*) has been suppressed to meet confidentiality requirements.

5.3.1 THE SELECTION OF FIRMS

The number of firms potentially available for the cost analysis in the provinces of Quebec, Ontario and Alberta are 133, 163 and 95 respectively. However, many of these firms have been judged to be inappropriate for the specific study at hand on the basis of one or more criteria. These criteria fall into two categories: those that deal with the nature of the firm, and those that deal with the reliability of the data. Let us consider the second type first. The TOD survey data is used to estimate the firm's output characteristics, e.g., the firm's total production of ton-miles (both LTL and TL), average length of haul and average shipment weight.[7] The purpose of the TOD Survey is to generate estimates of revenues, tons, ton-miles, etc. at a fairly high level of aggregation. However, at the firm level, such estimates may not be reliable.

Table 5.3.2 illustrates this point. Here we show the total of firms' transportation revenues as reported in their income statements, and as estimated from the TOD data. The firms are again grouped by class and province of domicile. The figures in the bottom right-hand corner show that over all provinces and firm classes the MCF and TOD estimates of total transportation revenues are very close. However, within certain groups there are problems. For example, the TOD data tends to underestimate the transportation revenue earned by the larger firms, but grossly overestimate the revenues earned by the smaller firms. This very strongly suggests that the total ton-miles produced by small

TABLE 5.3.2

Distribution of Transportation Revenue by Firm Class and Province of Domicile
($ millions)

Province	Class I		Class II		Class III		Household Goods I, II		Total	
	TOD	MCF	TOD	MCF	TOD	MCF	TOD	MCF	TOD	MCF
Nfld.	*	*	3	4	2	2	*	*	7	8
P.E.I.	*	*	*	*	*	*	*	*	2	2
N.S.	*	*	10	10	10	3	*	*	35	32
N.B.	40	38	15	14	6	3	0	0	62	55
Que.	242	265	106	69	56	14	0	7	404	355
Ont.	618	809	113	70	73	14	4	5	808	898
Man.	119	138	9	8	9	3	1	1	138	151
Sask.	*	*	14	15	8	4	*	*	24	23
Alta.	136	176	59	52	32	9	2	3	230	240
B.C.	148	188	43	31	32	8	3	2	226	230
Yukon	*	*	*	*	*	*	*	*	*	*
N.W.T.	*	*	*	*	*	*	*	*	*	*
Total	1322	1638	374	275	230	63	12	20	1938	1995

firms is also grossly overestimated by the TOD data. The problem does not lie so much with the raw data on shipment revenue, weight, etc. which is taken from waybills, but with the sampling weight factors which are used to "blow up" the raw data to obtain estimates of total revenues, tons, etc.[8]. The same sampling weight factors are applied to all shipment characteristics (weight, revenue and length of haul). Consequently, the errors in total revenue, total ton-miles, etc. will be in the same direction.

Two steps were taken to minimize the errors in the TOD estimates of each firm's output. First, firms were deleted from the sample if the ratio of TOD to MCF revenues, and vice versa, fell short of 0.2. Even this allows the revenue figures to differ by a factor as large as 5, which is clearly not satisfactory. We, therefore, decided to correct the estimates of firm output obtained from the TOD data. For example, in the case of ton-miles we computed TMA = TM*RMCF/ROD, where TM is total ton-miles produced by the firm as estimated by the TOD data. RMCF/ROD is the ratio of transportation revenue reported by the firm to the estimate of total transportation revenue obtained from the TOD data. We believe TMA is a better estimate of total output than TM. The empirical work confirms this.

We turn now to the question of criteria that apply to the firm's characteristics. We are principally interested in firms that earn most of their revenue from their transportation business. Some firms earn a large proportion of their revenue from non-transportation sources, and presumably, there are costs associated with these activities that are included in total costs. We have deleted all firms that earn less than 80% of their revenue from truck transportation.

Secondly, we are interested in making cost comparisons between provinces for firms that operate under provincial regulations. In other words, firms that are mainly in the business of extra-provincial movements of freight have been deleted. Again we used TOD information to judge whether a firm is an intra- or extra-provincial carrier, and since this data is possibly unreliable at the firm level, we have not applied a stringent condition. Our aim is to be sure to delete firms which are extra-provincial carriers, i.e., those firms that are estimated to earn at least 60% of their revenue from extra-provincial movements.

The two final criteria for firm selection are more technical in nature. In the next section, we report the results of estimating a joint-output cost function. The nature of the specification requires that all firms produce both TL and LTL outputs, and that they report expenses for all four factor inputs (labour, capital, purchased transportation and fuel).

When all these criteria are applied, the number of firms that we are left with for the provinces of Quebec, Ontario and Alberta are: 50, 68, and 42, respectively.

5.3.2 FACTOR PRICES

The factors of production have been aggregated into four composites: labour, capital, purchased transportation and fuel. The firm's total costs have been similarly allocated to these four categories. In order to get an estimate of the price of labour, we simply took the total wage bill and divided it by the number of employees. The price of fuel is not so easily computed because some firms did not report either a fuel expense, or the total number of gallons used. If both fuel expense and the total number of gallons used were not reported, the firm was deleted. It was also deleted if the implied price per gallon was simply unbelievable, e.g., $8.00 per gallon. For these firms, we imputed a fuel price by relating fuel prices to firm size. The details of this method is presented in Appendix A5.

A similar problem occurred in the case of purchased transportation. Many of the 608 firms in the whole sample either reported no purchased transportation services (130 firms), or no quantity measure such as total miles (408 firms). As with fuel prices, we established a relationship between firm size and the price of purchased transportation services for those firms that reported information which could be used to compute a unit price. We then imputed a price for those firms for which we could not compute a price. Unlike the case of fuel prices where few firms required the imputation of a price, most firms required the imputation of a price for purchased transportation. Cairns and Kirk preferred to take this price as constant for all firms. This, of course, produces an exact multicollinearity between this variable (?) and the constant term. Consequently, it must be omitted from the regression. The coefficient on this price which Cairns and Kirk report was presumably generated by the homogeneity restriction rather than being the result of direct estimation.

Finally, we come to the question of computing a price for capital services. We have assumed that all expenses which are not for labour, fuel or purchased transportation are payments for capital services. By dividing this expense by the value of the firm (debt plus equity), we computed the cost of capital services to the firm.

5.3.3 OTHER VARIABLES

The remaining variables to be discussed are: capacity utilization and the traffic balance variable. The latter is fully explained in Appendix A4 to which the reader has already been referred. Capacity utilization is measured by dividing total ton-miles by the number of power units owned or leased by the firm. We also computed an adjusted capacity utilization variable which is the ratio of adjusted ton-miles (TMA) to the number of power units.

5.4 EMPIRICAL RESULTS

In this section, the empirical results are presented and interpreted. Table 5.4.1 shows the estimated coefficients and their standard errors for the model described in Section 5.2. Recall that 43 coefficients appear in the full model, but 7 of these are redundant due to the symmetry conditions. Consequently, only 36 coefficient estimates appear in each of the columns of the table. A further 7 coefficients are redundant due to the imposition of the homogeneity condition. The 7 coefficients that

TABLE 5.4.1

COST FUNCTION COEFFICIENT ESTIMATES USING UNADJUSTED OUTPUT MEASURES

Variable Label	Coeff.	Quebec Coeff.	Quebec Std.Error	Ontario Coeff.	Ontario Std.Error	Alberta Coeff.	Alberta Std.Error
Constant	a_o	7.195	0.685	8.465	0.156	8.396	0.248
LTL	a_1	0.286	0.125	0.477	0.069	0.221	0.080
TL	a_2	0.477	0.123	0.339	0.089	0.339	0.104
LTL*LTL	a_{11}	0.036	0.025	0.120	0.024	0.024	0.028
TL*TL	a_{22}	0.179	0.070	0.079	0.041	0.042	0.025
LTL*TL	a_{12}	-0.026	0.026	-0.055	0.031	-0.024	0.023
PL	b_1	0.401	0.016	0.416	0.016	0.331	0.028
PF	b_2	0.092	0.007	0.084	0.006	0.075	0.009
PPT	b_3	0.063	0.018	0.156	0.028	0.255	0.045
PK	b_4^*	0.444	0.016	0.344	0.014	0.339	0.023
PL*PL	b_{11}	0.056	0.043	0.160	0.045	0.165	0.066
PL*PF	b_{12}	0.004	0.019	0.011	0.015	-0.038	0.020
PL*PPT	b_{13}	-0.041	0.042	-0.213	0.062	-0.181	0.088
PL*PK	b_{14}^*	-0.019	0.028	0.042	0.023	0.054	0.035
PF*PF	b_{22}	-0.008	0.033	-0.001	0.018	-0.126	0.032
PF*PPT	b_{23}	0.030	0.034	-0.013	0.025	0.161	0.043
PF*PK	b_{24}^*	-0.025	0.015	0.003	0.009	0.003	0.013
PPT*PPT	b_{33}	-0.074	0.066	0.275	0.101	0.032	0.148
PPT*PK	b_{34}^*	0.085	0.034	-0.049	0.041	-0.012	0.061
PK*PK	b_{44}^*	-0.041	0.088	0.004	0.100	-0.045	0.146

TABLE 5.4.1 (Cont'd.)

Variable Label	Coeff.	Quebec Coeff.	Quebec Std.Error	Ontario Coeff.	Ontario Std.Error	Alberta Coeff.	Alberta Std.Error
TB	C_1	0.140	0.064	0.033	0.069	0.150	0.049
LA	C_2	0.325	0.309	0.069	0.065	0.028	0.063
CM	C_3	-0.053	0.045	0.011	0.029	0.002	0.045
CU	C_4	0.052	0.044	0.034	0.034	0.290	0.088
LTL*PL	d_{11}	0.003	0.004	0.013	0.005	0.019	0.009
LTL*PF	d_{12}	-0.002	0.002	-0.009	0.002	-0.010	0.003
LTL*PPT	d_{13}	-0.006	0.004	-0.001	0.009	-0.004	0.014
LTL*PK	d_{14}^*	0.005	0.004	-0.003	0.004	-0.004	0.007
TL*PL	d_{21}	0.001	0.008	-0.012	0.008	-0.018	0.010
TL*PF	d_{22}	0.002	0.004	0.004	0.003	0.005	0.003
TL*PPT	d_{23}	-0.012	0.009	0.011	0.014	0.024	0.016
TL*PK	d_{24}^*	0.010	0.009	-0.003	0.009	-0.016	0.011
WLTL	g_{11}	-0.027	0.747	-0.718	0.175	-0.196	0.414
HLTL	g_{12}	3.174	1.68	-0.410	0.231	-0.296	0.731
WTL	g_{21}	1.161	0.594	0.753	0.711	1.509	0.754
HTL	g_{22}	-1.584	0.634	0.310	0.326	1.524	0.577
Log-likelihood		157.7		211.4		127.1	

*Coefficients marked with an asterisk have been computed via the constraints described in section 5.2.2.

were derived from these latter restrictions rather than estimated directly are indicated by an asterisk. See, for example, b_4 and b_{14}, the coefficients on the price of capital and the interaction term between LTL output and the price of capital. Of course, the results are not sensitive to which coefficients are estimated directly and which are computed via the restrictions. Table 5.4.4 provides a description of the variable labels that appear with the estimates of the cost functions contained in Tables 5.4.1 to 5.4.3.

Because the data have been scaled so that all the variables have a mean of unity, the coefficients in Table 5.4.1 can be easily interpreted. For example, the sum of the elasticities of cost with respect to LTL and TL output at the sample mean is simply LTL + TL, which for Quebec is approximately 0.286 + 0.447 = 0.733. This implies that a one percent increase in the output of both LTL and TL shipments gives rise to an increase in costs of about 0.73 percentage points. These figures apply to the representative firm, i.e., the firm which has characteristics identical to the sample mean of all the variables. Thus, at the sample mean, significant economies of scale are indicated. The comparable cost elasticities for Ontario and Alberta are about 0.82 and 0.56 respectively. These estimates are in broad agreement with the findings of Cairns and Kirk (1980), but we would prefer not to emphasize these results which are based on the unadjusted output variables. Table 5.4.2 shows the results of a similar equation. The difference lies in the fact that the output variables have been adjusted along the lines described in the previous section. The dependent variable is identical (given the province) so that the log-likelihoods do provide an indication of the improvement offered by the adjustment. For all three provinces, the log-likelihood increases rather substantially. As one would expect, the coefficients on the output variables are affected most and invariably the standard errors are lower. For example, the implied "t-statistic" on the LTL variable in the Quebec equation rises from just over 2 to over 5. Also, in all cases the effect of adjusting output is to reduce the estimated scale economies. The cost elasticities at the sample means for Quebec, Ontario and Alberta are approximately 0.89, 0.92 and 0.80 respectively.

It should also be noted that the equations reported in Table 5.4.2 contain both the capacity utilization variable (CU) and the traffic balance variable (TB). The estimated coefficient on the capacity utilization variable is not statistically significantly different from zero in any of the provincial cost functions. This is in stark contrast to the results obtained by Cairns and Kirk (1980) for their single-output model. They recognized that the role of this variable in their equation was simply to pick up the effect of commodity mix, i.e., long haul truckload carriers have higher utilization rates than LTL carriers. Our model with its hedonic output measure does not allow this confusion to emerge. Secondly, it is clear that adjusting the output variable also reduces the effect of the capacity utilization variable. As we have pointed out, the unadjusted output measures are possibly a poor measure of actual output for some firms. To the extent that the number of power units serves as a proxy for output, the CU variable goes some way towards explaining cost in the unadjusted-output equations. Note that CU is significant in the unadjusted Alberta equation (Table 5.4.1), but not significant in the adjusted-output equation. Indeed, all the capacity utilization coefficients move towards zero when output is adjusted.

We turn now to the traffic balance variable. In all three of the cost equations reported in Table 5.4.2, the coefficient on this variable is positive, and in all cases the standard error is less than one-half the size of the coefficient. We argued in Section 5.2 that the expected sign of this coefficient is negative, i.e., the more a firm's traffic is balanced (the larger is TB), the lower will be total costs, other things being equal. We find, in fact, that the opposite is true. Possibly the traffic balance variable serves to standardize for commodity mix. Consider, for example, the case of a firm that tends to carry heavy TL shipments, but has few opportunities for backhauls--a firm that transports bulky items would be a good example. Despite having empty backhauls, the firm may have low costs per ton-mile. On the other hand, a firm that ships more expensive-to-handle items might have higher costs per ton-mile despite having fewer empty backhauls. In other words, it may be that the carriers of crude materials have both low costs and few backhauls. The results reported in Table 5.4.3 support this view. Here we have deleted both the capacity utilization variable and the traffic balance variable. In all

TABLE 5.4.2

COST FUNCTION COEFFICIENT ESTIMATES USING ADJUSTED OUTPUT MEASURES

Variable Label	Coeff.	Quebec Coeff.	Quebec Std.Error	Ontario Coeff.	Ontario Std.Error	Alberta Coeff.	Alberta Std.Error
Constant	a_0	8.100	0.350	8.448	0.085	8.405	0.148
LTL	a_1	0.348	0.065	0.408	0.038	0.174	0.052
TL	a_2	0.544	0.067	0.514	0.047	0.626	0.078
LTL*LTL	a_{11}	0.040	0.015	0.094	0.011	0.025	0.016
TL*TL	a_{22}	0.121	0.035	0.133	0.023	0.081	0.025
LTL*TL	a_{12}	-0.024	0.016	-0.060	0.014	-0.049	0.081
PL	b_1	0.395	0.016	0.412	0.017	0.329	0.029
PF	b_2	0.090	0.008	0.080	0.006	0.067	0.009
PPT	b_3	0.069	0.017	0.172	0.028	0.268	0.046
PK	b_4^*	0.446	0.016	0.335	0.014	0.336	0.024
PL*PL	b_{11}	0.074	0.044	0.135	0.047	0.163	0.067
PL*PF	b_{12}	-0.014	0.019	0.001	0.015	-0.027	0.019
PL*PPT	b_{13}	-0.033	0.043	-0.147	0.065	-0.193	0.088
PL*PK	b_{14}^*	-0.026	0.028	0.011	0.024	0.057	0.034
PF*PF	b_{22}	0.021	0.031	0.003	0.017	-0.085	0.030
PF*PPT	b_{23}	0.031	0.032	0.003	0.025	0.125	0.041
PF*PK	b_{24}^*	-0.038	0.014	-0.007	0.009	-0.012	0.013
PPT*PPT	b_{33}	-0.109	0.065	0.139	0.104	0.082	0.145
PPT*PK	b_{34}^*	0.111	0.034	0.004	0.041	-0.015	0.058
PK*PK	b_{44}^*	-0.047	0.087	-0.008	0.103	-0.031	0.144
TB	C_1	0.067	0.032	0.120	0.036	0.056	0.027

TABLE 5.4.2 (Cont'd.)

Variable Label	Coeff.	Quebec Coeff.	Quebec Std.Error	Ontario Coeff.	Ontario Std.Error	Alberta Coeff.	Alberta Std.Error
LA	C_2	0.064	0.154	-0.003	0.033	0.036	0.035
CM	C_3	-0.014	0.022	-0.038	0.015	-0.010	0.025
CU	C_4	0.016	0.023	-0.018	0.017	0.026	0.055
LTL*PL	d_{11}	0.003	0.004	0.015	0.005	0.019	0.009
LTL*PF	d_{12}	-0.002	0.002	-0.008	0.002	-0.011	0.003
LTL*PPT	d_{13}	-0.007	0.005	-0.004	0.002	-0.004	0.014
LTL*PK	d_{14}^*	0.006	0.005	-0.002	0.004	-0.003	0.007
TL*PL	d_{21}	-0.005	0.009	-0.018	0.009	-0.026	0.013
TL*PF	d_{22}	0.000	0.004	0.005	0.003	0.003	0.004
TL*PPT	d_{23}	-0.011	0.010	0.020	0.015	0.044	0.019
TL*PK	d_{24}^*	0.015	0.011	-0.008	-0.011	-0.021	0.015
WLTL	g_{11}	-0.197	0.297	-0.692	0.126	-0.304	0.361
HLTL	g_{12}	2.066	0.659	-0.561	0.161	-0.412	0.589
WTL	g_{21}	0.471	0.273	-0.145	0.225	0.046	0.258
HTL	g_{22}	-1.127	0.260	-0.279	0.121	0.271	0.206
Log-likelihood		190.1		258.8		150.7	

*Coefficients marked with an asterisk have been computed via the constraints described in section 5.2.2.

TABLE 5.4.3

COST FUNCTION COEFFICIENT ESTIMATES USING ADJUSTED OUTPUT MEASURES - CU AND TB EXCLUDED

Variable Label	Coeff.	Quebec Coeff.	Quebec Std.Error	Ontario Coeff.	Ontario Std.Error	Alberta Coeff.	Alberta Std.Error
Constant	a_o	8.035	0.366	8.459	0.089	8.424	0.150
LTL	a_1	0.333	0.065	0.375	0.039	0.169	0.051
TL	a_2	0.579	0.068	0.496	0.048	0.653	0.066
LTL*LTL	a_{11}	0.035	0.016	0.083	0.011	0.023	0.016
TL*TL	a_{22}	0.067	0.044	0.142	0.047	0.165	0.067
LTL*TL	a_{12}	-0.015	0.015	-0.069	0.015	-0.049	0.017
PL	b_1	0.395	0.015	0.412	0.017	0.329	0.029
PF	b_2	0.090	0.007	0.080	0.006	0.068	0.009
PPT	b_3	0.070	0.017	0.172	0.028	0.266	0.046
PK	b_4	0.445	0.016	0.335	0.014	0.337	0.024
PL*PL	b_{11}	0.067	0.044	0.142	0.047	0.165	0.067
PL*PF	b_{12}	-0.011	0.020	0.004	0.015	-0.028	0.018
PL*PPT	b_{13}	-0.025	0.042	-0.160	0.065	-0.195	0.088
PL*PK	b^*_{14}	-0.021	0.028	0.159	0.024	0.154	0.035
PF*PF	b_{22}	0.019	0.031	0.002	0.018	-0.084	0.030
PF*PPT	b_{23}	0.027	0.033	0.000	0.025	0.125	0.041
PF*PK	b^*_{24}	0.101	0.014	-0.170	0.009	-0.002	0.012
PPT*PPT	b_{33}	-0.120	0.063	0.168	0.104	0.086	0.145
PPT*PK	b^*_{34}	-0.027	0.033	-0.000	0.042	-0.125	0.059
PK*PK	b^*_{44}	-0.052	0.087	0.012	0.103	-0.028	0.144

TABLE 5.4.3 (Cont'd.)

Variable Label	Coeff.	Quebec Coeff.	Quebec Std.Error	Ontario Coeff.	Ontario Std.Error	Alberta Coeff.	Alberta Std.Error
LA	c_2	-0.013	0.023	-0.027	0.016	0.001	0.025
CM	c_3	-0.440	0.327	-0.737	0.150	-0.423	0.371
LTL*PL	d_{11}	0.004	0.004	0.014	0.005	0.019	0.009
LTL*PF	d_{12}	-0.002	0.002	-0.008	0.002	-0.011	0.003
LTL*PPT	d_{13}	-0.007	0.005	-0.003	0.008	-0.005	0.013
LTL*PK	d_{14}^*	0.006	0.264	-0.002	0.238	-0.003	0.259
TL*PL	d_{12}	-0.005	0.010	-0.019	0.009	-0.025	0.013
TL*PF	d_{22}	0.000	0.005	0.003	0.003	0.003	0.004
TL*PPT	d_{23}	-0.011	0.011	0.022	0.015	0.043	0.019
TL*PK	d_{24}^*	0.016	0.009	-0.008	0.007	-0.020	0.010
WLTL	g_{11}	-0.440	0.327	-0.737	0.150	-0.423	0.371
HLTL	g_{12}	1.765	0.676	-0.462	0.172	-0.413	0.609
WTL	g_{21}	0.376	0.264	-0.171	0.238	-0.054	0.258
HTL	g_{22}	-0.983	0.251	-0.264	0.127	0.331	0.213
Log-likelihood		188.4		253.5		148.7	

*Coefficients marked with an asterisk have been computed via the constraints described in section 5.2.2.

three provincial cost equations, the coefficient on the variable CM (proportion of revenue earned from transporting crude materials) increases in absolute value markedly. Only the coefficient in the Ontario regression is statistically significantly different from zero. Nevertheless, this change in the point estimates strongly suggests that the traffic balance variable takes low values for carriers of crude materials, and these carriers have relatively low costs per unit of output.

Because of the difficulty of interpreting the traffic balance variable, and because capacity utilization plays no role in the cost equations, the remainder of the analysis is based on the regressions reported in Table 5.4.3

5.4.1 THE MEASUREMENT OF OUTPUT

In Table 5.4.4, we report the test statistics for two hypothesis tests. The first concerns the question of whether the data are consistent with a single-output cost specification. As the first row of Table 5.4.5 indicates, the answer is definitely not. In all three provinces the hypotheses is rejected at the 1% level of significance. The second hypothesis is that ton-miles is an adequate measure of output for both LTL and TL outputs. In terms of the coefficients in Table 5.4.3, the null hypothesis is that $g_{ij} = 0$ for i, j = 0. This is clearly rejected for Quebec and Ontario, but the hypothesis is not rejected for Alberta.

The interpretation of the hedonic output function may not be immediately obvious. The negative sign attached to the average

TABLE 5.4.4

LEGEND

VARIABLE NAME	DESCRIPTION
ELTL	Less-than-truckload output
ETL	Truckload output
PL, PF, PPT, PK	Factor prices for labour, fuel, purchased transportation and capital services
TB	Traffic balance
CU	Capacity utilization
LA, CM	Proportion of revenue from hauling live animals and crude materials
WLTL, WTL	Average shipment weight of LTL and TL shipments
HLTL, HTL	Average length of haul for LTL and TL shipments

TABLE 5.4.5

TEST STATISTICS

Hypothesis	Likelihood Ratios ($-2\ell n\ \lambda$)		
	Quebec	Ontario	Alberta
1. Single Output vs Joint Output	49.5*	138.8*	70.2*
2. Simple Output vs Hedonic Output	18.2*	36.4*	1.8

*Null hypothesis is rejected at the 1% significance level.

shipment weight in all three provincial cost functions obviously does not imply that costs fall as shipment weight increases. The hedonic measure of output for both LTL and TL is

$$Y = y\bar{H}^{a}\,\bar{W}^{b}$$

where y is total ton-miles and $\bar{H}$ and $\bar{W}$ are average length of haul and average shipment weight respectively. Now, y can be written as

$$y = \sum_{i=1}^{N} H_i W_i ,$$

when N is the number of shipments, and H_i and W_i are the length of haul and the weight of the i^{th} shipment respectively. Now if we assume that the correlation coefficient between shipment weight and length of haul is zero[9], then $Y = N\,\bar{H}\,\bar{W}$, so that

$$Y = n\,\bar{H}^{1+a}\,\bar{W}^{1+b} .$$

The following table summarizes the estimated output measures for LTL and TL shipments by province. These measures have been constructed on the assumption that length of haul and shipment weight are uncorrelated for both LTL and TL shipments. It is clear from this table that given the number of shipments, N, costs rise with both length of haul and shipment weight. It would seem that for TL shipments in both Ontario and Alberta the output measure ton-miles is quite reasonable. This is also true of the LTL shipments in Alberta. Recall from Table 5.4.5 that ton-miles was not rejected for Alberta. For LTL shipments in

Ontario, however, shipment weight seems to be less important than length of haul in determining cost. The Alberta and Ontario LTL measures suggest that if one is looking for a simple measure of LTL output, the square root of ton-miles might be a reasonable index.

TABLE 5.4.6

HEDONIC OUTPUT MEASURES

PROVINCE	LTL	TL
Quebec	$NH^{2.8}W^{.6}$	$NW^{1.4}$
Ontario	$NH^{.5}W^{.3}$	$NH^{.8}W^{.7}$
Alberta	$NH^{.6}W^{.6}$	$NH^{.7}W^{1.0}$

N.B.: N is number of shipments

H is average length of haul

W is average shipment weight

5.4.2 ECONOMIES OF SCALE AND MARGINAL COST

As we discussed earlier, the sum of the coefficients a_1 and a_2 in each of the Tables 5.4.1 to 5.4.3 are estimates of the elasticity of cost with respect to output at the sample mean. When CU and TB are excluded, the cost elasticity estimates are 0.91, 0.88 and 0.82 for Quebec, Ontario and Alberta, respectively. Consequently, the deletion of the two variables, CU and TB does very little to change the estimates of the economies of scale at the sample mean. This analysis supports the findings of Chow (1980) and Cairns and Kirk (1980) that the For-hire trucking industry in the unregulated province of Alberta has a cost structure that exhibits increasing returns to scale at levels of output which are average for trucking firms in that province. Because the underlying technology is not homogenous, the measure of scale economies depends on the level of output. Tables 5.4.8 to 5.4.10 present the estimated cost elasticities and marginal costs at different levels of output for each of the provinces.

Since there are two outputs, the question arises as to how we should vary these outputs. Does it make sense to vary one, say LTL output, while holding the other at its sample mean? Table 5.4.7 shows the relationship between LTL output and TL output for the firms in each of the three provincial samples. While there is a positive association between the two, the relationship is weak. The lower panel of Table 5.4.7 shows some sample statistics for the two outputs measured in ton-miles. Recall that at the mean of all firms' average shipment weights and lengths of haul the hedonic output measure reduces to ton-miles. These statistics show that the largest LTL carrier is based in Ontario, and that Ontario LTL firms are much larger on average than LTL firms in Quebec and Alberta. The mean sizes of TL firms are much closer together and on average firms in Alberta are slightly larger than firms in Ontario (firm size being measured by output).

In Table 5.4.8, we see the effect of varying LTL output on economies of scale and the marginal cost of producing both LTL

TABLE 5.4.7

RELATIONSHIP BETWEEN LTL TON-MILES AND TL TON-MILES

REGRESSION RESULTS

Quebec:

$$LTL = 3155 + 0.0243\ TL, \quad R^2 = .035$$

$$\ell n(LTL) = -0.569 + 0.1984\ \ell n(TL), \quad R^2 = .073$$

Ontario:

$$LTL = 9070 + 0.0172\ TL, \quad R^2 = .014$$

$$\ell n(LTL) = -0.570 + 0.1377\ \ell n(TL), \quad R^2 = .047$$

Alberta:

$$LTL = 3225 + 0.0057\ TL, \quad R^2 = .007$$

$$\ell n(LTL) = -1.098 + 0.0380\ \ell n(TL), \quad R^2 = .003$$

SAMPLE STATISTICS

(Thousands of Ton-Miles)

	MINIMUM	MAXIMUM	MEAN
LTL			
Quebec	33.5	46,710	3,884
Ontario	2.7	82,253	9,714
Alberta	11.6	58,199	3,448
TL			
Quebec	44.5	307,281	29,968
Ontario	.5	760,969	37,473
Alberta	8.7	802,785	38,884

and TL output. All other variables are held constant at the sample means. For ease of comparison, the means of LTL output for each province are indicated. First, consider economies of scale. In both Quebec and Ontario, the measure of economies of scale diminishes as output increases throughout the whole range of outputs considered. In Alberta, however, the measure of economies of scale increases slightly with LTL output. Second, in all three provinces the marginal cost of producing LTL output declines as output increases. At their respective sample means the marginal costs of LTL output are 26.5¢, 18.2¢ and 22.4¢ per ton-mile in the provinces of Quebec, Ontario and Alberta, respectively. However, if LTL output is held at Quebec's mean level, these costs are 26.5¢, 30.2¢ and 20.6¢ per ton-mile. It would seem that the marginal cost of producing LTL output is lowest in Ontario, followed by Alberta. Ontario's cost advantage is due to the fact that the firms in Ontario are, on average, much larger than in Quebec and Alberta.

Turning to the marginal cost of TL output, these costs rise as LTL output increases in all three provinces. This is possibly due to the fact that large LTL carriers are not transporting bulk TL shipments, i.e., as we increase LTL output the nature of TL output changes.

Table 5.4.9 shows similar information, except that in this case the level of TL output varies, while the level of LTL output is held at the provincial means. We find now that in all three provinces, the degree of scale economies diminishes as output

TABLE 5.4.8

Sum of Output Elasticities and Marginal Costs As a Function of Less-Than-Truck-Load Output

LTL TON-MILES ('000)	QUEBEC			ONTARIO			ALBERTA		
	SUM OF ELAST.	MC LTL	MC TL	SUM OF ELAST.	MC LTL	MC TL	SUM OF ELAST	MC LTL	MC TL
3000	0.907	0.310	0.056	0.855	0.365	0.061	0.826	0.247	0.076
3447[A]	0.910	0.284	0.058	0.857	0.329	0.059	0.822	0.233	0.077
3884[A]	0.912	0.265	0.060	0.859	0.302	0.058	0.819	0.206	0.077
4000	0.913	0.261	0.060	0.859	0.296	0.058	0.819	0.202	0.078
5000	0.917	0.232	0.065	0.862	0.256	0.058	0.813	0.175	0.080
6000	0.921	0.214	0.070	0.865	0.230	0.058	0.808	0.156	0.083
7000	0.924	0.201	0.076	0.867	0.212	0.059	0.804	0.142	0.085
8000	0.927	0.192	0.081	0.868	0.199	0.060	0.800	0.132	0.088
9000	0.929	0.185	0.087	0.870	0.188	0.061	0.797	0.123	0.090
9714[O]	0.931	0.181	0.091	0.871	0.182	0.062	0.795	0.118	0.092
10000	0.931	0.180	0.093	0.871	0.180	0.063	0.795	0.116	0.093

N.B. For each province, TL output is held at the province's sample mean. The provincial sample means for LTL to-miles are indicated in the first column: Quebec (Q) Ontario (O) Alberta (A) Marginal costs are measured in dollars per ton-mile.

TABLE 5.4.9

Sum of Output Elasticities and Marginal Costs
As A Function of Truck-Load Output

TL TON-MILES ('000)	SUM OF ELAST.	MC LTL	MC TL	SUM OF ELAST.	MC LTL	MC TL	SUM OF ELAST.	MC LTL	MC TL
25000	0.894	0.243	0.063	0.84	0.167	0.070	0.806	0.201	0.010
27500	0.903	0.254	0.061	0.84	0.169	0.068	0.810	0.204	0.086
29968 [Q]	0.912	0.265	0.060	0.85	0.172	0.066	0.813	0.208	0.083
32500	0.920	0.277	0.059	0.86	0.175	0.065	0.816	0.211	0.080
35000	0.928	0.290	0.058	0.86	0.179	0.063	0.819	0.216	0.079
37472 [O]	0.935	0.303	0.058	0.87	0.182	0.062	0.821	0.221	0.077
38883 [A]	0.939	0.310	0.057	0.87	0.185	0.062	0.822	0.224	0.077
42500	0.948	0.331	0.057	0.88	0.190	0.061	0.826	0.232	0.075
45000	0.953	0.345	0.057	0.88	0.195	0.060	0.828	0.238	0.075

N.B. For each province, LTL output is held at that province's sample mean. The provincial sample means for TL ton-miles are indicated in the first column: Quebec (Q), Ontario (O), Alberta (A). Marginal costs are measured in dollars per ton-mile.

TABLE 5.4.10

Sum of Output Elasticities and Marginal Costs as a Function of Truck-Load Output

TL TON-MILES ('000)	SUM OF ELAST.	MC LTL	MC TL	SUM OF ELAST.	MC LTL	MC TL	ELAST.	MC LTL	MC TL
25000	0.893	0.247	0.062	0.842	0.169	0.070	0.807	0.205	0.089
27500	0.903	0.256	0.061	0.849	0.171	0.068	0.810	0.207	0.086
29968^{Q}	0.912	0.265	0.060	0.855	0.173	0.066	0.813	0.210	0.083
32500	0.921	0.275	0.059	0.861	0.176	0.065	0.816	0.213	0.080
35000	0.929	0.285	0.059	0.866	0.179	0.063	0.819	0.217	0.079
37472^{O}	0.936	0.295	0.058	0.871	0.182	0.062	0.821	0.221	0.077
38883^{A}	0.940	0.301	0.058	0.874	0.184	0.062	0.822	0.224	0.077
42500	0.949	0.317	0.059	0.880	0.190	0.061	0.826	0.231	0.075
45000	0.955	0.329	0.059	0.884	0.194	0.061	0.827	0.236	0.075

N.B. For each province, LTL output varys according to the relevant provincial relationship between LTL and TL output - See Table 5.4.4. The provincial sample means for TL output are indicated in the first column: Quebec (Q), Ontario (O), Alberta (A). Marginal costs are measured in dollars per-ton mile.

increases. Similarly, the marginal cost of TL shipments declines as TL output increases. At their respective sample means these marginal costs are 6.0¢, 6.2¢, and 7.7¢ in Quebec, Ontario, and Alberta, respectively.

Finally, Table 5.4.10 shows the effect of varying TL output, and at the same time, allowing LTL output to vary according to the logarithmic relationships shown in Table 5.4.7. Because the relationships between these two outputs is weak in all provinces, the information contained in Table 5.4.10 is very similar to that in Table 5.4.9 where TL output varies while LTL output is fixed.

The Cairns and Kirk (1980) study also presented marginal cost figures. They found declining marginal costs for all three types of output (LTL, TL short-haul, TL long-haul). However, Cairns and Kirk found that marginal costs are markedly different across the provinces. For example, their graphs suggest that the marginal cost of producing TL long-haul shipments in Quebec is a factor of four times the marginal cost in Alberta. For TL short-haul shipments the comparable factor is about 2. Our results are in direct contrast to these conclusions. While there are differences between provinces, we find that marginal costs are certainly of the same order of magnitude in each of the provinces. Unfortunately, due to the fact that we have used a general hedonic measure of output, while Cairns and Kirk use shipment miles, it is not possible to compare the absolute levels of marginal costs between the two studies.

5.4.3 RELATIVE EFFICIENCIES

The notion of average cost is not well-defined for multi-product firms because there is no unique way of attributing costs to the individual outputs. Consequently, it is not a straight-forward task to compare unit costs of LTL and TL service between provinces. In this section, we have attempted to compare the relative efficiencies of provincial trucking industries by computing the cost of, for example, producing Quebec's level of output at Quebec's factor prices according to the cost functions estimated for each of the provinces. Table 5.4.11 shows the results of these computions.

Consider the first column of this table. The first figure in this first column is the natural logarithm of the total costs of producing Quebec's mean output at Quebec's mean factor prices as predicted by the cost function fitted to Quebec data. The second number in this first column shows a similar figure that represents the predicted total costs of producing Quebec's mean output at Quebec's mean factor prices using the cost function fitted to Ontario's data. The two figures indicate that the Quebec cost function gives a lower predicted value of total cost. We can take this to mean that the cost-minimizing firms in Quebec are more efficient than the cost-minimizing firms of Ontario when it comes to producing Quebec's bundle of output at Quebec's factor prices. The last number in this first column indicates that cost-minimizing firms in Alberta are the most efficient of all.

TABLE 5.4.11

PREDICTED COSTS BY PROVINCE AND PROVINCIAL COST FUNCTION

Provincial Cost Function	Predicted Costs by Province* (In Natural Logarithms)		
	Quebec	Ontario	Alberta
Quebec	8.04	8.50	8.51
Ontario	8.06	8.46	8.08
Alberta	7.96	8.43	8.42

*Conditional on the mean values of the explanatory variables by province. Explanatory variables are constant within any given column.

The second column shows the results of a similar exercise; this time output and factor costs are equal to those at Ontario's mean values. The figures are in broad agreement with those of the first column, i.e., they suggest that Alberta has the most efficient trucking industry.

The last column produces quite different results. It would seem that Ontario's production function is such that Alberta's output can be produced more efficiently in Ontario than in Alberta. The reason for the apparent paradox lies in the fact that the output mix is quite different in the three provinces. In particular, Alberta's output is heavily weighted towards TL traffic while Ontario's output is much more LTL intensive. The results of the exercise are therefore consistent with the view that Ontario is relatively more efficient at producing TL output, but firms in Alberta are relatively more efficient at producing LTL output. Thus, the TL-intensive output bundle of Alberta is produced more efficiently in Ontario than in Alberta whereas the opposite is true of the LTL-intensive output of Ontario.

When considering the two extremes of output mix, Quebec firms are seen to be the least efficient of all. This contradicts the figures shown in the first column. However, the cost differences are slight, i.e., Quebec's costs are always very close to either costs in Alberta or Ontario. The table suggests that firms in Quebec are not particularly efficient at producing TL output. But recall that Table 5.4.6 suggests that Quebec's cost function is perhaps the least satisfactory of the three since the estimated hedonic output measures are quite different from those of Alberta and Ontario (which are very similar). Quebec's LTL output measure is very heavily weighted by length of haul, while TL output apparently depends only on shipment weight and is independent of length of haul.

An alternative way to compare costs across provinces is to estimate a cost function for all three provinces together, with provincial dummy variables allowing the level of costs, given the level of output anf factor prices, etc., to vary from province to province. The results of this exercise are reported in Table 5.4.12. Two sets of estimates are reported, the first includes the effects of capacity utilization (CU) and the traffic balance index (TB). However, the coefficients on these two variables are not statistically

TABLE 5.4.12

COEFFICIENT ESTIMATES FOR THE POOLED ALBERTA, ONTARIO AND QUEBEC DATA

Variable Label	Parameter	Est'd. Coeff.	Standard Error	Est'd. Coeff.	Standard Error
Constant	a_a	8.211	0.097	8.206	0.098
Ontario	a_o	0.188	0.083		0.083
Quebec	a_q	0.093	0.082	0.101	0.082
LTL	a_1	0.344	0.034	0.341	0.034
TL	a_2	0.570	0.037	0.565	0.037
LTL*LTL	a_{11}	0.072	0.010	0.069	0.010
TL*TL	a_{22}	0.117	0.015	0.118	0.015
LTL*TL	a_{12}	-0.046	0.010	-0.048	0.010
PL	b_1	0.386	0.012	0.386	0.012
PF	b_2	0.082	0.004	0.082	0.004
PPT	b_3	0.157	0.018	0.157	0.018
PL*PL	b_{11}	0.122	0.027	0.122	0.027
PL*PF	b_{12}	0.002	0.010	0.002	0.010
PL*PPT	b_{13}	-0.136	0.033	-0.136	0.033
PF*PF	b_{22}	0.007	0.012	0.007	0.121
PF*PPT	b_{23}	0.004	0.014	0.004	0.014
PPT*PPT	b_{33}	0.110	0.053	0.111	0.053
TB	C_1	0.032	0.020		
LA	C_2	-0.010	0.027	-0.005	0.027
CM	C_3	-0.023	0.013	-0.020	0.013
CU	C_4	-0.005	0.015		

TABLE 5.4.12 (Cont'd.)

Variable Label	Parameter	Est'd. Coeff.	Standard Error	Est'd. Coeff.	Standard Error
LTL*PL	d_{11}	0.015	0.003	0.014	0.003
LTL*PF	d_{12}	-0.006	0.001	-0.006	0.001
LTL*PPT	d_{13}	-0.010	0.005	-0.010	0.005
TL*PF	d_{22}	0.002	0.002	0.002	0.002
TL*PL	d_{21}	-0.019	0.006	-0.019	0.006
TL*PPT	d_{23}	0.022	0.010	0.022	0.010
WLTL	g_{11}	-0.540	0.147	-0.556	0.150
HLTL	g_{12}	-0.091	0.192	-0.054	0.195
WTL	g_{21}	0.758	0.156	0.045	0.155
HTL	g_{22}	-0.226	0.115	-0.233	0.116
Log-likelihood		507.217		505.967	

significantly different from zero. Consequently, the results of the two specifications are virtually identical. While the coefficient on capacity utilization is negative as one would expect, it is very small, with a standard error three times the size of the coefficient itself. The traffic balance variable again has a positive coefficient, but it too has a large standard error.

Turning now to the size of scale economies at the sample mean of all three provinces combined, we find the sum of the output elasticities of cost is 0.91. Again, positive scale economies at the sample mean are indicated since a one percent increase in both LTL and TL output gives rise to a 0.91 percentage increase in total cost (at the sample mean). The coefficients of most interest in this section are those on the dummy variables which represent the provinces of Ontario and Quebec. The intercept itself represents the base province of Alberta. The results indicate that the total cost of producing a given bundle of output at given factor prices is about 10 percent higher in Quebec than in Alberta, while costs in Ontario are estimated to be about 20 percent higher than in Alberta. The standard errors indicate that while the point estimates suggests that costs are higher in Quebec than in Alberta, the difference is not statistically significant. On the other hand, the estimated cost difference between Ontario and Alberta is statistically significant.

Qualitatively, these results are consistent with Chow (1980). However, after accounting for differences in the utilization of capacity, Chow finds that costs in Quebec and Ontario were higher than in Alberta (in 1975) by 33 percent and 42 percent respectively. Chow suggests two possible explanations for these differences. The first is that the traffic patterns may differ between provinces due, not to regulation, but to the natural conditions of demand. The second possible explanation is that regulation leads to higher costs by inhibiting competition through control of entry and/or traffic patterns through restrictions that are placed on trucking licenses. In this study, we have attempted to calculate traffic balance indices at the firm level. We find that this variable does not explain any of the cost differences that apparently exist between the provinces. Inefficiencies due to regulation remain a possible explanation for the observed cost differences.

5.5 SUMMARY AND CONCLUSIONS

In this study, we have presented estimates of trans-log functions for intraprovincial trucking firms that operate in the provinces of Alberta, Ontario, and Quebec. In order to account for the heterogeneity of output, a joint-output model has been estimated. This allows for a distinction to be made between LTL and TL shipments. In addition, firm output is qualified by the average shipment weight and the average length of haul.

The elasticity of total cost with respect to output is found to be less than unity at the sample mean in all three provinces. In other words, economies of scale exist at the sample mean of each of the provinces. These results are in agreement with those of

Cairns and Kirk (1980) and Chow (1980). However, it should be recognized that all three studies focused on intra-provincial carriers which are not necessarily the largest in the industry. This focus is necessary since all three studies are interested in the effects of provincial regulations on the performance of trucking firms. The larger firms are likely to be extra-provincial carriers who may well be large enough to have exhausted potential scale economies.

The estimated cost functions have been used to calculate the marginal costs of LTL and TL shipments in each of the three provinces. These calculations indicate that marginal costs are of the same order of magnitude in all three provinces. This conclusion is unlike Cairns and Kirk (1980) who find very large provincial differences. At a given level of output, the marginal cost of producing LTL shipments is highest in Ontario followed by Quebec and Alberta. However, within the sample, Ontario LTL carriers are much larger on average than in the other two provinces, and this gives an advantage to Ontario carriers since marginal costs fall with increasing LTL output. These results, coupled with the findings of Chapter 4 which indicate that LTL rates are relatively high in Ontario, suggest that LTL freight contributes substantially to profit at the margin. Turning to truckload shipments, the cost functions indicate that at a given level of truckload output marginal costs are lowest in Quebec followed by Ontario and Alberta. However, the estimated differences are not large.

This Chapter also attempted to judge the relative cost performance of trucking firms in the three provinces. The first approach used province-specific cost functions, and the second used a cost function fitted to pooled data.

(i) Costs in a particular province were evaluated at that province's sample mean values according to each of the three cost functions. This procedure was intended to answer the following question: What would, say, Quebec's costs be if the cost function of Ontario or Alberta held in Quebec? The results of this exercise suggested that Ontario is relatively more efficient at producing TL output than is Alberta, while the reverse is true of LTL output.

(ii) In order to judge overall efficiency, the data were pooled. Thus, the same cost structure was imposed on all three provinces, but cost levels, given the values of the explanatory variables, were allowed to vary from province to province through the inclusion of two dummy variables. The results of this exercise suggest that, overall, Alberta is the most efficient province, followed by Quebec, then Ontario. Cost levels in Ontario proved to be statistically significantly different from cost levels in Alberta. The point estimates indicate that costs in Quebec are about 10% above those in Alberta, while costs in Ontario are about 20% above those in Alberta.

Chow reaches a similar conclusion:

> "It appears then that Ontario and Quebec carriers are less efficient and charge higher rates overall... and it appears that LTL carriers (as opposed to TL carriers) in Ontario are at the greatest disadvantage relative to unregulated trucking".[10]

Capacity utilization has assumed some importance in the discussion of both economies of scale, and the relative efficiencies of the provincial trucking industries. As Chow (1980, p. 67) has argued, if the utilization rates of transportation equipment reflect exogenous factors such as demand patterns, then one should include a variable that captures this effect in the cost equations. However, if utilization rates are related to the size of operation, then the inclusion of such a variable simply obscures the effect of output on cost. Alternatively, if utilization rates differ across provinces because of the differing regulatory regimes, then the inclusion of such a variable will bias the measure of provincial cost differences that exist because of regulatory structure.

Unfortunately, none of the studies is able to categorically disentangle these possibilities. However, this Chapter suggests that if output is measured adequately, capacity utilization plays no role in determining costs. This strongly supports the view that capacity utilization differs between carriers, and therefore provinces, only inasmuch as the output mix is different between carriers. Thus, in both the provincial cost equations and the pooled cost equation, capacity utilization had no significant role to play. This was not due to a lack of variation. Indeed, within the sample, the provincial means differed substantially. In decreasing order with respect to utilization rates, the provincial ranking is: Ontario, Alberta, and Quebec.

It should be noted that in the Cairns and Kirk (1980) study, output was separated into three categories, but no additional output-qualifying variables were included. Chow (1980), on the other hand, used a single output measure (number of shipments) which was qualified by firm-specific output characteristics such as length of haul and shipment weight. Both studies found the capacity utilization played some role and tended to reduce estimates of provincial differences. However, in the present study a joint-output hedonic cost function has been estimated. Differences in provincial performances were estimated to be smaller than those found by Chow, but the estimates were unrelated to the inclusion or exclusion of utilization rates.

There are two explanations for the remaining differences in provincial cost levels. The first is that the traffic patterns may differ between provinces due, not to regulation, but to the natural conditions of demand. The second possible explanation is that regulation leads to higher costs by inhibiting competition through control of entry and/or traffic patterns through restrictions that are placed on trucking licenses. In this study, we have attempted to calculate traffic balance indices at the firm level. We find that this variable does not explain any of the cost differences that apparently exist between the provinces.

That is to say, after accounting for both traffic balance and capacity utilization, our point estimates indicate that trucking costs in Ontario and Quebec are, respectively, about 20 percent and 10 percent higher than costs in Alberta given factor prices and the level and characteristics of output. One cannot say categorically that such cost differences are due to entry and license restrictions, but this remains a probable explanation.

FOOTNOTES TO CHAPTER 5

1. The carriers in his sample reported in the 1975 Motor Carrier Freight Survey (MCF) that they earned more than 50% of their operating revenues from the movement of products classified as "general freight".
2. Chow (1980, p. 54)
3. Chow uses the quantity of ton-miles divided by the number of power units owned or rented by the firm.
4. Chow (1980 , p. 80).
5. Cairns and Kirk (1980, p. 8)
6. Caves _et. al._ suggest a variation of the trans-log specification based on the Box-Cox transformation that does allow for zero output, but this specification has not been examined here.
7. In this study, LTL shipments are those that weigh under 10,000 lbs. Other shipments are categorized as being truckload.
8. The other possibility, which we dismiss, is that the smaller firms report lower incomes than they actually earn.
9. This does not seem unreasonable given that shipments have been classified into LTL and TL categories.
10. Chow (1980, p.54).

APPENDIX A1

FOR-HIRE TRUCKING DATA SOURCES

The results contained in Chapters 4 and 5 of this Report are based upon the data tapes used by the Transportation and Communications Division of Statistics Canada to produce their publications Motor Carriers, Freight and Household Goods Movers (MCF), and For-hire Trucking Survey, also known as Truck Commodity Origin and Destination Survey (TOD).

The first publication provides information on each firm's income, expenses and balance sheet for Canadian domicled motor carriers of freight on the basis of a census of trucking establishments derived from the Statistics Canada Business Register. Firms specifically excluded from the universe of For-hire trucking firms include:

a) private carriers.

b) pool car operators.

c) rail and air express companies, with the exception of Canadian Pacific Express Limited.

d) courier and messenger services.

e) armoured car services.

f) firms earning less than $100,000 gross operating revenue from inter-city trucking in the previous year.

g) firms whose main activity is not For-hire trucking.

h) truck rental firms and brokers.

In addition to the income and balance sheet information, each firm describes its type of business by indicating: the form of ownership; the area of operation; the types of commodities that are hauled

(18 categories); and the sources of income (long distance hauling, local hauling, equipment rentals, etc.). Since the information contained in the MCF survey includes both the quantities of inputs and expenditures on inputs, it is possible to calculate factor prices at the firm level. However, the MCF data does not give any indication of the volume of a firm's output.

Estimates of each firm's output, and the characteristics of this output, can be obtained from the second data source, i.e., the TOD Survey. The ojbective of this survey is to provide statistics on Canada's For-hire trucking industry. In order to make these estimates, a sample of approximately 650 firms is selected from the total population of For-hire trucking firms. From the files of these firms, a large sample of individual shipment records is obtained. These individual shipment records include information on the commodity being transported, the origin and destination of the shipment, the weight of the shipment, the revenue earned on the shipment and other shipment characteristics. From this information, it is possible to estimate the total number of shipments transported etc. Although the objectives of the survey do not include the estimation of a firm's physical output, the data can be used to estimate the firm's total ton-miles as well as the average shipment weight and average length of haul.

Statistics Canada provides users with 4 cautionary notes with respect to this TOD data:

a) all revenue estimates are based on charges actually paid by the shipper, net of any subsidy payments.

b) the origin and destination information is as recorded on the shipping document, even though, in the case of piggyback movements, part of the distance travelled is by rail. For non-piggyback shipments moved partially by rail, the truck shipment destination is taken as the point at which the rail mode receives the good. Only revenues associated with the truck portion of the movement are reported.

c) for interlined shipments, there exists the possibility of double counting because essentially the same shipping document will be in the files of two or more carriers. Sampled documents which are duplicated because of interlining are considered to be one.

d) also excluded are international shipments, and shipments which move 15 miles or less from origin to destination.

In summary, the MCF survey gives information on each firm's profits, costs, revenues and factor prices, while the TOD survey provides information on the firm's physical output and total revenue earned from inter-city transportation. While the approximately 650 firms on the TOD tape can be linked to firms on the MCF tape, no information is given as to the actual identity of individual firms.

APPENDIX A2

Commodities Exempt from Regulation in the Province of Saskatchewan

SCC Description	SCC Code
1. Sand, gravel and crude stone	276
2. Cattle	001
3. Other crude wood materials	239
4. Eggs	053
5. Other insecticides and rodenticides	419*
6. Fish steaks, blocks, slabs and sticks	035
7. Coke of petroleum and of coal	435
8. Iron ores concentrates and scrap	251
9. Water and ice	278
10. Swine	003
11. Other live animals	009
12. Poultry	006
13. Cereal grains, unmilled	061
14. Lumber and sawn timber	331
15. Cement and concrete basic products	475*
16. Zinc in ores, concentrates and scrap	257*
17. Copper in ores, concentrates, matte and scrap	253
18. Other crude non-metallic minerals	279
19. Other metal bearing ores	259

*Not included in regression analysis due to absence of observations.

APPENDIX A3

Derivation of the Estimating Equation for The Saskatchewan/Alberta Case Study

To derive the estimation form of the model used in Section 4.2 note that the total number of observations is $NS = \sum_{i=1}^{2} \sum_{j=1}^{NC} NS_{ij}$ where NS_{ij} is the number of observations on commodity j in province i, NC is the total number of commodities, and there are two provinces (i = 1 for Alberta, i = 2 for Saskatchewan). If the equations which relate revenue per ton-mile (y) to weight (W) and distance (H) are allowed to have different multiplicative constants for each commodity in each province, then the full set of equations has the form

A.2) $$y = W^a H^b e^Z$$

$$\text{where } Z = \sum_{i=1}^{2} \sum_{j=1}^{NC} c_{ij} X_{ij} + u$$

and X_{ij} is a dummy variable which has unit value for commodity j in province i, and zero otherwise. Note that each of the vectors, y W, H X_{ij} are NS x 1.

The restrictions that are imposed in order to estimate the effect of regulation in Saskatchewan can be described in the following way:

$$c_{1j} - c_{2j} = d_u , j = 1, \ldots NC_u ,$$

$$c_{1j} - c_{2j} = d_r , j = NC_r, \ldots NC ,$$

where NC_u is the number of commodities which are unregulated and NC_r = NC_u + 1 is the first of the regulated commodities which are indexed NC_r to NC. The first set of restrictions forces the ratio of unit prices in Alberta to those in Saskatchewan to be identical for all unregulated commodities. In fact, $[\exp(d_u) -1] \times 100\%$ is the percentage by which

Alberta rates exceed Saskatchewan rates for unregulated commodities. A similar interpretation can be placed on the second set of restrictions. The effect of regulation is measured by $d_u - d_r$.

To derive the estimable form, substitute for c_{2j} to give

$$Z = \sum_{j=1}^{NC} c_{1j} X_{1j} + \sum_{j=1}^{NC_u} (c_{1j}-d_u)X_{2j} + \sum_{j=NC_r}^{NC} (c_{1j}-d_r)X_{2j}$$

$$= \sum_{j=1}^{NC} c_{1j} (X_{1j}+X_{2j}) - d_u \sum_{j=1}^{NC_u} X_{2j} - d_r \sum_{j=NC_r}^{NC} X_{2j}$$

now define $c_{11} = e$ and $c_{1j} = e + e_j$, $j = 2 \ldots NC$, so

$$Z = e \sum_{j=1}^{NC} (X_{1j}+X_{2j}) + \sum_{j=2}^{NC} e_j(X_{1j}+X_{2j}) - d_u \sum_{j=1}^{NC_u} X_{2j}$$

$$+ (d_u-d_u-d_r) \sum_{j=NC_r}^{NC} X_{2j}$$

$$= e \sum_{j=1}^{NC} X_{1j} + \sum_{j=2}^{NC} e_j C_j + (e-d_u) \sum_{j=1}^{NC} X_{2j} + (d_u-d_r) \sum_{j=NC_r}^{NC} X_{2j}$$

Hence,

$$Z = \sum_{j=2}^{NC} e_j C_j + eD_1 + (e-d_u)D_2 + (d_u-d_r)D_3$$

where $C_j = X_{1j} + X_{2j}$ is a commodity dummy

$D_1 = \sum_{j=1}^{NC} X_{1j}$ is an Alberta dummy

$D_2 = \sum_{j=1}^{NC} X_{2j}$ is a Saskatchewan dummy

$D_3 = \sum_{j=NC_r}^{NC} X_{2j}$ is a Saskatchewan dummy for regulated commodities.

Adding another dummy variable, D_4, set equal to unity if a surcharge is included in revenue per ton-mile, zero otherwise; and a time interaction variable (T), equal to unity for 1976 and zero for 1975, produces the final estimating equation.

A.3) $$y = W^a H^b e^Z ,$$

where $$Z = \sum_{j=2}^{NC} e_j C_j + eD_1 + (e-d_u)D_2 + (d_u-d_r)D_3 + d_4 D_4 + t_1.(T*D_1) +$$

$$+ t_2.(T*D_2) + t_3.(T*D_3) + u$$

APPENDIX A4

THE TRAFFIC BALANCE INDEX

This appendix describes how the firm-specific traffic balance index (TB) was constructed. Essentially, this index measures, for all origins, the proportion of out-going freight that is matched in incoming freight (or alternatively, for all destinations, the proportion of incoming freight that is matched by outgoing freight). Two examples are presented as illustrations.

Let A be the set of all origins and destinations, and let OR_i and DR_j, for $i,j \varepsilon A$, be the revenue earned by a particular firm on all shipments that originate in i and all shipments that are destined for j respectively.

Total revenue earned by the firm is

$$R = \sum_{i \varepsilon A} OR_i = \sum_{j \varepsilon A} DR_j .$$

The traffic balance index, TB, is defined as

$$TB = [\sum_{i \Sigma A} \min (OR_i, DR_i)] \div R$$

Some properties of T are:

1. $0 \leq TB \leq 1.0$.

2. TB = 0 implies no origin is a destination and vice versa, i.e., that traffic is completely unbalanced.

3. TB = 1.0 implies that all origins are destinations and vice versa and that for any given origin or destination revenue from "in-traffic" is equal to "out-traffic". In this sense traffic is completely balanced.

Example 1: In this example there are just two areas, 1 and 2. Traffic that leaves 1 (2) must go to 2 (1).

Fig. 1

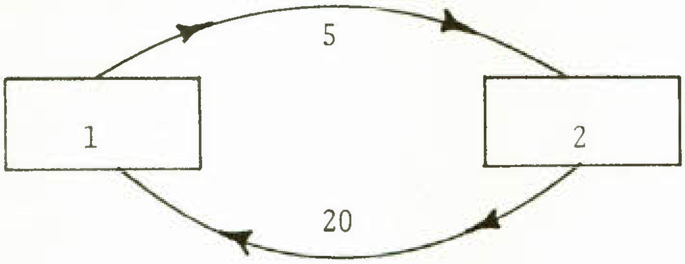


Fig. 1 shows the traffic flows between area 1 and area 2. This information can be put in tabular form.

Origin		Destination		Min. (OR_i, DR_i)
Code	Revenue	Code	Revenue	
1	5	1	20	5
2	20	2	5	5
	25		25	10

Total revenue for this firm is 25, while 5 units of freight leaving 1 and 5 units of freight leaving 2 are matched by income freight so the traffic balance index, is TB = 10 ÷ 25 = 0.4.

Example 2: In this example there are three areas, but only area 1 is both an origin and a destination.

Origin		Destination		Min. (OR_i, DR_i)
Code	Revenue	Code	Revenue	
1	10	1	15	10
2	30	2	0	0
3	0	3	25	0
	40		40	10

In this case, only the 10 units of freight leaving origin 1 is matched by incoming freight. Since total revenue for the firm is 40, the traffic balance index is TB = 10 ÷ 40 = 0.25. That is to say, 25% of all outgoing freight is matched by incoming freight. It is also true of course that 25% of all incoming freight is matched by outgoing freight.

APPENDIX A5

FUEL PRICES

The price of fuel is defined in terms of dollar per gallon which we computed by taking the ratio of total fuel expenses to total gallons purchased for all firms. Unfortunately, some firms did not report one or other of these items, and other firms obviously reported incorrect information. As an example, one firm reported a fuel price over $8.00 per gallon! Table A5.1 shows the distribution of firms by class and reported (implied) fuel prices. The vast majority of firms (86%) reported fuel prices within the range of $.50 to $1.25. Table A5.2 shows the average price paid, by province, for these firms. In order to adjust the "incorrect" fuel prices, we investigated the relationship between fuel price and firm size measured by transportation revenue for Quebec and Ontario. The regression results are reported in Table A5.3. In both provinces, there is an inverse relationship between fuel price and firm size. Consequently, we decided to fit an equation to data from all provinces, the dependent variable being fuel price, and the explanatory variable being transportation revenue. Separate intercepts for each province were estimated. Adjusted fuel prices were obtained for all firms with reported prices outside the range $0.5 to $1.25 by taking the predicted fuel price conditional on reported transportation revenue. The distribution of firms by class and adjusted fuel price is given in Table A5.4.

TABLE A5.1

Distribution of Firms by Class and Reported Fuel Price

Fuel Price ($/ Gal.)	Class I	Class II	Class III	Household Goods I, II	Total
0	3	4	2	0	9
0.01-0.49	16	24	20	1	61
0.50-0.74	110	128	84	10	332
0.75-0.99	37	53	68	9	167
1.00-1.24	8	8	9	0	25
1.25-1.49	0	4	4	0	8
1.50-1.74	0	0	2	0	2
1.75-1.99	0	0	1	0	1
2.00+	0	0	3	0	3
	174	221	193	20	608

TABLE A5.2

Mean Fuel Prices* by Province
($ per Gal.)

Province	Mean Price	Province	Mean Price
Newfoundland	$.79	Ontario	$.72
Prince Edward Island	.94	Manitoba	.75
Nova Scotia	.79	Saskatchewan	.75
New Brunswick	.76	Alberta	.68
Quebec	.73	British Columbia	.72

* for prices within the range $.5 to $1.25.

TABLE A5.3

Regression of Fuel Price on Transportation Revenue

	Constant	Transportation Revenue	R^2
Quebec	0.739	-0.359	0.031
		(0.182)	
Ontario	0.723	-0.157	0.016
		(0.100)	
All Provinces	*	-0.002	0.100
		(.0007)	

TABLE A5.4

Distribution of Firms by Class and Adjusted Fuel Price

Fuel Price ($/Gallon)	Class I	Class II	Class III	Household Goods I, II	Total
0.50-0.74	129	152	104	11	396
0.75-0.99	37	61	80	9	187
1.00-1.25	8	8	9	0	25
	174	221	193	20	608

*Each province had its own intercept. These are not reported.

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