Logistics Competitiveness Framework

RESEARCH PAPERS

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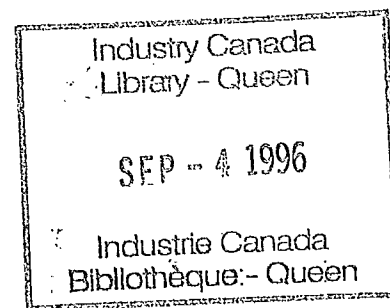K1A OH5

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RESEARCH PAPERS

- **An Assessment of the Competitiveness of Canadian Supply Chains**
  W. Qu and A. Staruch

- **The Economic Costs of Logistics: Canada & the United States Compared**
  A. Jones

- **The Distribution & Storage Sector: The Supply & Demand of Transportation Services, A. Jones**

- **Manufacturers Inventory Management & Implications for Logistics in Canada, A. Jones**

- **Customer Driven Logistics, S. Long**

Logistics Competitiveness Framework

The Authors:

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Wendy Qu, a Logistics Economist with Industry Canada, has a Doctorate in Management Sciences (Logistics) from the University of Waterloo. She has published and presented papers on the subjects of supply chain management and logistics performance evaluation.

Allan Staruch is the Logistics Sector Development Officer at Industry Canada and team leader for the Logistics Competitiveness Framework. He is the author of the Department's Freight Forwarding and Courier industry profiles. He has both private and public sector experience in managing productivity improvement, industrial development and trade projects.

LOGISTICS COMPETITIVENESS FRAMEWORK

DRAFT ISSUES PAPER

Assessment of the Competitiveness of Canadian Supply Chains

Prepared by W. Qu and A. Staruch
November 16, 1994

Distribution Service Industries Directorate, Industry Canada

LOGISTICS COMPETITIVENESS FRAMEWORK
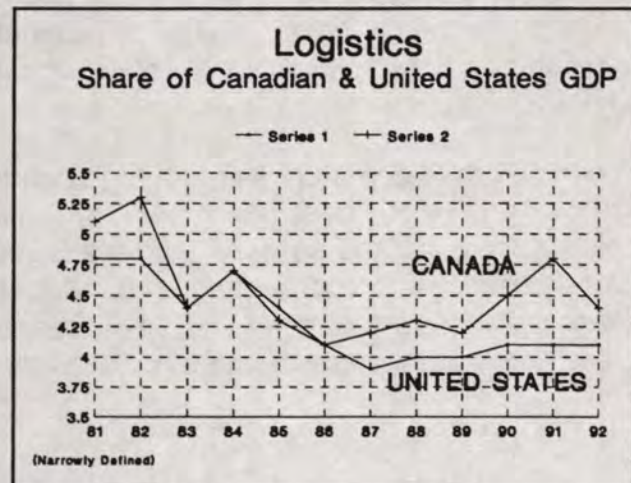## ISSUES PAPER

INTRODUCTION

Industry Canada is seeking views on how to improve the competitiveness of Canadian supply chains. The logistics of distributing goods through supply chains has become a critical factor in today's customer driven markets. Logistics, broadly defined, involves business activities and services used to move materials and information through supply chains from their source to points of consumption at the least cost and in the optimum time to meet customer service requirements. The Logistics Competitiveness Framework is a process to find new ways for Canadian industry to compete and encourage strategic thinking among the stakeholders.

Production cost advantages have diminished to the point that competition is now based on who can provide the best service to consumers, as well as remain price competitive. Consequently, the reliability and flexibility of logistics services to deliver the right products, at the right price and at the right time has become a critical part of the business strategies of companies to increase their market shares.

Canadian supply chains may not be as competitive as those of our foreign competitors. At issue is whether Canadian users and suppliers of logistics services have been able to restructure their business practices in response to an increasingly customer driven business environment, and to more open competition in a global marketplace.

This chart shows the trend of logistics GDP over time in Canada and the United States. In Canada, logistics narrowly defined to exclude the internal logistics activities of the firm is estimated to have constituted 4.8% of Gross Domestic Product (GDP) in 1991. It is clear that logistics requires a very significant quantity of economic resources.

Logistics
Share of Canadian & United States GDP

— Series 1   —+— Series 2

Distribution Service Industries Directorate, Industry Canada

More broadly defined to include the internal or private logistics activities of producers and distributors of goods, the total economic cost of logistics in Canada is estimated to have constituted 7.6% of Canadian economic activity in 1991. Private logistics activities of shippers include purchasing, order processing, private fleets, packaging, insurance, storage, trade documentation activities. This figure is considered to be low due to the lack of some of the private sector logistics data. Some experts estimate total logistics cost to be closer to 8.5% of GDP.

THE NEW ECONOMY

The business environment in the 1990s is significantly different from that which existed in the previous decade. Competition in the New Economy is customer driven. It is based on knowledge of the business environment, rapid access to information, capitalization on new ideas, creation of strong business relationships and the application of technologies.

There have been major changes in markets, technologies and government policies. The production, distribution and marketing of goods have become more global. The worldwide lowering of tariffs and the creation of large trading blocks has forced firms to adjust their business practices to remain competitive. This new market environment depends on customer service and time-based competition. It is supported through strategic alliances, particularly those with third party logistics services. The most important technological development has been electronic commerce. In respect to policies, governments have reduced or eliminated barriers to competition and changed trade patterns. Examples are transportation deregulation and the North American Free Trade Agreement.

Companies are taking a continental approach to their business strategies and restructuring their business practices. Action includes the rationalization of sources of supply for products and services, and the restructuring of production and distribution facilities to serve the North American market. In response, shippers, carriers and logistics providers are forming strategic alliances to create systems which have reduced costs and improved customer service.

TRENDS

Supply Chain Requirements

Domestically, the manufacturing sector is the still the major user of logistics, as measured by the demand for transportation services. However, its use of logistics services has declined in recent years. Historically the <u>two largest consuming industries</u> of transportation services have been the Pulp and Paper industry and the Refined Petroleum & Coal products industry. Other volume users include the Primary Steel industry, the Food industry and the Motor Vehicles industry. Of the top 20 users of transportation services in the manufacturing sector in 1971, all but three were in the top twenty in 1990.

Internationally, according to an internal study by Transport Canada[1], there have been changes in the mix of commodities being exported from Canada to the other countries. An increasing share of exports tend to be more highly processed products. Changes in the shipping strategies to provide quicker customer response services also increased the need for faster transportation.With better transportation services at reduced rates, shippers now can afford to use faster transportation modes. These changes in the mix of Canadian commodities transported in our international trade and other factors are affecting modal choices.

Traditional rail and water carriers are losing ground to the truck and air modes. Motor carriers have added 20% to their market share since 1976 and accounted for 54% of the transportation market in 1992. More higher valued, service sensitive products, such as motor vehicles, communication equipment, and industrial machinery are moving into the United States by truck. Air more than doubled its market share to 8.5%. Rail lost 4% of its share to hold 13% of the market. Water's drop of 6% its market share brought it to an 18% share.

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[1] A Profile of Canadian Trade and Modal Shares
Economic Research Branch, Transport Canada

**Distribution Service Industries Directorate, Industry Canada**

Inventory Management

The charts below show that the value of inventories held in both Canada and the United States have been increasing. However, when compared to economic growth, firms on average are holding less inventories today than they did, a decade ago. The cost of holding inventories as a percent of GDP has declined.
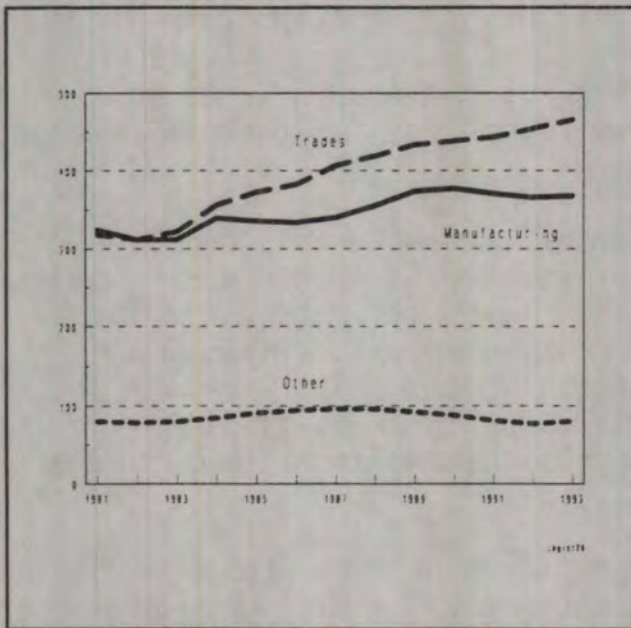
U.S.: Non-Farm Business
Inventories (Constant $, Billions)
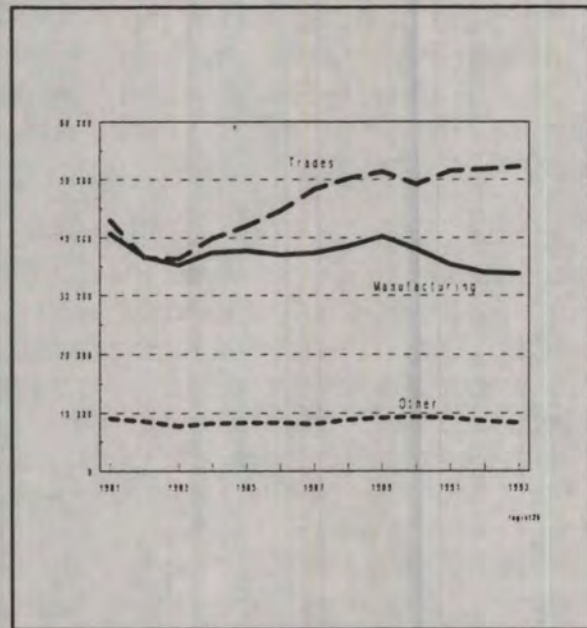
Canada: Manufacturing & Trades
Inventories (Constant $, Millions)

A greater value of inventories are being held by wholesalers and retailers (trades) than manufacturers. This shift may suggest a major change in North American inventory management practices. This trend is more pronounced in Canada than in the United States. In Canada, the trades share rose from 46% in 1981 to 55% in 1993 while in the United States the Trades share rose from 44% in 1981 to 51% in 1993.

This may reflect structural differences in the integrated logistics management of the flow of inventories through supply chains from points of production to consumers. This may be due to a lag in Canada's adoption of applications of electronic commerce.

Other reasons may be the more regional procurement and distribution of products in the United States versus the centralized production of goods in Canada for national distribution, as well as more advanced development of intermodal and shipper/carrier strategic alliances in that country.

Transportation

It would appear that lower transportation prices are allowing firms to trade-off the use of more transportation to lower inventory carrying costs and provide better customer service. More transportation services are being used due to the overall growth in the economy. Inventory holding costs as a share of GDP have been on the decline. The influence of interest rates appear to have been less of a factor in inventory holding costs in the United States than in Canada.
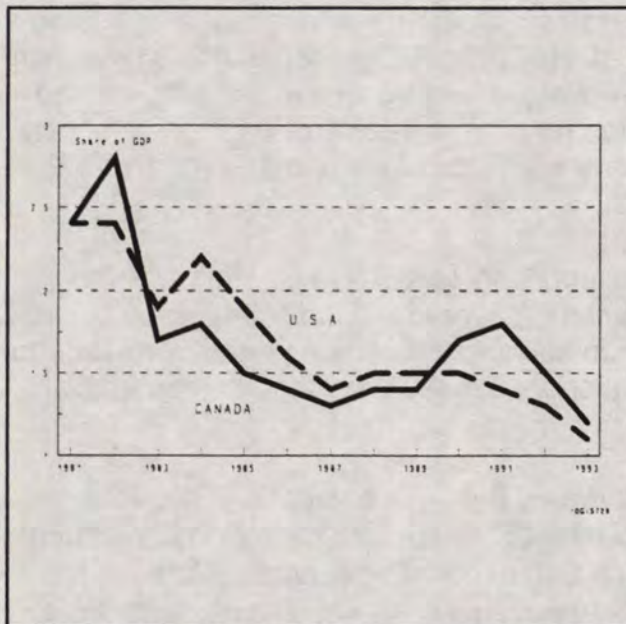
Total Inventory Carrying Cost as a Share of GDP (Canada and the U.S. Compared

Transportation's Consumption of GDP
Canada-United States
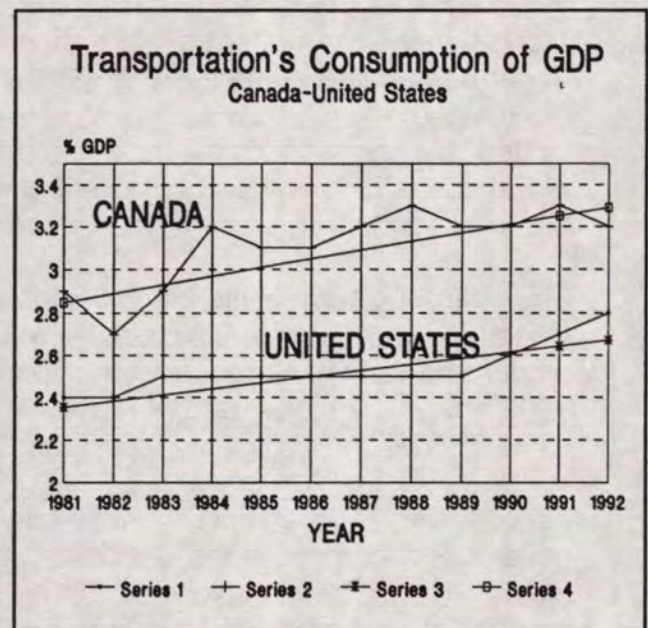
Transport Canada[2] research on trucking prices notes "*Trucking prices were basically flat, with nominal increases of 4% between 1986 and 1991. In real terms, the cost of trucking for users has dropped by 15% over this period*". There have been sharp gains in labour productivity reported by the National Transportation Agency, as measured in revenues per tonne-mile per employee. As the sector restructures, the relative importance of labour in the overall cost structure of transportation services providers is decreasing. In all transportation industries, telecommunications expenditures have grown faster than production; as well, business services have risen in relative importance in all industries. The Truck, Air and Rail industries experienced a significant growth in the cost of insurance, as well as financial services provided by the banking and trust industries between 1970 and 1990.

In general, transportation has become a smaller percentage of the operating costs for the majority of producers and distributors of goods in Canada. A few large industries are experiencing greater transportation intensities, where transportation is becoming a larger percentage of the value of goods sold. However, The transportation component of GDP experienced low and stable growth over the last decade in Canada and the United States. In 1992, freight transportation represented 3.2% of GDP. The supply of transportation services grew 3.0% annually from $11.7 billion in 1981 to $16.2 billion in 1992.

The chart above presents the GDP for transportation services in Canada and the Unites States. Canada consistently consumes on average approximately 15% more labour and capital in producing transportation services. Over the period from 1981 to 1992, there is a higher rate of growth in transportation GDP in Canada than in the United States.

No conclusions on competitiveness can be drawn from this comparison due to structural differences in the Canadian and United States economies. Some structural differences are geographical, goods produced, transportation services, distances required to ship products to domestic and international markets, shipment lot sizes, traffic densities, levels of capital investments in transportation infrastructures and equipment, or overcapacity in the supply of logistics services.

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[2]**Trucking Price Indices 1981-1992**
Economic Analysis Directorate, Transport Canada

Distribution Service Industries Directorate, Industry Canada

ISSUES

The importance of supply chains to the competitiveness of industry is reflected by the logistics practices used to respond to the demands of the New Economy. The competitiveness of Canadian supply chains can be qualitatively measured by comparing the effectiveness of Canadian and United States responses.

Some new initiatives include the restructuring of distribution channels and the application of electronic commerce. Other changes in the management of supply chains are re-engineering, rationalization of production and distribution systems, rationalization of sources of supply for products and services, and the use of strategic alliances. Current research[3] in Canada shows:

Issue 1. A significant gap exists in the logistics performance of Canadian companies and United States companies

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Canadian companies have failed to match United States logistics performance. It was found that they have not introduced effective logistics strategies and tactics through logistics improvement programs in the areas of customer and supplier interfaces, warehousing, transportation, and materials management. There have been some improvements in service and distribution productivity. It is expected that future progression will be generated in the areas of information and materials management other than in the traditional areas of transportation and warehousing.

Issue 2. Canadian distribution channels are operating at a disadvantage with their United States counterparts

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Canadian channels are composed of relatively more retail and wholesale establishments. Canadian establishments tend to be about one-half the size of United States wholesalers and retailers. Products made in the United States and brought into Canada actually pass through an additional level of distribution channels in our supply chains. These structural differences affect distribution and inventory management efficiency.

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[3] **See Bibliography**

Distribution Service Industries Directorate, Industry Canada

In international trade, the creation of effective channels and distribution efficiencies is hindered by the small size of our domestic market. We often lack sufficient volumes of traffic to enter into distribution agreements with foreign nationals. In these cases, Canadians have found it more effective to distribute their goods through United States or large distributors in other countries. The downside of this arrangement is that often Canadian goods become secondary sources of supply. Part of the cause of this situation is a general trend for Canadian manufacturers to sell on a F.O.B factory door to export markets due in part to low volumes of trade or the lack of knowledge to establish international supply chains. This might be overcome through greater shipper /carrier cooperation in establishing shipment consolidation services and foreign distribution hubs for these markets.

Issue 3. Canadian industry is lagging behind the United States in the use of electronic commerce, particularly by small business.

A 1993[4] survey revealed that the percentage of Canadian respondents with action plans in place to convert from manual to computerized order processing was 67%, while in the United States the figure was 75%. A higher percent of United States companies had plans for productivity improvement programs, such as on-line confirmation of stock availability and centralized order entry systems.

Issue 4. There are no comprehensive logistics performance indicators to help Canadian industry develop supply chain strategies

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Little information exists on the comparison of the competitiveness of Canadian supply chains with their foreign competitors. Collecting logistics information is difficult due to its application across many sectors, particularly in respect to service factors.

Performance comparisons at the firm or sector levels for specific groups of products could provide valuable insights into underlying factors affecting the impact of logistics on the competitiveness of companies. Starting from an examination of supply chain

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[4]Doing Business on the Information Highway
Canadian Electronic Commerce Committee

Distribution Service Industries Directorate, Industry Canada

requirements of customers, a more rigorous comparison would need to look at unit costs, customer service levels, applications of technologies and logistics practices.

This requires a quantitative comparison with foreign competitors for specific products showing:

- present supply chain cost and service performance, and
- real measures of customer service generated by Canadian supply chains, such as order cycle times, customer response time and quality.

It also requires a qualitative analysis of:

- the application of technologies in the supply chains
- the quality of logistics services available to Canadian and foreign supply chains, such as the availability and reliability of services and routes
- the impact of logistics practices on supply chain efficiency

Generalization of the conclusions from this information may offer opportunities to develop national strategies. This includes an impact analysis to determine what benefits would be derived for an industry sector from matching the performance of United States or other foreign supply chains in terms of increased market shares, profitability or jobs.

ASSESSMENT

Our assessment of Canadian logistics performance is positive. Canadian business appears to be managing inventories, as well as United States competitors. Productivity gains have occurred in the transportation sector. Canadian shippers are enjoying lower transportation prices. However, Canadian carriers are facing more foreign competition from new entrants into the market, in particular, the U.S. motor carriers. Similar pressures exist for Canadian shippers, as foreign distributors enter Canadian markets with more efficient supply chains.

Despite the downward pressures on transportation rates, Canadian carrier prices and service levels are still considered by some shippers to be higher than those available to them in the United States. As noted in the Issues section, there are opportunities to enhance the competitiveness of Canadian supply chains. Canada needs to

improve its application of electronic commerce, its domestic and particularly its international distribution channels, and the integrated management of inventories. Of particular importance is the need to obtain more detailed information on the relative competitiveness of Canadian and United States supply chains for products.

Canadian firms are adopting new supply chain management techniques to remain competitive. They are forming shipper-carrier strategic alliances, out-sourcing logistics services, rationalizing service suppliers and distribution facilities, and opening new distribution channels. While these are positive measures, it is not known how well some of them are being applied in comparison with foreign competitors. There is a need for a closer examination of the strengths, weaknesses, opportunities and threats affecting the competitiveness of our supply chains through the framework process.

STRATEGIES AND PUBLIC POLICIES

The objective of the Framework process is to develop strategies for improving the competitiveness of Canadian supply chains. A consensus on what factors have the greatest impact on the competitiveness of firms is the first step in this process. Central to these discussions is the need to identify practical initiatives that can be carried out by industry or in partnership with governments. There must be benefits for stakeholders to encourage them to jointly examine common supply chain management concerns.

Japan is an example of a country using supply chain strategies to enhance its industrial development and trade. Firms can manage inventories more effectively using new techniques, such as Just-in-time, zero inventory concepts. It has a service based trade strategy which allows firms to quickly identify market opportunities and use shorter order cycle times to respond to these market opportunities ahead of competitors.

Canada's product mix may require different strategies. One approach to developing a strategy could be to focus on the benefits of improving supply chain costs, service levels and/or simply using existing distribution channels more effectively. For low value-high logistics cost products, reduction of supply chain costs may generate increased market shares, profits and jobs. For others with lower logistics costs, advantages may lie in the improvement of customer service using just-in time and efficient customer response techniques. In cases, where no cost or service

advantages are achievable, we may need to focus on establishing better distribution channels to sell Canadian products. Each of these options for different products has a benefit and cost which must be weighed before initiatives are taken.

The role of government in supply chain management is threefold. On behalf of Canadians, it regulates commerce, finance, transportation and telecommunications; it develops transportation and communication infrastructures and it provides incentives to encourage growth of commerce through industrial and trade policies, programs and services. Governments often play a broker's role in bringing diverse interests together through means, such as the Logistics Framework process.

Some industry experts generally feel the proper role of government should be to create a positive business environment and a "level playing field for all Canadian business. "In the area of electronic commerce, it has been noted that the government can play a role in data security and the expansion of the use of electronic commerce throughout all levels of government. The government's lead by example in using electronic commerce within its operations and with the public would provide a stimulus to private sector decision-makers.

Government and industry strategies exist for improving productivity and marketing products. However, none exist for improving the distribution of goods beyond the development of transportation systems. The challenge is to determine what government and/or industry logistics initiatives have the greatest pay-off for the Canadian economy to warrant action.

CONSULTATION

The advice of business is essential for obtaining practical direction and commitment for improving the competitiveness of Canadian supply chains. This is a complex challenge for solutions, as professed by Demming, "to be successful one must optimize all requirements for the production, distribution and marketing of products, whose activities are controlled by many diverse interests". This paper has highlighted some of the issues. Industry Canada is interested in industry's views on what other issues exist, where priorities should be placed on critical issues and ways to develop strategies for improving the competitiveness of Canadian supply chains.

Distribution Service Industries Directorate, Industry Canada

BIBLIOGRAPHY

Bay Consulting Group.(1994) Structural Change in Canada's Wholesale Industries, <u>Industry Canada</u>

Canadian Business Telecommunications Alliance (1994), The Availability and cost of Telecommunications Services in Canada and the United States, <u>Industry Canada</u> (unpublished)

The Change Corp. (1994), "Doing Business on the Electronic Highway", <u>Canadian Electronic Commerce Committee</u>

Delaine V.D. (1994), Fourth Annual State of Logistics Report, <u>Cass Logistics Inc.</u>

Economic Analysis Branch (1994), Trucking Price Indices 1981-1992, <u>Transport Canada</u>

Economic Research Branch (1994), A Profile of Canadian Trade and Modal Shares, Transport Canada (Internal Study)

Henriksson, L.E., G. Chow and T.D. Heaver (1994) "Trends in Logistics: Implications for Carriers, Researchers and Policy Makers", <u>Canadian Transportation Research Forum</u>

Houlden B. (1994), "Supply chains improving..but the journey has just begun", The Retail Advisor 94-4, <u>Deloitte & Touche</u>

Jones A. (1994), "The Economic Cost of Logistics, Canada and the United States Compared", <u>Industry Canada</u> (unpublished)

Jones A. (1994), "The Distribution and Storage Sector: The Supply and Demand of Transportation Services", <u>Industry Canada</u> (unpublished)

Long S. (1994), "Logistics Responses in Customer Driven Markets", Stephen Long Consulting, <u>Industry Canada</u> (unpublished)

Tullpan G. (1994), Trucking Price Indices 19981-1992, TP10785E, Economic Analysis, <u>Transport Canada</u> (Internal Study)
Westier, R, (1994) "EDI in Transportation", <u>Canadian Transportation Research Forum</u> .

Byrne, P.M. (1993), "Canadian Logistics Performance Improving", <u>Transportation and Distribution</u>, August, 41-49.

Christopher, M. (1993) "Logistics and Competitive Strategy", <u>European Management Journal</u>, Vol.11, No.2, 258-261

Eckler, H.J., R.B. Lennox and M.E.Lynch (1993), "Canadian Logistics Benchmarks", <u>KPMG Management Consultants.</u>

Bowland, J.M. and F.R. Denham (1992), "Canadian Shippers Needs Assessment", <u>KPMG Management Consultants.</u>

Byrne, P.M. (1992), "Improve the Customer Service Cycle", <u>Transportation & Distribution</u>, June, pages 66-67.

Ernst & Young (1992), Responding to Cross Border Shopping, A study of the competitiveness of distribution channels in Canada, <u>The Public Policy Forum</u>

Johnson A., B. Allen and M. Crum (1992), "The State of EDI Usage in the Motor Carrier Industry", <u>Journal of Business Logistics</u>, Vol.13, No.2, 43-68.

Kearney, A.T. Inc. (1991), Achieving Customer Satisfaction Breakthroughs

Inglis, P. and T. Summers (1991), "The Customer is No.1", <u>A.T.Kearney Management Consultants.</u>

Denham, R., "Competitiveness, Logistics and Business Process Re-engineering", <u>Materials Management and Distribution</u>, 10-12.

Emmelhainz, M. A. (1990) <u>Electronic Data Interchange, A Total Management Guide</u>, New York, Van Nostrand Renhold.

Industry, Science and Technology Canada and Communications Canada (1990), "Technologies in Services".

Moody, F. (1990), "Silent Partners", <u>Canadian Transportation</u> February, 22-25.

Porter, M. and Monitor Company (1991), "Canada at the Crossroads-The Reality of a New Competitive Environment", <u>Harvard Business School and Monitor Company</u>.

Emmelhainz, M. A. (1988) "Strategic Issues of EDI Implementation," <u>Journal of Business Logistics</u>, Vol.9, No.2, 55-70.

2

DISCUSSION PAPER #1
not for quote or attribution

THE ECONOMIC COSTS OF LOGISTICS:

THE COST OF DISTRIBUTING & STORING
GOODS AND SERVICES

CANADA and the UNITED STATES COMPARED

**Prepared for the Distribution Service Industries Directorate
Distribution and Construction Industries Branch
Industry Canada**

by Alan Jones

[Views, comments and opinions contained herein are those of the author, and
do not represent those of either Industry Canada or the Government of Canada]

November 1994

EXECUTIVE SUMMARY

The **market for logistics services** is the result of a need on the part of business to physically distribute and store goods (and services). The costs associated with logistics constitute a significant element of business and economic activity of a nation.

This investigation appears to be the first empirical estimate of the costs of logistics in Canada and in a comparative context with the U.S.A.

CANADA

□ The largest element of logistics costs is the freight transportation component; in the broad context, own logistics costs incurred by firms is of equal magnitude; the highly volatile cost of carrying inventories (including their storage or warehousing) is substantially less;

□ broadly defined, logistics costs are estimated to have constituted 6.9% of GDP on average in the period 1981-1992; although cyclical, this share was unchanged in 1992 compared to 1981;

□ narrowly defined to include only transportation and inventory costs, logistics costs declined as a share of GDP

COMPONENTS

► **freight transportation costs** rose 3% annually over the period, thus accounting for a growing share of GDP; on average the transportation bill totalled $14.0 billion;

► **inventory carrying costs**, while highly interest rate sensitive, averaged $8.7 billion in the period 1981-1992 (including storage & warehousing); the trend was one of decreasing costs over time;

► **own logistics costs**, which are estimated at $16 billion in 1992, rose by 3.9% annually on average, thus accounting for a rising share of economic activity;

U.S.A.

❑ *although the same methodology was applied to the U.S. situation, data constrained a complete investigation;*

❑ *the U.S. situation parallels the situation in Canada; in the period 1981-1992, logistics costs as a percent of GDP declined;*

➤ *however transportation costs grew at a higher rate than in Canada;*

➤ *declining logistics costs were found to be almost exclusively due to the decline in real interest rates and low price inflation.*

IN CONCLUSION

→ *WHILE THE COSTS OF DISTRIBUTING AND STORING GOODS IN CANADA AND THE U.S. ROSE OVER THE PERIOD, THESE COSTS HAVE NOT APPRECIATED AS A SHARE OF TOTAL ECONOMIC ACTIVITY; IN FACT, IN TERMS OF A NARROW DEFINITION, INCLUDING ONLY FREIGHT TRANSPORTATION AND INVENTORY COSTS, THIS SHARE DECLINED;*

→ *THIS WAS THE RESULT PREDOMINANTLY OF DECLINING INVENTORY CARRYING COSTS WHICH IN TURN ARE A FUNCTION OF INTEREST RATES AND INFLATION;*

→ *IT WAS DETERMINED THAT IN BOTH CANADA AND THE U.S. REAL FREIGHT TRANSPORTATION COSTS ROSE AS A SHARE OF TOTAL ECONOMIC ACTIVITY.*

METHODOLOGY[1]

The present research constitutes an attempt to estimate the 'economic' costs of logistics to the Canadian economy. As well, it draws comparisons with the U.S. experience. It reports estimates of the proportion of total economic activity that logistics functions represent and the dynamic associated with this cost, especially in relation to the business cycle.

Following, I employ the concept of alternative or opportunity cost to measure net economic costs. The economic cost measure will diverge from, and should not be expected to be the same as an accounting cost measure. That is, the economic cost of logistics and in particular, the production of transportation services is the *value foregone of employing scarce resources in transportation and not in an alternative use*. This means that the measure of cost used to assess each **transportation mode** in turn is the value-added or gross domestic product of transporting freight in each industry. Value added is measured at factor cost (market prices in the U.S.) and includes the return to the factors of production, both labour (i.e. wages, salaries and supplementary benefits) and capital (and indirect taxes in the U.S.).

The economic cost of holding **inventories** is valued as the alternative use of using a dollar's worth of capital. A user cost is first calculated to arrive at the cost of holding inventories.

The final magnitude to be valuated are the costs associated with 'own **logistics** activities'. Specifically two activities make up the bulk of own logistics costs. These are private trucking services and materials handling (e.g. wrapping, crating and other preparations for distribution). Unlike the two previous measures, the own costs of logistics are measured in gross terms at the producer's price of the goods used. Measures of these goods are taken from the input matrices produced by the Input-Output Division of Statistics Canada.

The sum of these three costs are then used as an estimate of the total costs of logistics.

An explanatory note seems appropriate in regard to the concept being employed. Opportunity cost should not be regarded as a negative consequence of economic activity. That is, even though there is a resource use 'cost' of undertaking or providing transportation services, for example, there is at the same time a benefit; employment (and the earnings of workers) being the most obvious. Consequently, the opportunity cost of providing transportation services and holding inventories provides a simultaneous economic 'benefit'.

This paper is organized in two sections. All calculations and the raw data are contained in Appendix I. The procedure outlined in the Appendix I arrives at the value for each element of the cost of logistics in Canada (adjusted for inflation). What follows is a summary based on Appendix I and presented, for the most part, in graphical format, including share and growth calculations.

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[1] A debate has been ongoing in the U.S. concerning the correct methodology to be applied to this issue. Robert V. Delaney of Cass Logistics has been the centre of this controversy and supports the notion that logistics costs have declined since the deregulation of the U.S. economy. Dr. Michael Evans with the Coalition for Sound General Freight Trucking has been a major critic of the Delaney approach. In 1988 the U.S. Department of Transportation reviewed this debate, utilizing third party opinions solicited from Dr. F. J. Beier of the University of Minnesota and Dr. G. B. Stone from Northwestern University.

INTRODUCTION

That the cost of moving goods, materials and information through the supply channels of an economy is directly related to supply and demand conditions which prevail at any given point in time seems a reasonable hypothesis. In an economic sense, we would expect these costs, that is the costs of logistics, to be positively correlated with the business cycle. All else being equal, economic prosperity is positively correlated with a rise in the demand for goods and hence, a proportionate rise in the costs of getting those goods to the end-user. Conversely, in recessionary periods, logistics costs should decline in proportion to the decline in demand. In the long run, a rising trend in the aggregate costs of logistics may be expected.

Table (i) presents the industrial output of the Transportation and Storage sectors for Canada and the U.S. Transportation costs are the largest element of the cost of logistics and the values presented illustrate the cyclical nature of output.

TABLE (i)
TRANSPORTATION & STORAGE SECTOR
GROSS DOMESTIC PRODUCT ($M)

	Canada $1986	U.S.A. $1987	Canada\U.S.A. Ratio
1991	21.3	173.0	0.12
1982	16.2	115.5	0.14
1981	17.1	116.5	0.15
1977	15.4	117.2	0.13
Average 1977-1981	2.6	-0.2	
Annual 1977-1991 Growth %	2.3	2.8	

Source: Statistics Canada 51-001 and Survey of Current Business, Nov. 1993

In 1991, the output of the Transportation and Warehousing sector in the U.S. was $173 billion ($1987), and over the period 1977-1991, output grew at an average annual rate of 2.8%. The result was relatively stable share of total economic activity in the

U.S. economy. The Transportation and Warehousing sector constituted 3.3% of GDP in 1977 and 3.6% in 1991.

In Canada, much the same story was witnessed. GDP in inflation adjusted terms, grew at an average annual rate of 2.3% in the 1977-1991 period, slightly below that in the U.S. In 1991, output was just over $21 billion after undergoing a slight decline during the 1981-1982 recession. As a share of GDP, the Transportation and Storage sector's share declined marginally from 4.4% in 1977 to 4.3% of GDP in 1991.

Noteworthy in the comparison offered by Table (i) is that the size of the Transportation and Storage Industry in Canada relative to the U.S. is slightly smaller in 1991 than in 1977.

The aggregate cost of moving goods and services however, need not be fixed, neither in terms of a rising trend nor in proportion to demand. Efficiency gains made by firms may translate into lower costs of transportation, and improved inventory storage and handling procedures in conjunction with better organizational and management techniques may mean that lower levels of inventories need be stocked and financed. If however, the real cost of moving goods and services in the economy is rising faster than economic activity on the whole, that is the logistics share of aggregate output is increasing, then productivity and efficiency gains <u>may</u> be negative.

Further, the costs of supplying goods to the marketplace may be influenced by factors outside the direct control of a firm. In particular, the regulation of various modes of transportation may be cited as well as real interest rates. In Canada, there has been a growing trend toward deregulation of the transportation sector and the regulatory framework contained in the federal transportation legislation[2] enacted in 1987 has now been in place for five years. In the U.S. deregulation has been a factor since the early 1980s. Another factor that may raise the cost of logistics is an inadequate infrastructure, one that has deteriorated or that has experienced less than optimal investment. On the other hand, the behaviour of real interest rates has recently had a positive effect on costs, a contrast to the state of affairs in the early 1980s.

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[2]   The National Transportation Act, the Motor Vehicle Transport Act and the Shipping Conferences Exemption Act, all from 1987, constitute Canada's new transportation laws. These new laws are intended to promote a more dynamic and competitive environment for transportation services through a greater reliance on competition and market forces. To achieve this objective, the laws establish a simpler regulatory system to reduce economic regulation.

PART I

<div style="text-align: center;">

TRANSPORTATION COSTS

</div>

INTRODUCTION

It is generally conceded that since the domestic market in Canada is concentrated in an east-west corridor, the total transportation bill associated with the movement of goods in Canada is relatively high. In addition, the Canadian transportation sector has operated in a regulated environment in the past thus adding to the high cost distribution base, and even though partial deregulation has been in effect for more than six years, it may be still too early to expect that this sector's share of the total logistics costs have declined in relation to total economic activity. Nevertheless, it is still of interest, both in an absolute and comparative sense to estimate the total cost of moving goods (and services) in the Canadian economy and appraise the cost saving of deregulation, if any.

A Cautionary Note:

The following sectoral descriptions pertain to the movement of freight. Consequently, the reader should bear in mind that the magnitudes reported may or may not be equal to the total value added of an industry. Adjustments may have been required to remove the costs associated with passenger transportation.

A-   Truck Transportation

Changes to the regulatory environment in the 1980s made entry into extra-provincial trucking less difficult. Yet increased competition did not put a cap on rate increases until economic recession interceded. While trucking costs in Canada represent a relatively small share of economic activity, Figure 1 suggests that deregulation in the trucking sector may be beginning to have a positive impact on the economy.
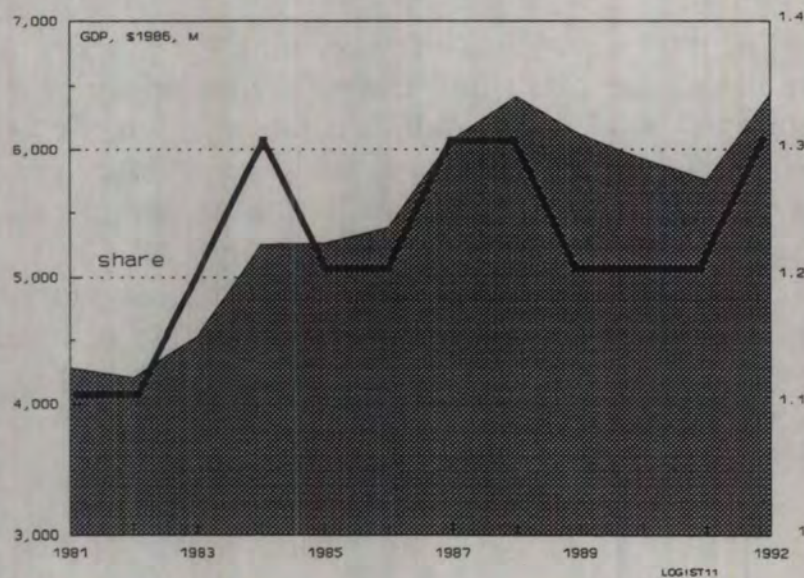
Figure 1
CANADA: Economic Cost of For-Hire Truck Transport

The largest share of the freight transportation bill in both Canada and the U.S. is represented by the trucking component[3]. The Canadian for-hire Truck Transport industry grew at an average annual rate of 3.7% in the

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[3]   These data represent the for-hire trucking element of the total trucking universe. That is trucking services performed 'in-house' is not captured.

1981-1992 period, <u>faster</u> than the Canadian economy as a whole. Consequently truck transportation's share of GDP advanced over the period.

In the post-1982 recessionary period, the trucking industry's share of GDP has been relatively stable (Table A-12). As the Canadian economy began to soften in 1990 and 1991, this figure changed little. In 1992, the trucking industry share of GDP in Canada was 1.2% and in the U.S., it is estimated that trucking constitutes 1.5% of economic activity.
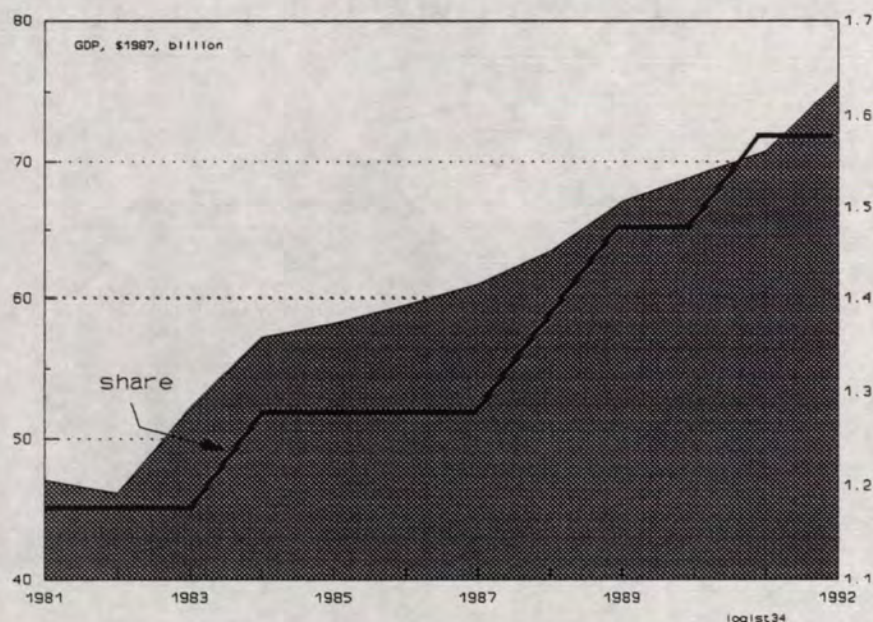
Figure 2
U.S.A.: Economic Cost of For-Hire Truck Transport

In 1992, the GDP of the trucking industry in the U.S. was almost 12 times that of trucking in Canada and over the period 1981-1992 grew faster than in Canada.

B-   Railway Transportation

The Rail sector in Canada supports two major competitors with a
minor supporting cast at the fringe. According to the latest National
Transportation Agency Review, railways in Canada benefited from reform
with gains in operating efficiency, reduced costs and better services.
Shippers using the rail mode have experienced some upward movement in
rates, especially if they did not negotiate confidential contracts.

Figure 3
CANADA: Economic Cost of Rail Freight Transport
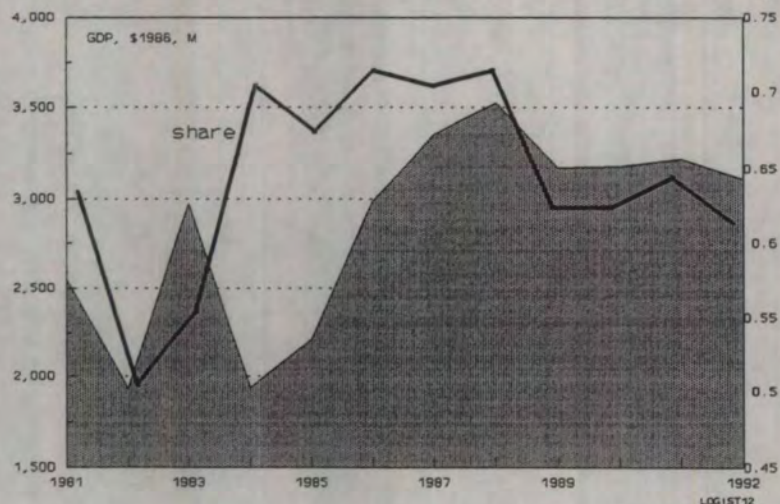
Rail freight GDP in Canada has been on the increase since 1982. In
the period 1981-1992, the rail freight industry's contribution to GDP rose at
an average annual rate of 0.4%, lower than aggregate economic growth
(Table A-16).

Aggregate rail freight costs in the U.S. are approximately eight times that in Canada and have grown at an average rate of 2.7% annually in the 1981-1992 period.

As a share of GDP, costs in Canada have fluctuated in the range of 0.5% (1982) to 0.7% (1986-88), while in the U.S. the share of rail freight in GDP has changed little.

Figure 4
U.S.A.: Economic Cost of Rail Freight Transport
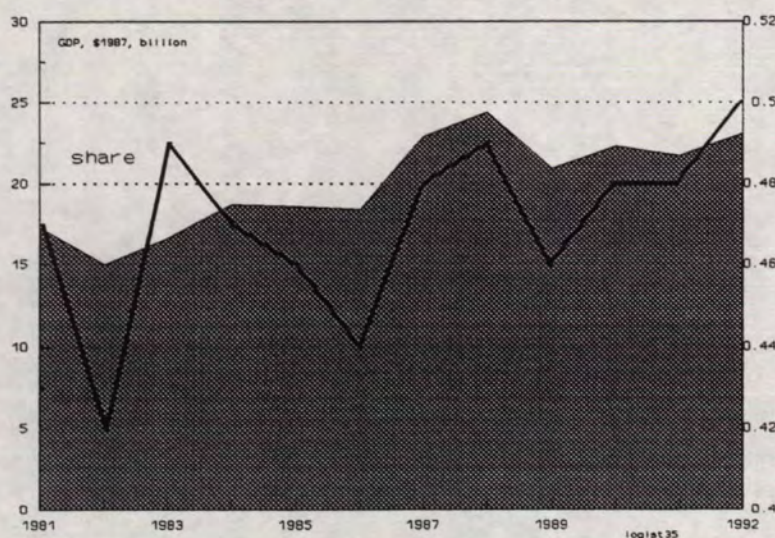
C - Airline Transportation

The **Canadian airline industry** evolved into two large carrier groups in the 1980s. The development of networks, centred on hubs located in major centres, has expanded air services. Current events suggest that further consolidation in the industry might be expected in the near future.

Figure 5
Canada: Economic Costs of Air Transport
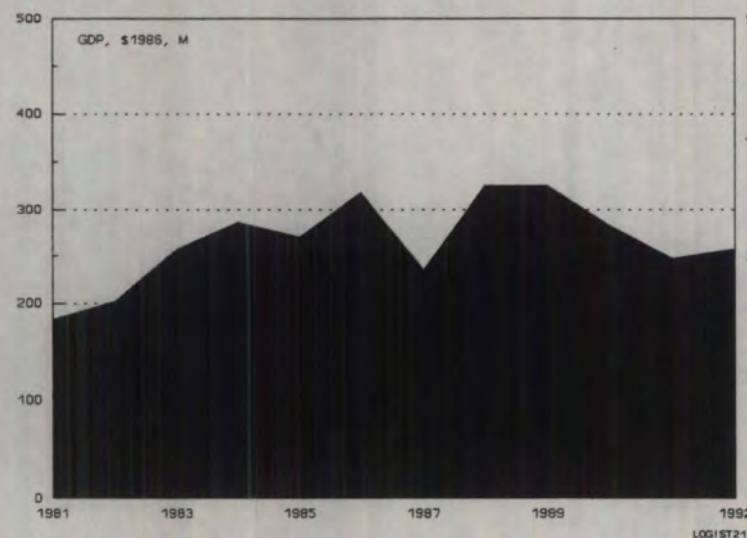
Shippers have experienced modest price increases of late and air cargo revenue constitutes a small but rising share of the total revenues of Canadian and U.S. carriers (Tables A-14 and A-15 presents the freight share of airline GDP in Canada and the U.S.).

The movement of goods (and services) in Canada by air, in terms of the share of GDP that it contributes and in comparison to the U.S., is small.

Nevertheless air freight GDP has grown substantially (8.0%) in the 1981-1992 period.

In 1992, air freight GDP in the U.S. was over twenty times larger than air carrier freight GDP in Canada. Significant growth has been experienced by the sector, especially in the latter half of the 1980s (partly due to the addition of Federal Express to the survey). Over the period 1981-1992, 12.6% annual growth was recorded on average.

D-   Pipeline Transport

The Pipeline transport industry in Canada consists of four or five relatively large regulated firms with a fringe of smaller players. The output of the industry is roughly comparable in magnitude to the Canadian rail industry. The Pipeline industry has become increasingly important as energy users increasingly choose natural gas and pipeline oil and gas transport substitutes for traditional means of energy distribution, predominantly truck, rail and water transport.

Figure 6
CANADA: Economic Cost of Pipeline Transport
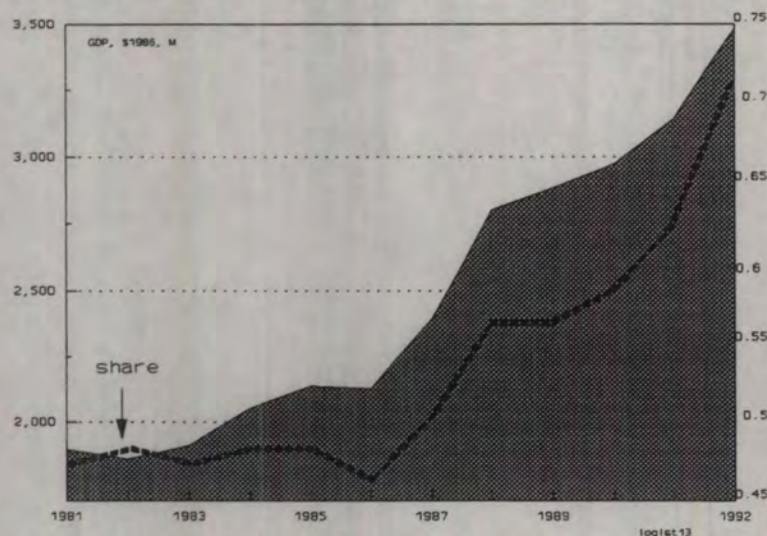
Unlike either the trucking or rail industry, the pipeline transportation industry in Canada experienced buoyant year-to-year growth in the 1980s. In the period 1981-1992, the pipeline transport industry expanded at an

average annual rate of 5.5% while the economy moved ahead by 2.2%. This resulted in a real gain in the GDP share of the industry (Table A-18).

The U.S. industry stands in contrast. The Pipeline Transport industry (which includes only the oil pipelines) declined sharply over the decade. In 1981, the U.S. industry was three times larger than the Canadian industry in terms of GDP contribution, but by 1992 this had fallen to just over 1.6 times the size.

Figure 7
U.S.A.: Economic Cost of Pipeline Transport
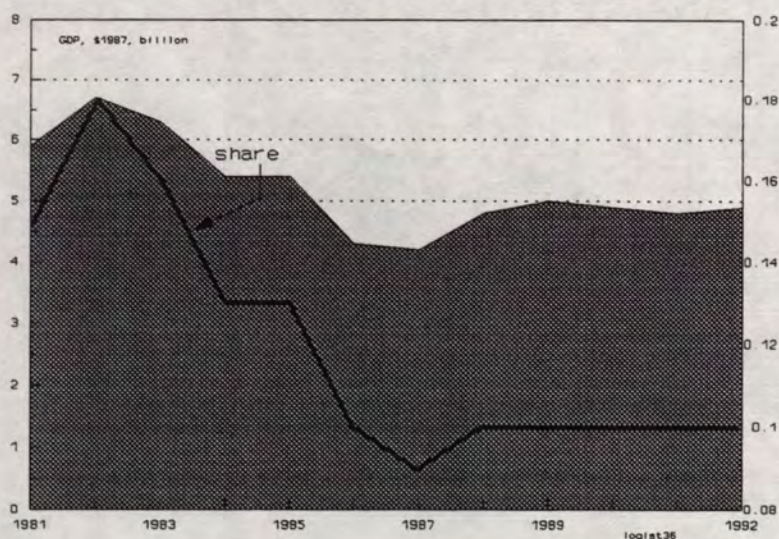
E-   Other Costs

Water transportation, other miscellaneous transportation costs and highway and bridge maintenance associated with moving goods and services in the Canadian and U.S. economies represent the final elements to be valuated for the transportation component of the logistics systems of these two economies. The contribution of these three industries are illustrated in Figure 8 below (Tables a-19 and A-20).

Figure 8
CANADA: Economic Cost of Freight Transport
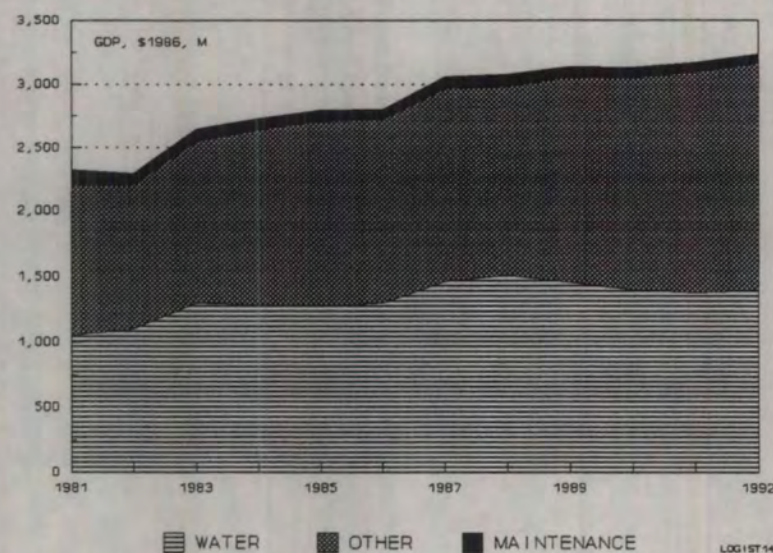
i)   Other Transportation Services

This sector represents the contribution of freight forwarding and other incidental services. Over the 1981-1992 period, the Other Transport Services industry grew at an average annual rate of 3.9%, significantly faster than the Canadian economy as a whole. In 1992 this sector contributed 0.35% of Canada's GDP or approximately $1.7 billion.

In the U.S., Other Transportation Services has grown substantially as well. Over the 1981-1992 period 5.7% average annual growth was recorded.

ii)   Water Transportation

Water transportation in Canada plays a relatively minor role in the economy and is small relative to the U.S. Water-borne commerce in the U.S. is well developed along a number of inland water systems as well as internationally.

In 1992 the water transportation industry contributed $1.1 billion ($1986) or 0.28% of the GDP of Canada (Table A-19). The Water Transportation industry has been growing more slowly than the economy as a whole and stands at a level below that of 1982.

Water freight transportation in the U.S. also declined over the 1981-1992 period, falling from $9.7 billion in 1981 to an estimated $8.3 billion of GDP in 1992.

iii)   Highway and Bridge Maintenance

Expenditures and the GDP contribution from the maintenance of Canada's highways, bridges and tunnels, including snow clearing and pothole filling, declined over the last decade. The general magnitude of this sector suggests a minimal role in the total logistics system costs.

Nevertheless, the maintenance and repair of the transportation infrastructure has been argued to have a major significance for the efficiency and productivity of transportation.

TRANSPORTATION COSTS: SUMMARY

CANADA

> ▷ in absolute terms, the real cost of moving goods (and services) in Canada is estimated in excess of $16 billion ($1986) at its pre-recessionary peak in 1988;

> ▷ after declining for two periods due to recession, the 1992 estimate is again in excess of $16 billion[4];

Figure 9
CANADA: Economic Cost of Freight Transportation

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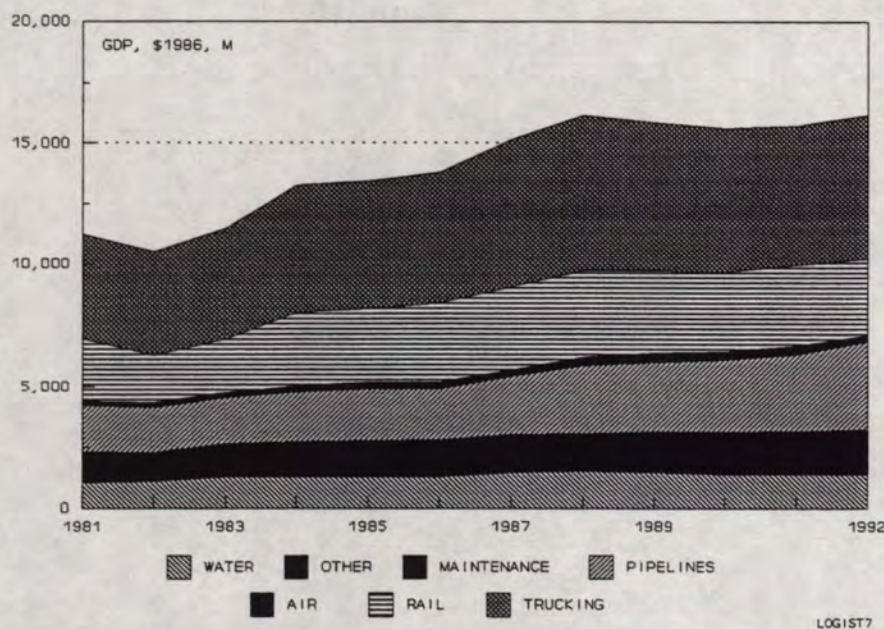
[4]   Not included in the transportation cost estimate are the private trucking fleet costs and the transportation of goods by bus. In 1990, private trucking fleet revenues were estimated by Statistics Canada to be approximately $2.3 billion, while the revenues of intercity bus operators consisted of a $89 million component earned from transporting goods.

▷ freight transportation costs grew 3.0% annually from $11.7 billion in 1981, to $16.2 billion in 1992 - compared to an average annual growth rate of 2.2% for the Canadian economy as a whole;

▷ trucking, which represents the largest single component of transportation costs, contributed approximately 40% of the total in 1992;

- Rail costs are the second largest component followed by pipeline transport;

- the rail, air, water and maintenance industries recorded growth levels lower than that of the economy;

Figure 10

FREIGHT TRANSPORTATION SHARE OF REAL
GROSS DOMESTIC PRODUCT
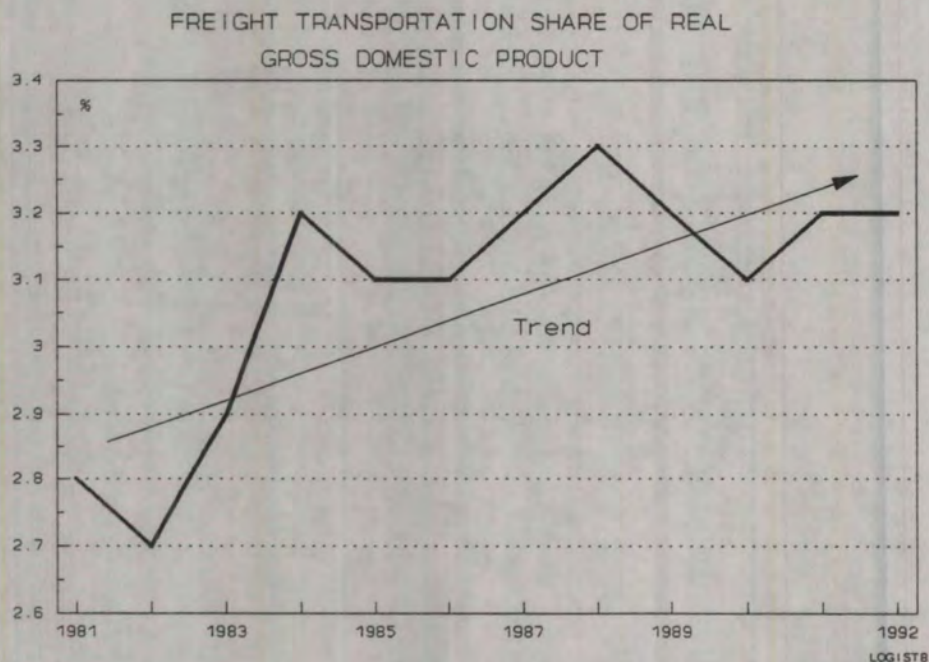
▷ Transportation costs as a share of GDP in Canada experienced low and stable growth over the last decade;

- in 1982, a recessionary trough, transportation constituted 2.7% of GDP - over the next seven years transportation's share rose gradually to 3.3% as the business cycle began to peak in 1988;

- in 1992, freight transportation represented 3.2% of economic activity in Canada.

In relation to aggregate economic activity, then, the transportation bill for moving goods (and services) in Canada has risen, in absolute terms and as a share of total economic activity.[5]

U.S.A

▷ the aggregate transportation costs (inflation adjusted) of moving goods (and services) in the U.S. was approximately $138 billion in 1992, up 4% annually on average, since 1981 (Figure 8 presents the components of freight costs in the U.S. graphically);

▷ freight transportation's share of total economic activity rose from 2.4% in 1981 to 2.8% in 1992, a 17% change over the period.

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[5] The relatively high rate of growth of the pipeline sector begs the question as to whether the real increase in transportation services costs is significantly influenced by pipeline transport. The total cost of transportation services net of pipelines was $9.8 billion in 1981 rising to $12.7 billion in 1992. This was equivalent to an average annual growth of 2.3% annually, marginally higher than the economy as a whole (2.2%).

Figure 11
U.S.A.: Economic Cost of Freight Transportation
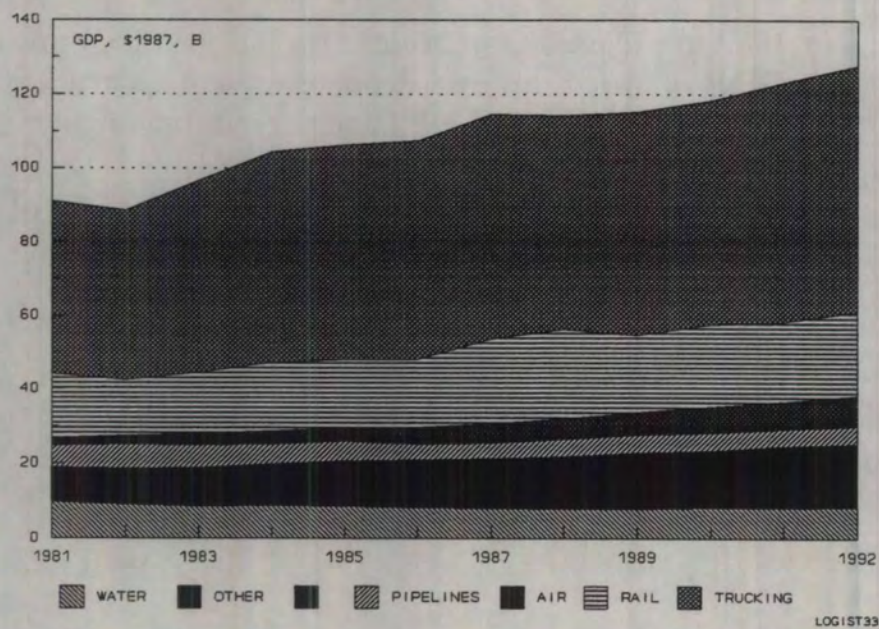
PART II

INVENTORY & STORAGE COSTS

INTRODUCTION

In the 1980s, the business cycle completed one full movement through time. After reaching a peak in 1981 and followed by a trough in 1982, a further economic high was achieved in 1989. Within the short span of a decade, we have the opportunity to investigate the temporal behaviour of the various elements of logistics in the economy.

Figure 12
CANADA: GROSS DOMESTIC PRODUCT AT FACTOR COST
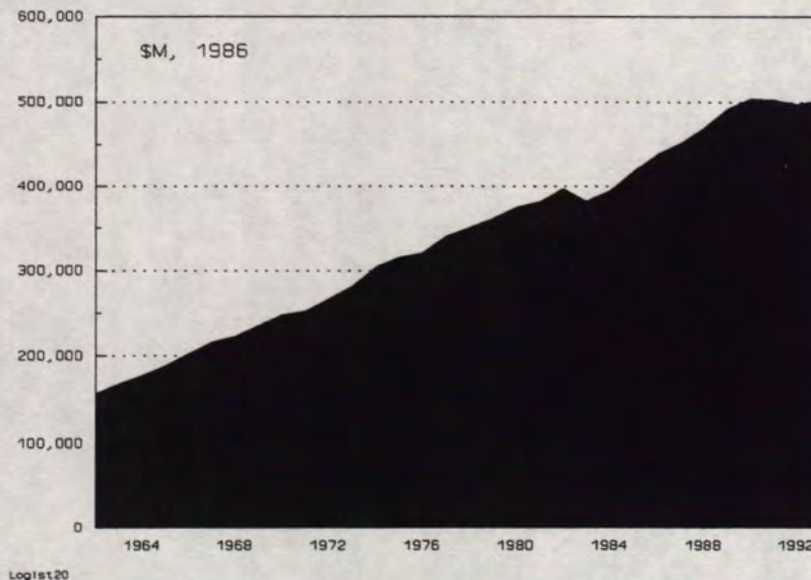
The Canadian economy, measured by real gross domestic product (GDP at factor cost), grew by 2.9% annually on average, between the pre-recessionary peak in 1981 and 1989. In 1990 aggregate economic activity declined. However over the past two years, growth has returned.

The Retail trade sector provided much of the impetus in the 1980s as sales grew by 6.4% per year on average (unadjusted for inflation). Only in 1991 did retail sales decline. Manufacturing on the other hand did not fair quite as well. The value of manufacturing shipments decreased in 1990 and 1991 after consecutive yearly increases from 1982. Over the 1981-1989 period, growth of 3.7% was experienced.

Profitability of commercial industries in Canada was mixed as a result of this cycle. After the 1982 recession, profits per unit of output in Canada grew steadily through 1988. Commercial sector profits were still relatively high in 1989 (14.7%) but receded to 8.5% in 1991, well below the 1982 rate of 9.1%.

INVENTORY MANAGEMENT

Figure 13 presents the level of Canadian **non-farm business inventory stocks** in the 1980s (adjusted for inflation; see Appendix Table A-2 for values in both current and constant dollars; Table A-3 for the U.S.).

Figure 13
CANADA: Value of Non-Farm Inventories
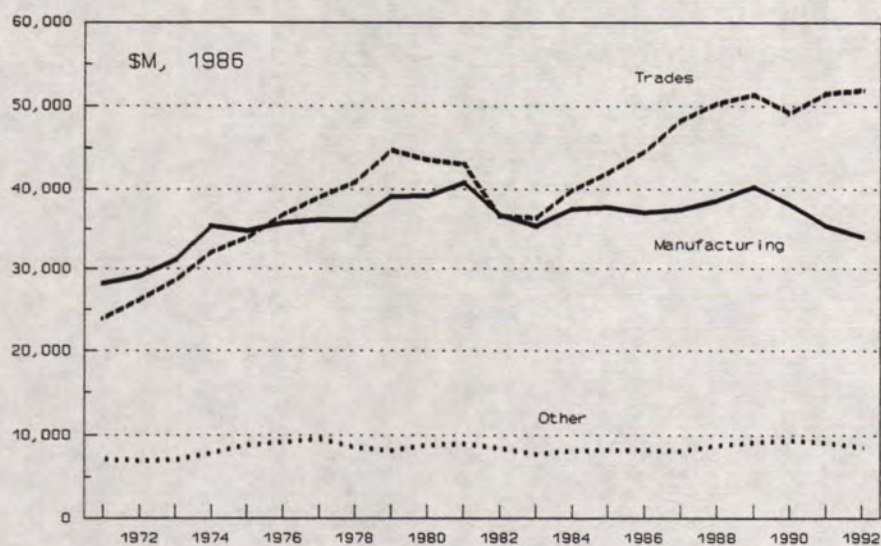
logist1

A major distinguishing feature of Figure 13 is that inventories held by Canadian manufacturers have been trendless over the last decade. The level of manufacturing inventories in 1992 was below that at the beginning of the 1980s.

A second feature of note is the upward trend from 1983 onward in the stock of inventories held by the Trades sector. Consequently the mix of inventories held in the economy appears to have changed over the 1981-92

period. Manufacturing
inventories declined from
43.4% of total inventories
in 1981 to 35.7% in 1992
(Figure 14).

In the aggregate
there was a slight rising
trend in the real value of
inventory holdings in
Canada over the 1981 to
1989 period.

Figure 14
CANADA: Distribution of Inventory Holding
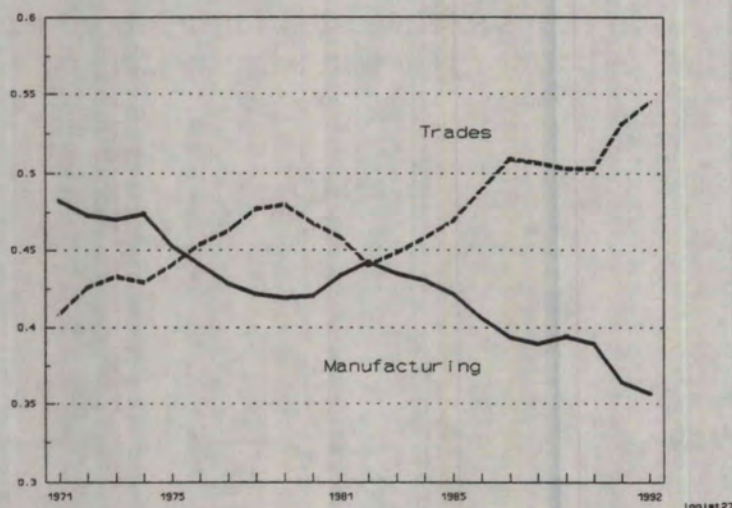
The Cost of Holding Inventories

The real cost of holding inventory is a function of a number of variables: the overall cost of finance to a firm, capital gains, the real interest rate and the corporate income tax rate (the methodology and calculations are shown in Appendix 1).

Figure 15
CANADA: Cost of Holding Inventories

Figures 15 and 16 presents the inflation adjusted costs, or real opportunity costs of holding inventories for firms in Canada and the U.S. (Tables A-5 and A-5a).

The real cost of holding inventories at the interest rate peak of 1990 in Canada was much reduced compared to that of the previous recession.

As interest rates increased and then declined in the 1980s so too did inventory costs (over the decade, the stock of inventories rose).

Figure 16
U.S.A.: Cost of Holding Inventories
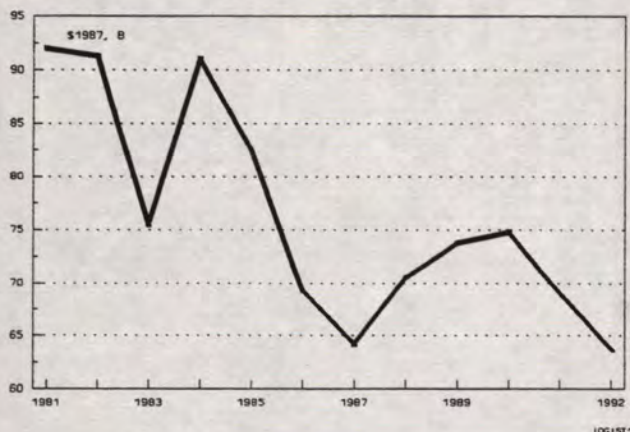
In the U.S., the post 1981 recessionary period experienced high inventory holding costs. As in Canada, the costs of holding inventories was not as onerous during the recession of the 1990s as compared to the recession of the 1980s.

Inventory Storage Costs

Inventory storage costs in Canada are estimated as the contribution to gross domestic product of the Storage and Warehousing Industry. The Storage and Warehousing industry in Canada includes establishments that operate refrigerated warehousing including frozen food storage, refrigerated services and fur storage, and other establishments engaged in bonded warehousing and general merchandise warehousing. It also includes the operation of elevators for the storage of grain.[6].

The cost of Storage and Warehousing services totalled $714 million in 1991, up from $672 million in 1981. The industry has not kept pace with the growth of the Canadian economy over the 1981-91 period (see Appendix Table A-9).

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[6]   Some storage of finished goods and work in progress will undoubtedly take place at the manufacturing facility. I do not attempt to capture the costs associated with this element.

THE TOTAL COSTS OF HOLDING INVENTORY

Figure 17 presents the total real economic costs of holding inventories for Canada and the U.S.A. as a share of GDP.

Total inventory holding costs are comprised of the opportunity cost or user cost of inventories (those values represented in Figures 15 and 16), plus the storage costs associated with holding inventories (the values from Table A-6).

Figure 17
CANADA & the U.S.A.:
Total Costs of Holding Inventories:

In both cases, the data suggests that the burden imposed by inventory carrying costs have declined as a share of economic activity over time.

PART III

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OWN ACCOUNT LOGISTICS COSTS

</div>

INTRODUCTION

Part I presented the economic costs of logistics purchased in the marketplace for transportation services on a 'for-hire' basis. Part II addressed inventory holding costs.

In addition, firms spend a significant amount of time and resources preparing goods for distribution and physically transporting goods to markets using 'in-house' resources.

Firms have intermediate goods requirements for the movement of product within the manufacturing facility, other materials handling functions and to the point of sale, with private fleets of trucks. Such purchases include boxes, wrapping papers and pallets and of course vehicles, parts and repair expenditures.

Figure 18 presents annual estimates of own account logistics costs.

It is estimated that own logistics costs totalled approximately $16 billion ($1986) in 1992 and in the period 1981-1992 averaged approximately $12 billion annually.

In the period 1981-1992 own account costs are estimated to have grown at an average annual rate of 3.9% (the economy grew by 2.2% on average annually).

Transportation related costs, those current costs incurred for vehicle parts and maintenance, fuel, lease and rental etc. are estimated at

Figure 18
CANADA: OWN ACCOUNT LOGISTICS COSTS
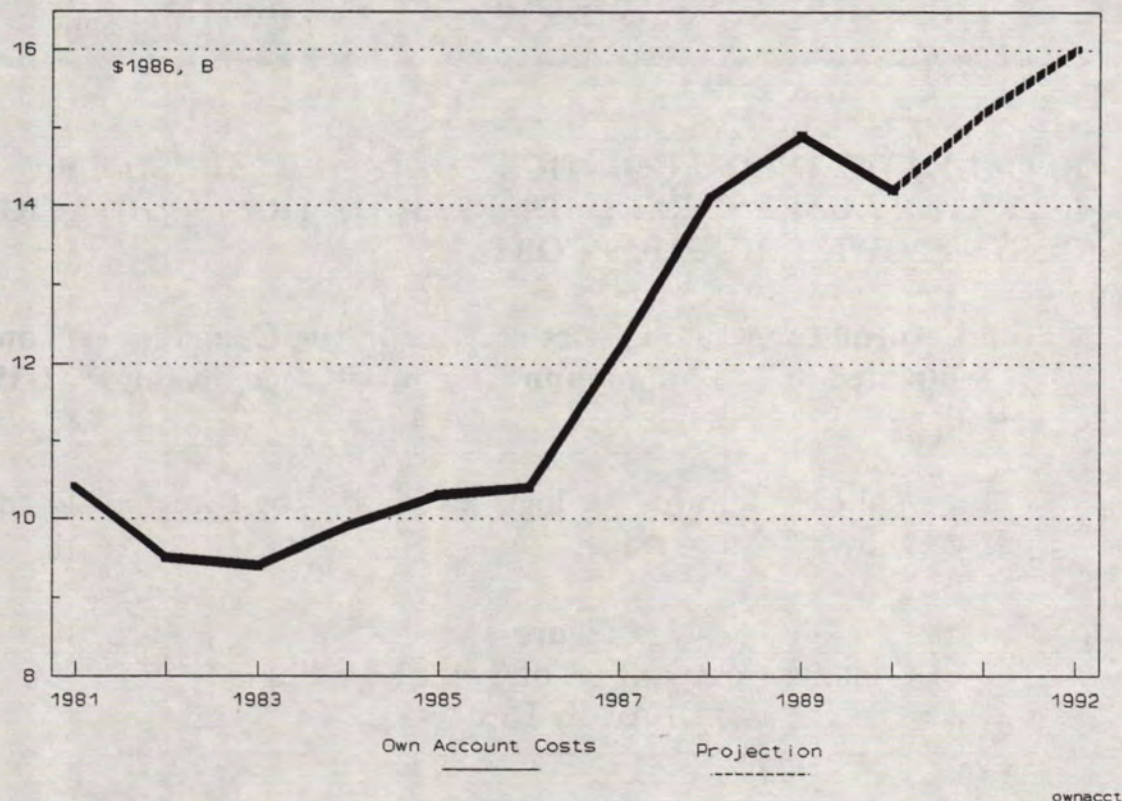
approximately $8.3 billion in 1992. These costs are estimated to have grown by 1.9% on average annually in the 1981-1992 period.

Other logistics costs incurred in the movement and distribution of goods are estimated at approximately $7.7 billion in 1992. The costs associated with preparation and packaging are estimated to have grown by 6.9% annually, on average, over the 1981-1992 period.

PART IV

<div style="border:1px solid;">
THE TOTAL COST OF LOGISTICS IN CANADA
</div>

BROADLY DEFINED, LOGISTICS COSTS ARE THE SUM OF INVENTORY CARRYING COSTS, FREIGHT TRANSPORTATION COSTS & OWN LOGISTICS COSTS

⫫ Total expenditures on logistics services in the Canadian economy are estimated at $35 billion annually, on average, in the 1981-1992 period;

- annual expenditures for logistics services by firms in Canada grew by 2% on average;

Figure 19
Canada: Components of Total Logistics Costs
Broadly Defined
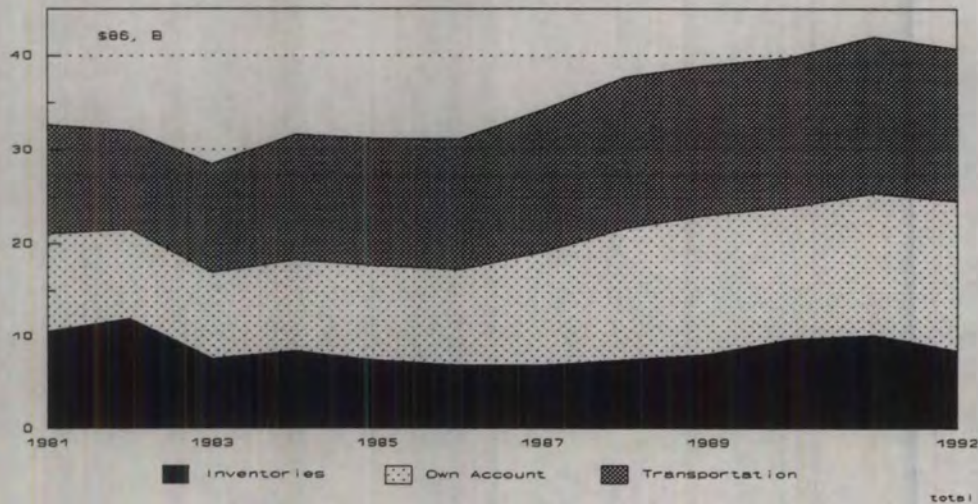
Figure 20
Canada: Transportation Share in
Total Economic Activity
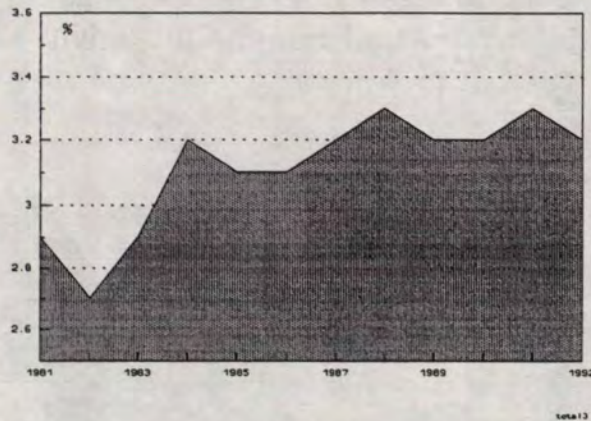
╫ logistics services
expenditures constituted 6.9% of
economic activity on average
between 1981 and 1992;

- freight transportation constituted
the largest component

Figure 21
Canada: Inventory Costs Share
in Total Economic Activity
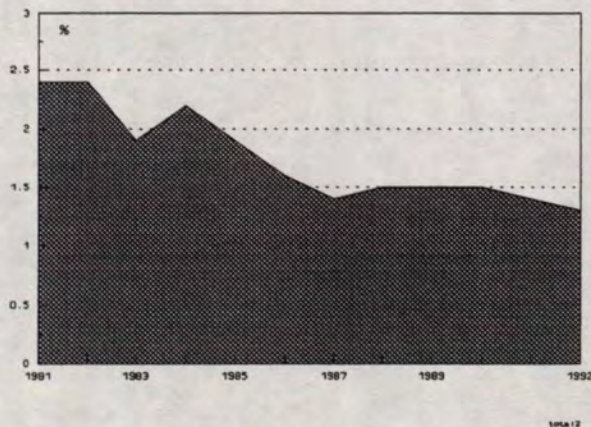
╫ logistics services as a
share of GDP was unchanged
between 1981 and 1992;

Figure 22
Canada: Own Logistics Costs as a
Share of Total Economic Activity
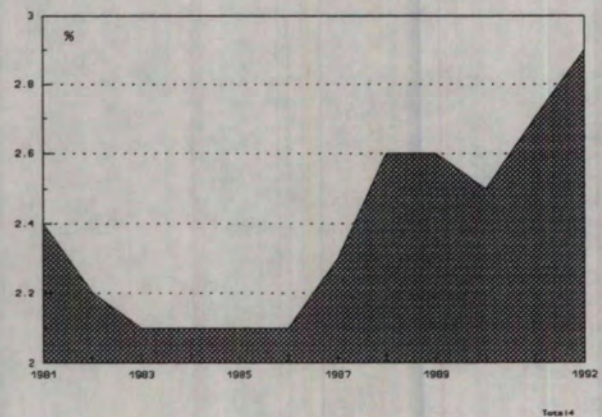
TO FACILITATE COMPARISON WITH THE U.S.A., LOGISTICS COSTS ARE NARROWLY DEFINED AS THE SUM OF FREIGHT TRANSPORTATION COSTS & INVENTORY CARRYING COSTS:

‖ the share of logistics in economic activity declined over the period 1981-1992 in both Canada and the U.S.;

CANADA

Figure 23
CANADA - Components of Logistics Costs

logistics costs rose from $22.3 billion in 1981 to approximately $25 billion in 1992, but declined from 5.1% of GDP in 1981 to 4.8% in 1991 and 4.4% in 1992;

the share of the transportation component rose modestly while the inventory component declined;
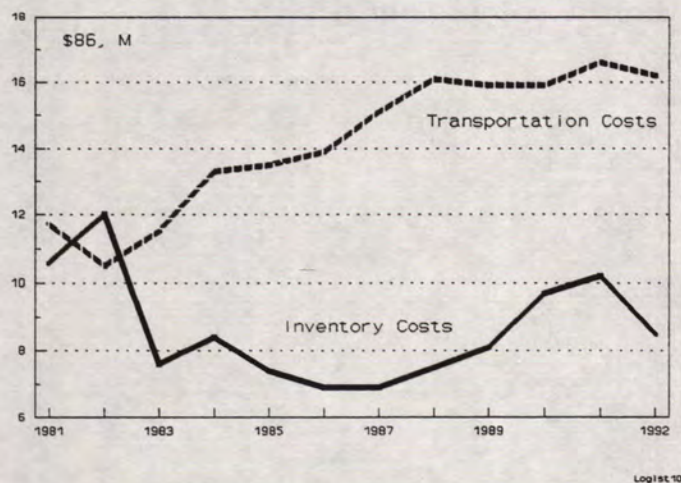
U.S.A.

- the estimated cost of logistics rose from approximately $167 billion in 1981 to $201 billion in 1992; the share of logistics costs in GDP declined from 4.8% in 1981 to 4.1% in 1992;

- as in Canada, the share of the transportation component rose modestly while the inventory component declined;

**Figure 24
U.S.A. - Components of Logistics Costs**
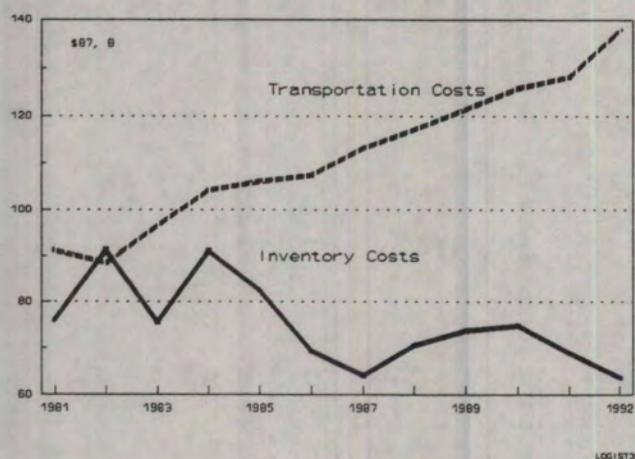
APPENDIX I
LOGISTICS COSTS
IN CANADA & THE U.S.

COSTS CALCULATIONS: COMPONENTS
OF LOGISTICS MARKETS IN CANADA & THE U.S.

(I)   SUMMARY: TOTAL LOGISTICS COSTS

II)   INVENTORY COSTS

(a) Carrying Costs
(b) Storage Costs

III) OWN ACCOUNT LOGISTICS

IV) TRANSPORTATION COSTS

(i)   For-Hire Trucking
(ii)   Railway Services
(iii) Pipeline Transport
(iv) Water Transport
(v)   Air Transport
(vi) Other Transport Services
(vii) Maintenance

(I)   TOTAL ECONOMIC COSTS OF LOGISTICS

A net economic cost or opportunity cost approach is used to assess the costs of transporting and storing goods (and services) in Canada and the U.S.[7]

THE TOTAL COSTS OF LOGISTICS (Table A-1)

BROADLY DEFINED

⊹ Logistics costs in Canada, broadly defined as the sum of total inventory carrying costs, freight transportation costs and own logistics costs of firms in the economy are estimated at $40.7 billion ($1986) in 1992 or 7.3% of GDP; this share was unchanged from 1981;

NARROWLY DEFINED:

⊹ Logistics costs in Canada, narrowly defined as the sum of inventory carrying costs and freight transportation costs, averaged $23 billion ($1986) annually between 1981 and 1992;

in the U.S., the average annual costs of logistics was approximately $US 187 billion ($1987);

⊹ logistics costs in Canada as share of GDP have consistently been higher than in the U.S.;

---

[7] The Canadian transportation industry data is gross domestic product measured at factor cost. It is the value added by the industry's labour and capital used in production and as such, it is equal to wages and salaries, supplementary labour income, net income of unincorporated business and surplus. The U.S. industry data (gross product originating (GPO)) is as well gross domestic product but is measured at market prices and hence includes indirect business taxes. For ease of comparability, I calculate logistics costs as a percent of GDP at market prices.

⧾ the total cost of logistics has declined as a share of total economic activity in both Canada and the U.S. since 1981; from 1981 logistics costs in both countries declined as a share of GDP through 1986 and subsequently rose again through 1991;

THE ELEMENTS OF TOTAL LOGISTICS COSTS (Figures 21, 22 and 23)

INVENTORY COSTS:

⧾ total inventory carrying costs have fluctuated with interest rate movements;

⧾ as a share of GDP inventory costs (including Storage industry costs) in Canada <u>declined</u> from a high of 2.8% in 1982 to 1.3% in 1987 and subsequently rose again to 1.8% in 1991;

> inventory costs performed much the same in the U.S.;

> on average, inventory costs constituted an equal share of economic activity in Canada and the U.S. over the 1981-1992 period;

TRANSPORTATION COSTS

⧾ the largest element of the total cost of logistics;

⧾ in Canada, freight transportation cost rose at an average annual rate of 3%, from approximately $12 billion in 1981 to $16 billion in 1992;

> as a share of economic activity, <u>transportation costs grew</u> from 2.9% in 1981 to 3.2% in 1992;

⧾ freight transportation costs rose more quickly in the U.S. (4% annually) from $US 91 billion in 1981 to $US 138 billion in 1992;

> freight transportation's share of the economic activity rose from 2.4% to 2.8% over the period;

OWN LOGISTICS COSTS

‡ expenditures by Canadian firms on goods and services to store, distribute or prepare for the distribution of their products are substantial;

‡ in the most current period (1990) for which data is available, it is estimated that some $14 billion ($1986) in expenditures were incurred;

‡ it is estimated that own logistics costs averaged $12.2 billion over the 1981-1992 period;

Table A-1
CANADA: TOTAL ECONOMIC COSTS OF LOGISTICS ($B, constant)

| | CANADA | | | TOTAL LOGISTICS COSTS | | SHARE OF GDP, % | |
	Inventory Holding Costs	Own Account Logistics	Transportation Costs	NARROW	BROAD	NARROW	BROAD
1992	8.5	16.0e	16.2	24.7	40.7	4.4	7.3
1991	10.2	15.2e	16.6	26.8	42.0	4.8	7.6
1990	9.7	14.2	15.9	25.6	39.8	4.5	7.0
1989	8.1	14.9	15.9	24.0	38.9	4.2	6.9
1988	7.5	14.1	16.1	23.6	37.7	4.3	6.8
1987	6.9	12.2	15.1	22.0	34.2	4.2	6.5
1986	6.9	10.4	13.9	20.8	31.2	4.1	6.2
1985	7.4	10.3	13.5	20.9	31.2	4.3	6.4
1984	8.4	9.9	13.3	21.7	31.6	4.7	6.8
1983	7.6	9.4	11.5	19.1	28.5	4.4	6.5
1982	12.0	9.5	10.5	22.5	32.0	5.3	7.5
1981	10.6	10.4	11.7	22.3	32.7	5.1	7.4
Ave. (1981-92)	8.7	12.2	14.2	22.8	35.0	4.5	6.9

Note: Own account logistics costs for 1981-1985 are calculated based on the growth rates of data based in $1981; estimates for 1991 and 1992 are based on the projection of the log linear trend.
Source: BSI Branch, Industry Canada.

Table A-1a
U.S.A. - TOTAL ECONOMIC
COSTS OF LOGISTICS ($B, constant)

	Inventory Holding Costs	Transportation Costs	TOTAL LOGISTICS COSTS	Share
1992	63.7	137.7	201.4	4.1
1991	69.0	128.2	197.2	4.1
1990	74.8	125.8	200.6	4.1
1989	73.8	121.4	195.2	4.0
1988	70.5	117.2	187.7	4.0
1987	64.2	113.2	177.4	3.9
1986	69.3	107.5	176.8	4.1
1985	82.5	106.1	188.6	4.4
1984	91.0	104.3	195.3	4.7
1983	75.5	96.7	172.2	4.4
1982	91.3	88.5	179.8	4.8
1981	76.2	91.2	167.4	4.8
Ave. (1981-92)	75.0	111.5	186.6	4.3

Source: BSI Branch, Industry Canada.

Figure 25
Canada: Components of Total Logistics Costs
Broadly Defined
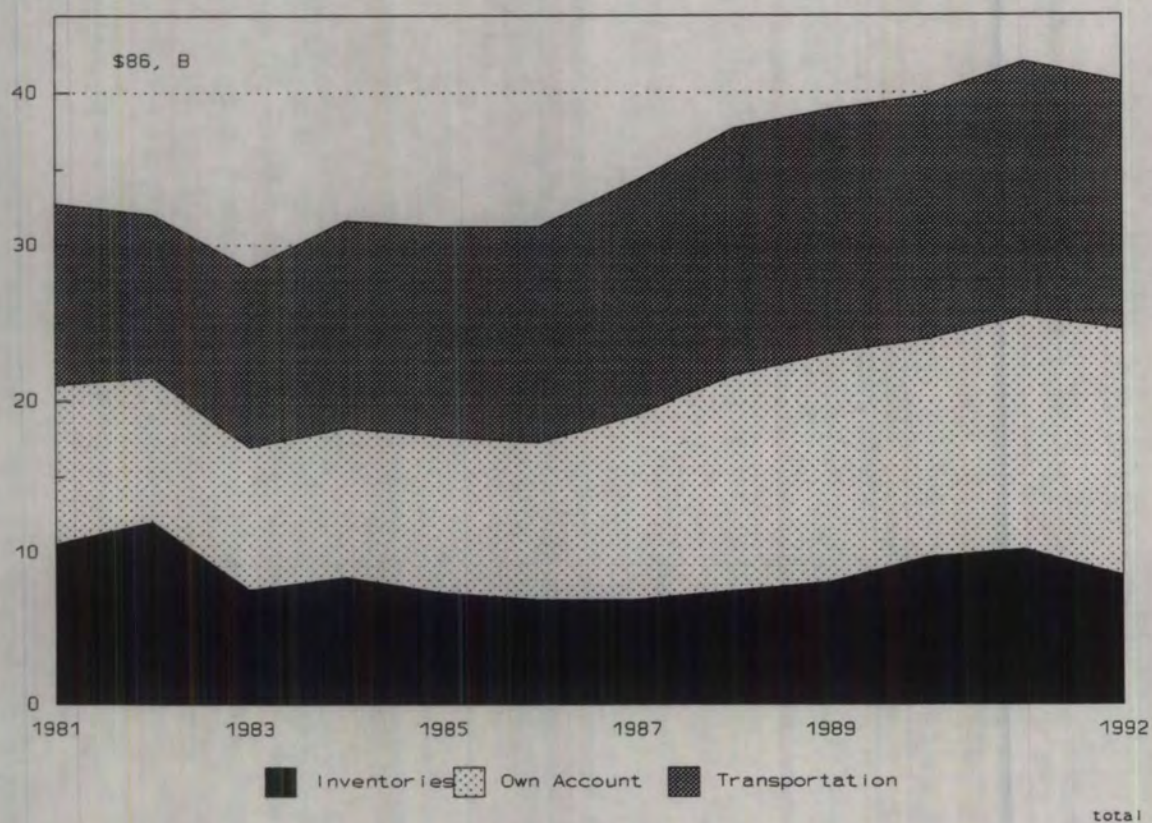
Figure 26
Canada: Transportation Share in
Total Economic Activity
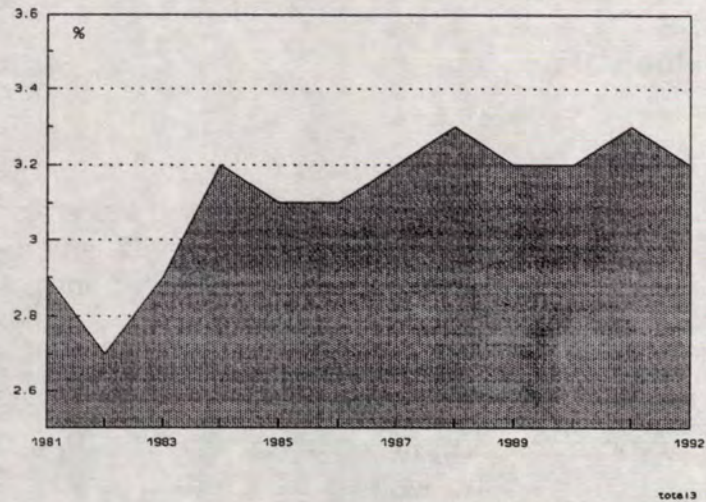
Figure 27
Canada: Inventory Costs Share
in Total Economic Activity
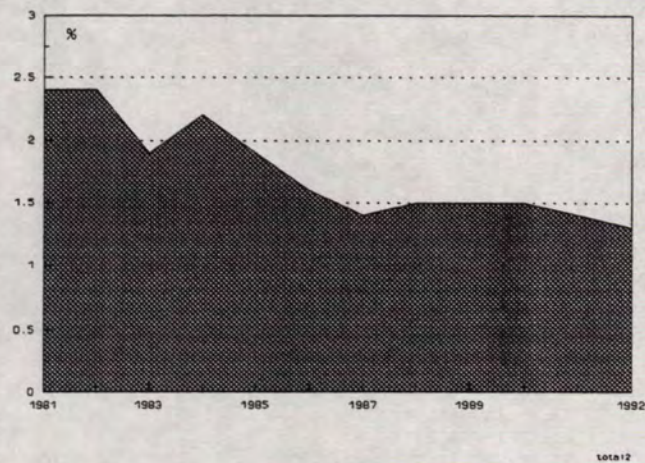
II - INVENTORY CARRYING COSTS

**INVENTORY STOCKS -
A Comparison with the U.S.A.**

Tables A-2 and A-3 present inflation adjusted values for the annual stocks of non-farm inventories held by businesses in Canada and the U.S.A for the major sectors of each economy. Totals are presented in current dollars as well.

Table A-2
Canada: Non-Farm Business Inventories ($1986, million)
(end-of-year book values)

	Manufacturing	Trade	Other	Total	Total Current$
1993	33,789	52,244	8,304	94,811	107,423
1992	33,979	51,836	8,591	95,146	105,032
1991	35,335	51,512	9,183	97,020	103,789
1990	38,068	49,179	9,385	97,736	107,067
1989	40,226	51,362	9,192	102,026	110,762
1988	38,562	50,247	8,825	99,089	106,153
1987	37,360	48,308	8,101	94,871	99,086
1986	37,040	44,620	8,297	91,189	92,347
1985	37,720	42,027	8,291	89,444	88,790
1984	37,486	39,903	8,209	87,098	85,033
1983	35,274	36,352	7,703	81,083	76,640
1982	36,715	36,523	8,504	82,993	76,087
1981	40,758	43,052	9,047	93,926	82,696

Source: Statistics Canada. National Accounts & Environment Division

Figures 24 and 25 present the stocks in Tables A-2 and A-3 graphically.

At 1993 year end, Canadian firms held over $107 billion in inventories, or almost $95 billion in inflation adjusted dollars (totals include estimates of gold and private grain dealers).

The level of inventories carried by the manufacturing and trade sectors in the U.S. was approximately $1.0 trillion in 1993 or $914 billion in inflation adjusted (1987) dollars. This is roughly 10 times that of the Canadian economy.

Historically, the real value of inventory holdings has been sensitive to the business cycle. Inventory levels declined during the 1982 recession in both countries but recovered in the following year rising to a peak in 1989 in Canada (1990 in the U.S.). The most recent economic downturn witnessed declining levels for a prolonged period. In both countries, the manufacturing sector witnessed a prolonged decline from their respective peak levels, while in the Trade sector, stocks rebounded and have continued to grow in 1992 and 1993.

Table A-3
U.S. - NON-FARM BUSINESS INVENTORIES ($1987, billions)

	Manufacturing	Retail	Wholesale	Total	Total Current $
1993*	367.7	244.4	221.2	913.6	1,024.1
1992	365.9	236.4	217.7	897.2	1,003.9
1991	370.6	230.5	212.3	894.5	992.7
1990	376.9	229.4	208.8	903.1	1,015.7
1989	373.9	231.0	202.5	899.9	985.3
1988	355.3	219.7	199.1	870.0	929.6
1987	340.2	213.6	192.7	843.1	859.7
1986	333.6	196.7	185.7	810.4	797.3
1985	335.7	194.1	178.7	799.8	807.7
1984	339.4	181.4	174.7	780.0	797.9
1983	311.9	162.8	159.3	713.8	724.4
1982	311.3	151.7	159.9	701.0	713.5
1981	324.0	152.9	164.8	721.7	734.7

Source: National, Economic, Social & Environmental Data Bank, NIPA, Bureau of Economic Analysis;
* - third quarter estimate
Note: end of quarter annual average; adjusted for seasonal variation

Notable in Figures 24 and 25 (that present the constant dollar values of non-farm business inventories for Canada and the U.S.) is the clear upward trend in the real value of inventories for the trades sector. Manufacturers inventory stocks moved

lower in Canada in the 1981-1993 period while in the U.S. the stocks of manufacturing inventories moved slightly higher.

A major difference between Canada and the U.S. is the shares of inventories held in each major industrial segment.

In Canada, the distributive trades (Retail and Wholesale) and the manufacturing sector carried 55% and 36% of inventory values respectively in 1993 while in the U.S. the distributive trades accounted for roughly 51% of total inventories in 1993 while the manufacturing share was 40%.

A common characteristics is the increasing share of inventories held by the Trades in both countries. In Canada the Trades share rose from 46% in 1981 to 55% in 1993 while in the U.S. the Trades share rose from 44% in 1981 to 51% in 1993.

a.   CARRYING COSTS

Inventory holding is a day-to-day requirement of doing business, especially for retailers, wholesalers and manufacturers. All firms that hold inventories incur two costs. One cost is an **imputed or opportunity**

Figure 28
Canada: Manufacturing & Trades Inventories
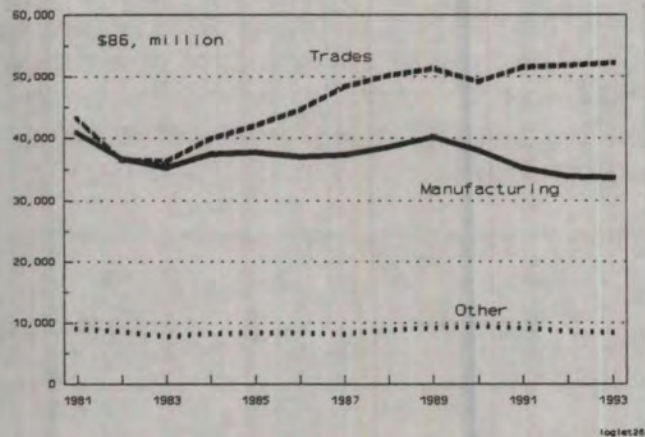
Figure 29
U.S. - Non-Farm Business Inventories
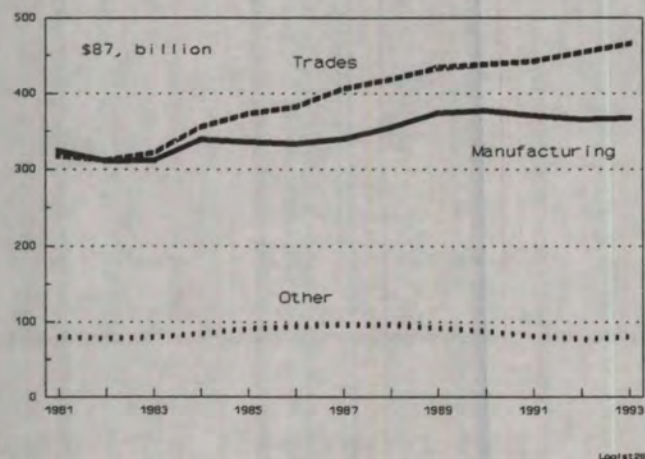
cost, the cost of having inventory on hand and not having those funds tied up available for alternative use; the second is a **storage cost**.

If a firms must borrow funds (issue bonds, take out a loan or issue new equity shares) with which to acquire inventory (e.g. to stock the shelves of a retail operation or hold parts and finished goods for a manufacturing operation), it must pay a premium on the funds.

Alternatively, if the firm uses its own money (retained earnings) with which to buy and stock inventory, there is an opportunity cost - the money tied up in inventory cannot be used for other purposes which may generate income, reduce indebtedness by paying down (high cost) capital loans or invest in new capital equipment.

Year-end inventory valuation in Canada is made either at cost or market value (book value). If the value of finished products held in inventory has declined due to obsolescence, the value of inventories will be made at market prices. The difference between what has been paid and the market valuation is an economic cost. In addition, (retail and wholesale) inventories are subject to buyer's preferences and may not be sold at cost but marked down to some price below cost. This as well is an economic cost. Damage or spoilage may also occur for some durables and non-durables, resulting in a further cost to the owner. Accounting for as many as possible of the costs associated with the holding of inventories must be included in the aggregate opportunity cost calculation[8].

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[8]   The Alford and Bangs formula utilized by R.V. Delaney (see for example, Fifth Annual "State of Logistics" Report, June 6, 1994, Cass Logistics Inc., St. Louis, MO.) also includes storage facilities, taxes, transportation and handling. These factors represent costs reflected in either the Storage (and Warehouse) industry's contribution to the costs of holding inventories or they constitute an intermediate input required by the manufacturer, retailer or wholesaler. Given either of the above, these factors will over-state a net economic cost of holding inventories calculation. What is required in this case is the value added component attributable to manufacturers for the storing of inventory.

The User Cost of Inventory Capital[9]

USER COST

The investment activities of firms include the purchase of physical capital to augment or replace their existing capital stock. If we assume that firms attempt to maximize the present value of the income that they pay to shareholders (discounted by the shareholders' discount rate), any investment will be undertaken if it increases the market value of the firm's equity. This occurs if the incremental unit of capital, when added to the firm's productive capacity, provides a stream of real returns that is sufficient to cover all of the costs associated with the investment. Specifically, the present value of the real returns to the investment when discounted at the appropriate interest rate must be no less than the present value of the economic costs (economic costs are defined as wages and accrued current costs, replacement costs of depreciation, the cost of financing and corporate taxes payable; these costs will generally differ from accounting income).

The costs associated with an investment can be expressed on a per period basis and is referred to as the user cost or implicit rental cost of using a dollar of capital for one period. This user cost generally consists of two parts: the real cost of finance, which results from the payments the firm must make on funds raised to purchase the physical asset; the second is the capital consumption cost, which results from the loss in the value of the capital asset due to depreciation, obsolescence and changes in the prices of capital goods.

THE REQUIRED RETURN ON INVENTORY CAPITAL

Inventories (raw materials and final goods) represent stocks of physical capital assets that do not depreciate in a physical sense. However inventory holding costs will differ from the cost of finance to the firm due to the way inventory must be costed

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[9] This section is based on three published works: R.W. Boadway, N. Bruce and J.M. Mintz, Taxes on Capital Income in Canada: Analysis and Policy, Canadian Tax Paper No. 80, Canadian Tax Foundation, 1987; ibid., Corporate taxation and the Cost of Holding Inventories, Canadian Journal of Economics, May, 1982; ibid., Taxation, Inflation and the Effective Marginal Tax Rate on Capital in Canada, Canadian Journal of Economics, Feb. 1984.

for tax purposes. Firms in Canada generally must use first in - first out (FIFO) accounting methods for costing inventory[10].

The user cost of a dollar of inventory (in the absence of the FIFO accounting rules, inventory allowance and taxes) is $(r_f - \epsilon)$ where r_f is the real cost of finance to the firm and ϵ is the rate of change of the relative price of goods in inventory (i.e. capital gains)[11].

Under FIFO accounting rules, an extra unit of inventory imposes an addition cost of γu per period where γ is the rate of change in the money price of goods in inventory (i.e. $\gamma = \pi + \epsilon$, and π is the rate of inflation) and u is the corporate profits tax rate. During the holding period, the price of goods in inventory rises (declines) at the rate γ $(-\gamma)$. If goods have appreciated in value when removed from inventory they are sold for a price that is $(1+\gamma)$ times greater than the price at which they were put into inventory. Since the latter is a cost allowed under FIFO, a capital gain of γ is added to corporate income and is subject to tax.

In the period 1977 to 1986 an inventory tax deduction allowed a fraction $v=0.03$ of the FIFO value of inventory stock to be deducted from taxable income, yielding a tax saving of uv. The holding of a unit of inventory earns a return to the firm by increasing revenues and/or reducing current costs. The former is taxable while the latter is deductible, so the holding cost is grossed up by dividing it by (1-u). This gives the required return gross of corporate taxes that the marginal inventory investment must earn to be just profitable.

Following Boadway, Bruce and Mintz (1987) I calculate the user cost of inventories as:

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10   The average holding period is assumed to be the tax period, that is one year

11   A firm may finance investment through debt or equity with the result that the real cost per dollar of funds from the respective source may differ; to obtain an overall cost of finance to the firm a weighted average is used. If we denote r_b as debt financing and r_e, financing by equity then

$$r_f = \beta r_b + (1-\beta) r_e$$

$$= [\beta i(1-u) + (1-\beta)\rho] - \pi \qquad\qquad (a)$$

To calculate β, the share of investment financed through debt, I use the formula (DB + BD - L)/(E + DB + BD - L) where DB, BD and L are respectively the book value of bank debt, outstanding bonds and liquid assets and E is the market value of the stock of equity. The source of this data for Canada is the Financial Flows Accounts. Data was obtained for the U.S. from Business Statistics 1961-1988, U.S. Department of Commerce, for commercial & industrial loans and leases and new security issues (page 73). I have constructed linear estimates of the data for 1989-1993.

$$F_k^I = [(r_f - \epsilon + u(\gamma - v)]/(1-u) \tag{1}$$

all variables have been defined previously.

Table A-4 summarizes the various elements used to calculate the user cost of inventories.

The real cost of holding inventories is based on this calculation.

INVENTORY CARRYING COSTS

The cost of holding inventories for Canada is presented in Table A-5 below and for the U.S. in Table A-5a.

	Canada	U.S.A.
Table A4 Summary of Cost of Inventories Calculation		
	1981-1993 Average	
Cost of Debt, r_b	6.5	6.6
Cost of Equity, r_e	3.4	3.9
Real Cost of Finance, r_f	4.6	5.6
User Cost of Inventories, F_k^I	8.6	9.3

Figure 26 presents annual inventory holding costs for Canada and the U.S. in graphic form. Aside from the level of costs in the U.S. relative to Canada, two features are noteworthy. First aggregate inventory holding costs appear interest rate sensitive and hence are higher in the recessionary periods.

More importantly perhaps is the clear downward trend reflected in the estimates for both countries. Inter-recessionary period costs appear to have been less volatile in Canada.

Figure 30
Real Cost of Holding Inventories
Canada and the U.S. Compared
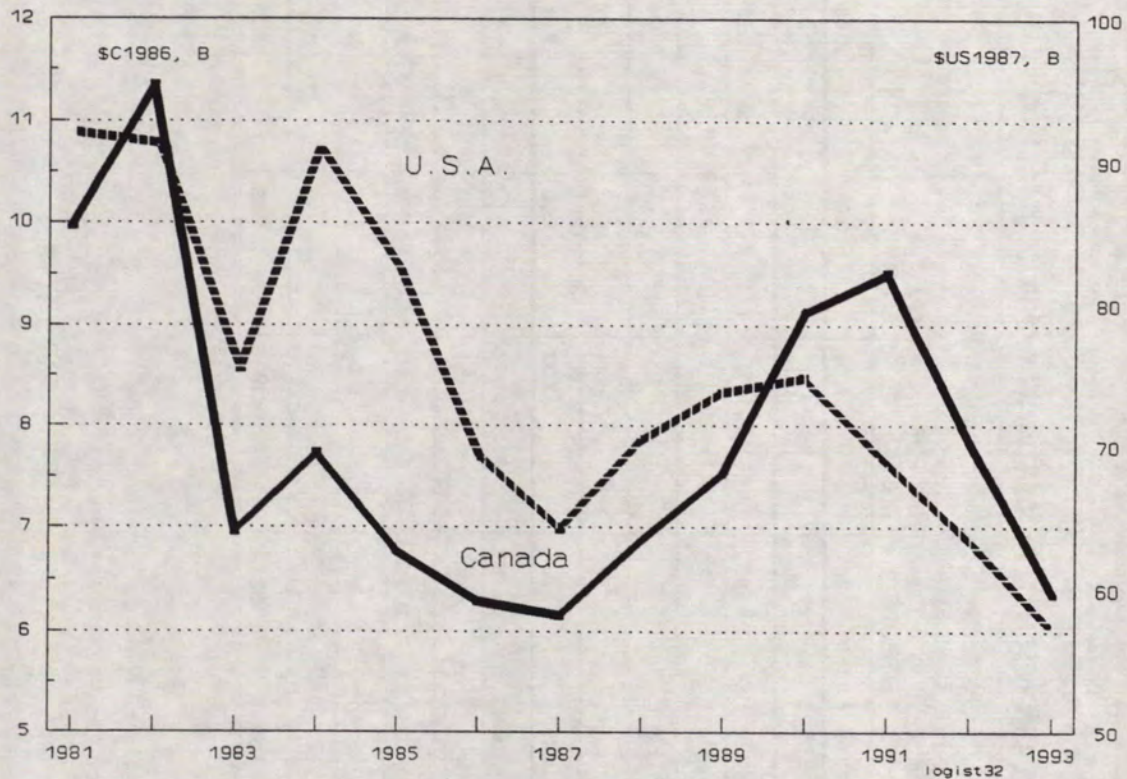
TABLE A-5
CANADA - INVENTORY CARRYING COSTS

	TOTAL STOCK OF INVENTORY $86, M	IMPLICIT PRICE OF INVENTORY	INTEREST RATE %	RATE OF INFLATION	EFFECTIVE CORPORATE TAX RATE, %	COST OF DEBT	COST OF EQUITY	USER COST OF INVENTORY	INVENTORY CARRYING COST (constant$)
1981	93,926	0.8804	16.22	10.95	46	8.68	3.96	10.63	9,986
1982	82,993	0.9168	15.87	8.97	60	6.24	5.08	13.66	11,337
1983	81,083	0.9452	12.84	5.29	43	7.27	3.34	8.56	6,937
1984	87,098	0.9763	13.57	3.80	40	8.11	3.64	8.84	7,698
1985	89,444	0.9927	11.74	3.55	37	7.41	3.29	7.53	6,732
1986	91,189	1.0127	10.83	3.95	37	6.83	2.98	6.91	6,297
1987	94,871	1.0444	11.21	4.40	35	7.30	2.60	6.51	6,180
1988	99,089	1.0713	11.33	4.02	29	8.02	3.17	6.97	6,906
1989	102,026	1.0856	10.81	4.97	40	6.47	3.22	7.42	7,574
1990	97,736	1.0955	11.91	4.83	53	5.60	3.66	9.36	9,147
1991	97,020	1.0698	10.80	5.61	64	3.89	3.34	9.79	9,503
1992	95,146	1.1039	9.90	1.51	56	4.37	3.12	8.28	7,881
1993	94,811	1.1330	8.93	1.80	53	4.18	2.53	6.73	6,377

Source: Business Services Industries Branch, Industry Canada
Note: see notes on page 57 for the definitions of the variables

Table A-5a
U.S. - INVENTORY CARRYING COSTS

	TOTAL STOCK OF INVENTORY ($87, B)	IMPLICIT PRICE	INTEREST RATE, %	RATE OF INFLATION	EFFECTIVE CORPORATE TAX RATE, %	COST OF DEBT	COST OF EQUITY	USER COST OF INVENTORY	INVENTORY CARRYING COST ($87, B)
1981	722	1.018	14.57	10.25	33.7	9.32	5.10	12.75	92.043
1982	701	1.019	14.44	6.02	53.3	9.21	5.75	13.02	91.287
1983	714	1.014	12.27	2.99	45.8	7.76	4.37	10.57	75.498
1984	780	1.023	13.23	3.51	44.3	8.03	4.60	11.67	91.043
1985	800	1.010	11.75	3.48	56.5	6.68	4.22	10.32	82.524
1986	810	0.984	9.91	1.59	62.9	5.05	3.46	8.56	69.313
1987	843	1.020	9.84	3.59	47.9	5.46	3.04	7.62	64.219
1988	870	1.069	9.92	4.00	38.9	5.97	3.60	8.10	70.447
1989	900	1.094	9.65	4.79	36.2	5.71	3.40	8.20	73.788
1990	903	1.125	9.81	5.22	37.9	6.04	3.56	8.29	74.814
1991	895	1.110	9.22	4.11	35.8	5.87	3.20	7.71	69.041
1992	897	1.119	8.52	2.90	37.0	5.34	2.96	7.10	63.697
1993	914	1.120	7.48	3.00	37.0	4.69	2.75	6.32	57.758

Source: Survey of Current Business Jan 1992, National Income & Product Accounts of the US 1959-1988 and Business Statistics 1963-1991
Note: see notes on page 57 for definitions of the variables

b. STORAGE COSTS

The second component of inventory costs is the storage costs[12]. It is assumed that all inventories are stored by an establishment separate from that in which they were produced with the consequence that the inventory owner must incur a cost. Given this assumption, the cost of storing inventories is the contribution to gross domestic product of the Storage and Warehousing Industry[13].

Table A-6 presents the for hire costs of warehousing and storage in Canada.

The Storage and Warehousing industry in Canada includes establishments that operate refrigerated warehousing including frozen food storage, refrigerated services and fur storage, and other establishments engaged in bonded warehousing and general merchandise warehousing. It also includes the operation of elevators for the storage of grain.

Table A-6 CANADA: STORAGE & WAREHOUSING INDUSTRY	
	GDP (86$, M)
1993	666
1992	635
1991	668
1990	616
1989	560
1988	662
1987	732
1986	635
1985	606
1984	651
1983	662
1982	684
1981	672
Average Annual Growth, % 1981-1993	-0.1

Public warehousing in the U.S. includes Household goods warehousing and storage, refrigerated warehousing and farm product warehousing and storage. In

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12   see footnote 7; storage costs are included in Transportation costs for the U.S.

13   Storage of finished goods and work in progress also takes place at the manufacturing facility. I do not attempt to capture the costs associated with this element.

addition some warehousing services are performed by the motor freight transport industry. Equivalent storage costs for the U.S. are captured by the trucking industry statistics.

c. THE TOTAL COSTS OF HOLDING INVENTORY

Table A-7 presents the total inflation adjusted costs of holding inventories for the Canadian and U.S. economies. In the case of Canada, the cost is comprised of the opportunity cost of holding inventories (those values presented in Table A-5) plus the value added of the Storage and Warehousing industry (the values from Table A-6). The latter is part of the truck transport data for the U.S.

Table A-8
Total Costs of Holding Inventory
(Carrying Costs plus Storage Costs)

| | CANADA | | U.S.A. | |
| | | Share of GDP | | Share of GDP |
	constant$, M	@ market prices	constant$, B	@ market prices
1993	7,000	1.2	57.758	1.1
1992	8,496	1.5	63.697	1.3
1991	10,171	1.8	69.041	1.4
1990	9,741	1.7	74.814	1.5
1989	8,100	1.4	73.788	1.5
1988	7,540	1.4	70.447	1.5
1987	6,894	1.3	64.217	1.4
1986	6,934	1.4	69.313	1.6
1985	7,371	1.5	82.524	1.9
1984	8,383	1.8	91.043	2.2
1983	7,624	1.7	75.498	1.9
1982	12,023	2.8	91.287	2.4
1981	10,644	2.4	76.210	2.4
Average	8,531	1.7	75.036	1.7

Source: Tables A-5 + Table A-6 above.

In the thirteen year period from 1981-1993 the inventory component of logistics costs in Canada has on average accounted for 1.7% of GDP (measured at market prices) or $8.5 billion.

Recessionary periods in Canada have proven to be the most costly periods for holding inventory. Both in 1982 and 1991, short term peaks occurred for inventory holding costs. Not surprisingly, 1981 and 1990 were also peak years for interest rates.

Although short term interest-rate sensitive peaks are evident, Figure 27 suggests a declining trend in the costs of holding inventories as a share of GDP in Canada.

In the case of the U.S., inventory holding costs averaged $75 billion in the 1981-1993. Inventory holding costs constituted 1.7% of GDP on average over the 1981-1993 period.

Figure 31
Total Inventory Carrying Costs as a Share of GDP
Canada and the U.S. Compared
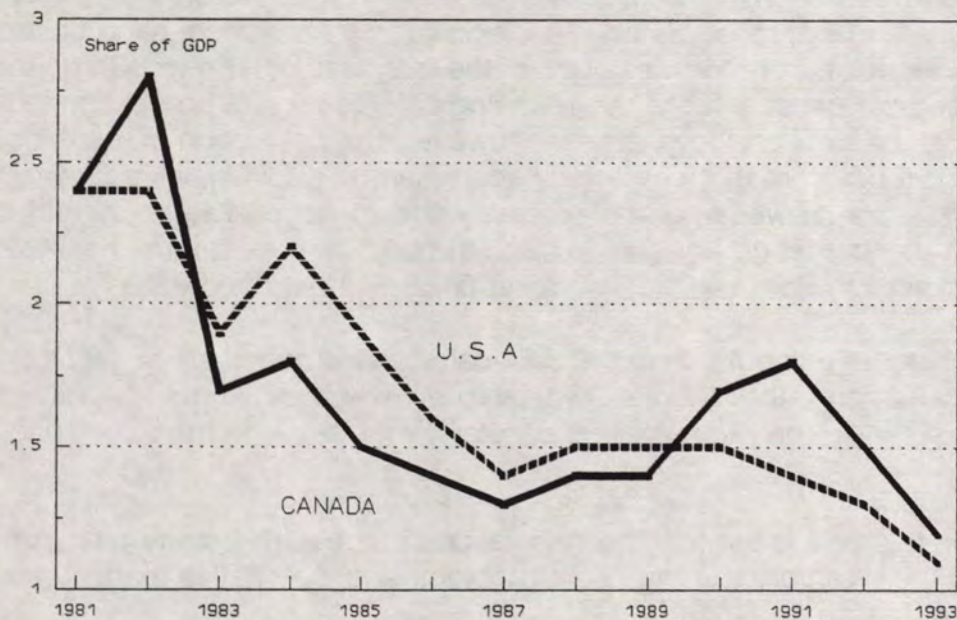
IOGIST29

The influence of interest rates appear to have been less of a factor in inventory holding costs in the U.S. As in Canada, inventory holding costs as a share of GDP have been on the decline.

FINAL REMARKS ON INVENTORY COSTS

The economics of inventories behaviour is not well understood but the empirical facts suggest that the business cycle influences the magnitude of inventory carrying costs. Factors which play a key role are sales (inventory investment and sales are positively correlated), the rate of inflation and of course the interest rate or opportunity cost of physical assets.

There is some evidence, a discussion of which is beyond the scope of this paper, suggesting that the traditional relationship between inventory holding and the business cycle may be breaking down[14]. Business practises such as order cycle time and just-in-time manufacturing are affecting the way in which firms determine their need to hold inventories. The change in these business practises may have wide ranging consequences for the economy as whole.

The above economic cost calculations are made based on the concept of alternative use and this measure will differ significantly from accounting costs. This may not be palatable from the viewpoint of the business person who in her day-to-day business operation must arrange the financing of all factors of production including labour, physical capital and inventories. However, the calculation is made not from this perspective but from that of the total economy. In addition, an economic cost calculation from the viewpoint of the economy should not double count and must net out those elements that do not add value to the bottom line. It must deal with and use aggregate indicators, for example, financing (including debt and equity).

A number of refinements to the cost calculations above are warranted for any future work. Primarily, the different ownership of inventories should be valued separately as should the price inflation of retail, wholesale and manufacturing inventories.

Nevertheless, it is felt that the calculations made at this stage offer some insights into the inventory holding costs problem, and the relative magnitudes with which we are dealing.

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[14] see Jane Sneddon Little, 1992, Changes in Inventory Management: Implications for the U.S. Recovery, New England Economic Review, November/December.

Note to Tables A-6 - Definitions:

Implicit price of inventories: the ratio of current to constant dollar stocks of inventories;

Interest Rate: Canada - the Scotia-McLeod long-term corporate bond rate; U.S. - Moody's corporate bond rate;

Rate of Inflation: the rate of change of the CPI;

Effective Corporate Tax Rate: the ratio of the difference between pre- and after tax profits to pre-tax profits; for the U.S. the rate is the ratio of corporate tax liabilities to pre-tax corporate profits;

Cost of Debt is derived as the product of the interest rate times one minus the corporate tax rate, minus inflation;

Cost of Equity: or the real yield on equity, is derived as the nominal yield measured by the TSE dividend yield (Standard & Poors Dividend yield for the U.S.) minus inflation;

Real Cost of Finance: derived as the sum of the cost of equity and the cost of debt weighted by their shares in total finance (the debt/equity ratio); see footnote 13 for data sources for the D/E share calculation;

User Cost of Inventory: derived as in equation (1);

Inventory Carrying Costs: derived as the user cost of inventory multiplied by the constant dollar value of the stock of inventories.

II - OWN ACCOUNT LOGISTICS COSTS

Firms undertake a large degree of the transportation and storage of goods on their own behalf. These activities may be diverse but the more obvious costs incurred include the operation of truck fleets (and other modes of transport such as the ownership or leasing of railroad cars, ships and aircraft), the preparation of goods for distribution through various types of secondary packaging including boxes, cartons and wooden pallets, as well as in-house storage of finished and in-process goods.

To be consistent with the methodology of this paper, the preferred approach would be to valuate only the net economic contribution of these activities (i.e. the value added component). This however is not possible. Consequently direct input costs are used as a proxy to estimate own logistics costs.

In an attempt to estimate the own logistics costs of firms in Canada, I use the Input-Output tables (the Input or commodity by industry matrix) prepared by Statistics Canada. Those inputs used by Canadian firms to transport and store goods (and services) on their own behalf are identified and are listed in Appendix III[15].

Table A-8
OWN ACCOUNT
LOGISTICS COSTS, 1981-1992

Year	$B	$1986, B
1992e	14.0	16.0
1991e	13.4	15.2
1990	13.6	14.2
1989	12.3	14.9
1988	11.8	14.1
1987	10.3	12.2
1986	10.4	10.4
1985	11.4	10.3
1984	10.5	9.9
1983	9.7	9.4
1982	9.1	9.5
1981	8.8	10.4

Source: Statistics Canada, Input Output Division and Business Services Industries Branch, Industry Canada
Note: see footnote 18 for the construction of the constant dollar estimates.

[15] The list of input-output commodities that are used to arrive at the own account cost of logistics has been chosen from among 602 commodities used by Statistics Canada in their worksheet level matrices. This list comprises a 'best guess' estimate by members of Distribution Services Directorate, Industry Canada.
Note that only the consumption of commodities used for distribution, handling and

Table A-8 presents estimates for the costs of logistics on own account for the period 1981-1992. The values are presented in current and constant dollars[16].

It is clear that own logistics costs are substantial in magnitude.

For example in 1990, the latest year available, own logistics costs are estimated at approximately $13.6 billion. After taking account of inflation the estimate for the same year rises to $14 billion. By 1992 the total is projected to rise to approximately $16 billion.

The real growth of expenditures on these commodities is estimated at 3.9% annually on average (for comparison it will be noted that GDP, adjusted for inflation, grew at an average annual rate of 2.2% in the same period).

Table A-9
OWN LOGISTICS COSTS
BY TYPE, $1986, B

Year	Transportation	Packaging
1992e	8.3	7.7
1991e	8.1	7.1
1990	8.0	6.3
1989	8.6	6.4
1988	8.4	5.8
1987	5.3	6.9
1986	6.7	3.7
1985	6.7	3.6
1984	6.5	3.4
1983	6.0	3.4
1982	6.1	3.4
1981	6.8	3.6

Source: Statistics Canada, Input Output Division and Business Services Industries Branch, Industry Canada
Note: the estimates of each component are obtained using the same methodology reported in Table A-8.

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storage purposes is being measured. These values will overstate the true net economic cost to the firm. On the other hand, firms also must devote primary factors of production i.e. labour and capital, to distribution, storage and handling - however, it is not possible to estimate these magnitudes at the current time. Consequently, the estimates presented may be considered as a lower bound for the total costs incurred.

[16] Constant dollar data based on the year 1986 exist only for the period 1986-1990. Own account logistics costs for 1981-1985 are calculated based on the growth rates of data based in $1981; estimates for 1991 and 1992 are then projected using the log linear trend.

Table A-9 divides the own logistics costs estimates according to transportation cost and packaging cost.

Although the transportation element is estimated to be larger than the packaging element, the latter grew at an average annual rate of 6.9% while the former grew by 1.8%.

III - TRANSPORTATION COSTS

(a) INTRODUCTION

The valuation of the transportation component of aggregate logistics costs requires identification of the opportunity cost of providing the respective service. Invoking the classical principal in economics that a factor of production is paid its marginal product, then it is this return to the factor of production that a transportation firm must forego to rent its services.

Consequently for each mode of transportation I use the value-added of the industry as that industry's contribution to the cost of logistics.

Obtaining the requisite data on a timely basis for each element of the transportation industry in the U.S.A. has proven problematic[17]. Nevertheless an aggregate transportation and warehousing comparison of Canada and the U.S. is first presented for the available time series. Table A-10 presents these estimates.

(b) The Transportation & Storage Sector as Whole[18]

The aggregate Transportation and Storage (T&S) sector of the U.S. economy grew at an average annual rate of 4.1% in the 1981-1992 period from $117 billion to an estimated $184 billion. In Canada the T&S sector grew at an average annual rate of 2.3% from $17 billion in 1981 to $22 billion in 1992.

As a result, the T&S sector of the respective countries consumed relatively more resources at the end of the period (1992) compared to the beginning of the

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[17] Revised industry GDP estimates have been taken from the Survey of Current Business Nov. 1993. Data for 1992 is forthcoming in November of 1994. The end point used for comparison is 1992 after extrapolating the trend for U.S. data forward one period.

[18] In this comparison a number of industries are included that are not relevant to the logistics function; for the U.S. this includes local and interurban passenger transportation; for Canada the same sector is included.

Table A-10

Transportation & Storage (including Warehousing) Industry GDP,

	Canada ($1986, B) ($1986)	Share of GDP, %	U.S.A ($1987)	Share of GDP, %
1993	22.5	4.36	na	
1992	21.9	4.35	183.6e	3.7
1991	21.3	4.27	173.0	3.6
1990	21.8	4.33	168.9	3.5
1989	22.0	4.37	161.2	3.3
1988	22.8	4.62	155.8	3.3
1987	21.7	4.59	152.7	3.4
1986	20.3	4.48	142.6	3.2
1985	19.8	4.51	137.4	3.2
1984	19.4	4.62	136.6	3.3
1983	17.3	4.39	127.3	3.3
1982	16.1	4.22	115.5	3.1
1981	17.1	4.31	116.5	3.0
Average Annual Growth, 1981-1992 %	2.3		4.1	

e - linear estimate

Source: Statistics Canada 15-201; Survey of Current Business, Nov. 1993

period (1981). In Canada, aggregate gross domestic product grew at an average annual rate of 2.2% in the 1981-1992 period while the U.S. economy grew by 2.3%.

The aggregate data presented in Table A-10 contains industry data that are not relevant to the current analysis (e.g. a passenger transportation component).

Tables A-11 summarize the transportation component of logistics in the Canadian and the U.S. economies. In each country transportation costs have risen as a share of GDP, although not dramatically. Each element is presented in further detail in what follows.

Table A-11a
CANADA: TOTAL ECONOMIC COSTS OF TRANSPORTATION SERVICES ($1986, MILLIONS)

	TRUCK FOR-HIRE	TRUCK PRIVATE	RAIL	PIPELINE	WATER	AIR	OTHER	MAINTENANCE	BUS	TOTAL	SHARE OF GDP
1993	6,786		3,352	3,856	1,091						
1992	6,435		3,110	3,482	1,184	174	1,770	70		16,225	3.2
1991	5,761	1,124	3,224	3,141	1,383	195	1,713	71		16,612	3.3
1990	5,925	1,548	3,180	2,970	1,400	223	2,066	88	89	15,852	3.2
1989	6,122		3,173	2,880	1,460	235	1,913	84		15,867	3.2
1988	6,418		3,525	2,798	1,514	271	1,473	88		16,087	3.3
1987	6,085		3,352	2,390	1,463	235	1,504	86		15,115	3.2
1986	5,385		3,235	2,126	1,298	318	1,425	77		13,864	3.1
1985	5,263		2,988	2,135	1,275	270	1,437	81		13,449	3.1
1984	5,254		2,987	2,050	1,288	286	1,354	86		13,305	3.2
1983	4,525		2,212	1,910	1,298	257	1,252	86		11,540	2.9
1982	4,201		1,934	1,857	1,101	202	1,107	85		10,487	2.7
1981	4,280		2,973	1,896	1,056	183	1,151	114	45	11,653	2.9
AVERAGE ANNUAL GROWTH, % 1981-1992	3.7		0.4	5.5	1.0	-0.5	3.9	-4.4		3.0	

* - total reported for private trucking and bus transport of goods are revenues and are not included in the totals; incidental transportation services are included in the respective transportation industry

Table A-11b
U.S.A: TOTAL ECONOMIC COSTS OF TRANSPORTATION SERVICES ($1987, BILLIONS)

	TRUCK FOR-HIRE	TRUCK PRIVATE	RAIL	PIPELINE	WATER	AIR	TRANSPORT SERVICES	BUS	TOTAL	SHARE OF GDP
1992	75.7		23.3	4.4	8.3	9.1	16.9		137.7	2.8
1991	70.8		21.7	5.2	8.2	7.5	14.8		128.2	2.7
1990	69.0		22.2	4.5	8.0	7.1	15.0		125.8	2.6
1989	67.1		20.9	4.9	7.8	6.1	14.6		121.4	2.5
1988	63.4		21.9	4.8	7.7	5.6	13.8		117.2	2.5
1987	61.0		20.6	5.2	8.0	5.3	13.1		113.2	2.5
1986	59.5		18.5	4.3	8.2	4.5	12.5		107.5	2.5
1985	58.2		18.5	5.4	8.4	3.6	12.0		106.1	2.5
1984	57.2		18.7	5.4	8.6	3.4	11.0		104.3	2.5
1983	52.2		16.6	6.3	8.5	3.1	10.0		96.7	2.5
1982	46.1		15.0	6.7	9.0	2.4	9.3		88.5	2.4
1981	47.1		17.4	5.9	9.7	2.1	9.0		91.2	2.4
AVERAGE ANNUAL GROWTH, % 1981-1992	4.3		2.7	-2.6	-1.4	12.4	5.7		4.0	

Source: GDP - Survey of Current Business; O.R. - ENO Transportation Foundation Inc; U.S. Industrial Outlook.

Note: Trucking GDP includes warehousing and storage; Water GDP has not been adjusted for a small percentage of passenger revenues (4.2% in 1991);

a)   TRUCK TRANSPORT INDUSTRIES

All of the for-hire truck transport industry gross domestic product is allocated to logistics in both Canada and the U.S.

Trucking constitute the largest single cost component of transportation logistics costs. In 1992, Canadian for-hire motor carriers contributed approximately $6.4 billion to GDP or 1.2% of the total gross domestic product of Canada after having grown at an average annual rate of 3.7% since 1981. The Canadian trucking sector (excluding warehousing) is approximately one-twelfth the size of the U.S. industry (including warehousing). The costs of moving goods by truck within the Canadian economy have risen faster than GDP in the 1980s.

Table A-12
GDP - TRUCK TRANSPORT INDUSTRY

	CANADA ($1986, M)	Share of GDP, %	U.S.A. ($1987, B)	Share of GDP, %
1993	6,786	1.3		
1992	6,435	1.2	75.7e	1.5
1991	5,761	1.2	70.8	1.5
1990	5,925	1.2	69.0	1.4
1989	6,122	1.2	67.1	1.4
1988	6,418	1.3	63.4	1.3
1987	6,085	1.3	61.0	1.3
1986	5,385	1.2	59.5	1.4
1985	5,263	1.2	58.2	1.4
1984	5,254	1.3	57.2	1.4
1983	4,525	1.2	52.2	1.3
1982	4,201	1.1	46.1	1.2
1981	4,280	1.1	47.1	1.2
Average Annual Growth % 1981-1992	3.7		4.3	

e - linear estimate

Trucking costs, which include warehousing in the U.S., as well, have risen in the 1980s from 1.2% of GDP in 1981 to an estimated share of approximately 1.5% in 1992.

b) AIR TRANSPORT SERVICES

The gross domestic product of the air transport industry in Canada was C$2.4 billion in 1992 compared to an estimate of approximately $46 billion in the U.S.

The contribution to the costs of logistics by Canadian air carriers is calculated in terms of the gross domestic product of the air transport industry and is proportioned according to the goods tonne-kilometers of total revenues.

Table A-13
Air Carrier Freight Service[*]
SUMMARY

	CANADA ($1986, M)	Share of GDP, %	U.S.A. ($1987, B)	Share of GDP, %
1993				
1992	174	0.004	9.1	0.18
1991	195	0.004	7.5	0.15
1990	223	0.004	7.1	0.15
1989	235	0.005	6.1	0.13
1988	271	0.006	5.6	0.12
1987	235	0.005	5.3	0.12
1986	318	0.007	4.5	0.10
1985	270	0.006	3.6	0.08
1984	286	0.007	3.4	0.08
1983	257	0.006	3.1	0.08
1982	202	0.005	2.4	0.06
1981	183	0.005	2.1	0.01

Average Annual Growth, %
1981-1992   -0.5   12.4
* - Air freight GDP has been estimated based on the cargo revenues share of total revenues
Source: Statistics Canada Catalogues 51-206, 51-501E, 52-216, 15-001; Survey of Current Business, Nov 1993 and ENO Transportation Foundation Inc.

More specifically, air services goods tonne-km is multiplied by goods revenue per goods tonne-km and then divided by total revenues to obtain the revenue share of goods movement in total revenues. This share is then multiplied by air services GDP to obtain the quantity attributed to logistics (Table A-14). In the case of the U.S. Air Transport industry I allocated air industry GDP to logistics according to the share of cargo revenues in total revenues (Table A-15).

The GDP of air carriers that is attributable to the cost of logistics in Canada is presented in Table A-13. The transport of goods by air constitute a very small share of GDP in both Canada and the U.S. Over the 1981-92 period air transport as a share of GDP varied little, at about 0.01% of GDP.

In the U.S., air freight service is small but has grown substantially in economic importance.

Table A-14
Canada - Airline Industry Statistics

	Airline Industry GDP ($1986, M)	Share attributable to logistics to Logistics ($1986, M)
1993	2,261.0	
1992	2,350.0	174
1991	2,442.7	195
1990	2,815.9	223
1989	2,902.6	235
1988	3,005.3	271
1987	2,867.2	235
1986	2,921.4	318
1985	2,810.7	270
1984	2,631.3	286
1983	2,289.7	257
1982	2,144.1	202
1981	2,176.8	183

	Goods tonne-km	Goods Revenue per goods tonne-km	Goods Rev	Total Rev	Share
1993					
1992	1,499,110	.371	556,170	7,538,022	7.4
1991	1,573,257	.384	604,131	7,600,445	8.0
1990	1,753,950	.372	652,469	8,240,355	7.9
1989	1,702,305	.375	638,364	7,886,303	8.1
1988	1,600,552	.401	641,821	7,136,375	9.0
1987	1,245,630	.420	523,165	6,386,280	8.2
1986	1,202,882	.456	548,514	5,980,819	9.2
1985	1,171,810	.458	536,689	5,621,370	9.6
1984	1,120,786	.419	469,609	5,093,000	9.2
1983	975,862	.427	416,693	4,676,000	8.9
1982	918,860	.479	440,134	4,679,000	9.4
1981	857,429	.455	390,130	4,649,000	8.4

Source: Statistics Canada 15-206

Table A-15
U.S. - Airline Industry Statistics, $B

	GDP $1987, B	Total Revenues	Cargo Revenues	Cargo Revenue Share	Cargo GDP, $1987, B
1993					
1992	46.0e	63.4e	12.5e	20	9.1
1991	40.4	54.7	10.1	19	7.5
1990	39.7	56.2	9.9	18	7.1
1989	36.0	52.4	8.8	17	6.1
1988	34.8	48.4	7.8	16	5.6
1987	35.1	44.2	6.7	15	5.3
1986	30.2	39.6	5.8	15	4.5
1985	25.5	38.6	5.2	14	3.6
1984	26.5	35.9	4.5	13	3.4
1983	25.5	31.2	3.7	12	3.1
1982	21.5	28.7	3.2	11	2.4
1981	19.1	28.8	3.2	11	2.1

Source: Survey of Current Business, U.S. Industrial Outlook various and BPS estimates

e - linear estimate
NOTE: Revenues include both air freight and airmail revenues transported by scheduled & unscheduled and Section 418 domestic air cargo carriers

c) RAIL TRANSPORT SERVICES

Table A-16 presents rail industry GDP attributable to logistics costs for Canada and the U.S.A.

In the case of rail transport, the freight revenue share of total operating revenues is multiplied by the constant dollar value of industry gross domestic product to obtain the share attributable to logistics.

The rail transport industry is dominated by the movement of freight. In Canada, freight revenues of approximately $5.9 billion in 1992 accounted for 86% of the total operating revenues of the rail transport industry. The transport of goods by rail represented between 0.5 and 0.7 per cent of GDP in the 1981-92 period.

In the U.S. the railways generated approximately $32 billion in operating revenues in 1992. Freight accounted for the greatest proportion of these revenues, almost $23 billion in 1992 (the contribution by Amtrak, the passenger rail operator, is small with revenues of $1.3 billion in 1992).

Table A-16
GDP - Railroad Freight Transportation

	CANADA $1986, M	Share of GDP, %	U.S. $1987, B	Share of GDP, %
1993	3,352	0.65		
1992	3,312	0.66	23.3e	0.47
1991	3,224	0.65	21.7	0.45
1990	3,180	0.63	22.2	0.45
1989	3,173	0.63	20.9	0.43
1988	3,525	0.72	21.9	0.46
1987	3,352	0.71	20.6	0.45
1986	3,235	0.72	18.5	0.41
1985	2,988	0.68	18.5	0.43
1984	2,987	0.71	18.7	0.44
1983	2,212	0.56	16.6	0.46
1982	1,934	0.51	15.0	0.40
1981	2,973	0.64	17.4	0.45

Average Annual Growth, %
1981-1992   0.4   2.7

Source: Statistics Canada Catalogues 51-206, 51-501E, 52-216, 15-001; Survey of Current Business, May 1993, ENO Transportation Foundation Inc.

Table A-17
Canada - Rail Industry Revenues and GDP, $1986, M

	Freight Revenues	Total Revenues	Share	Rail Transport GDP	GDP Attributed to Logistics
1993	na	na	85.0e	3,943	3,352e
1992	5,931	6,910	85.8	3,860	3,312
1991	6,032	6,995	86.2	3,740	3,224
1990	5,845	6,857	85.2	3,732	3,180
1989	5,941	7,233	82.1	3,865	3,173
1988	6,446	7,778	82.9	4,252	3,525
1987	6,446	7,711	83.6	4,009	3,352
1986	6,092	7,377	82.6	3,917	3,235
1985	6,000	7,452	80.5	3,712	2,988
1984	6,017	7,350	81.9	3,665	2,987
1983	5,120	6,786	75.5	2,930	2,212
1982	4,318	6,012	71.8	2,693	1,934
1981	4,659	5,271	88.4	3,363	2,973

Source: Statistics Canada 52-003, 52-216, 15-001

Table A-18b
U.S.A - Rail Industry Revenues and GDP, $1987, M

	Freight Revenues	Passenger Revenues	Share	Rail Transport GDP	GDP Attributed to Logistics
1992			94.2e	24.7e	23.3
1991	29,517	1,754	94.4	23.0	21.7
1990	30,056	1,719	94.6	23.5	22.2
1989	29,573	1,684	94.6	22.1	20.9
1988	29,544	1,629	94.8	23.1	21.9
1978	28,070	1,575	94.7	21.7	20.6
1986	27,518	1,533	94.7	19.5	18.5
1985	28,690	1,642	94.6	19.6	18.5
1984	30,038	1,438	95.4	19.6	18.7
1983	26,869	1,211	95.7	17.3	16.6
1982	26,652	1.004	96.4	15.6	15.0
1981	30,082	963	96.9	17.9	17.4

Source: ENO Transportation Foundation Inc.

d) Pipeline Transportation Services

The value of the GDP of Pipeline Transport services in Canada, includes both oil and gas pipeline transportation services and is comparable in magnitude to rail transport. In comparison to the U.S., the Pipeline Transport industry is of comparable magnitude. However only oil pipeline transport is reported for the U.S[19]. Pipeline transport in Canada grew substantially in the 1980s and as a share of GDP, ranged between 0.5 to 0.7% in the 1981-1992 period.

In comparison, Pipelines have declined in importance in the U.S. over the past decade.

Table A-18
Pipeline Transportation Industry GDP

	Canada $1986, M	Share of GDP, %	U.S. $1987, B	Share of GDP, %
1993	3,856	0.69	na	-
1992	3,482	0.72	4.4e	0.09
1991	3,141	0.63	5.2	0.11
1990	2,970	0.59	4.5	0.09
1989	2,880	0.57	4.9	0.10
1988	2,798	0.57	4.8	0.10
1987	2,390	0.51	5.2	0.11
1986	2,126	0.47	4.3	0.10
1985	2,135	0.49	5.4	0.13
1984	2,050	0.49	5.4	0.13
1983	1,910	0.48	6.3	0.16
1982	1,858	0.49	6.7	0.18
1981	1,896	0.48	5.9	0.15

Average Annual Growth, %
1981-1992   5.5   -2.6

Source: Statistics Canada 15-001; Survey of Current Business Nov. 1993;
e - linear estimate

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[19] Gas pipeline transport is reported with production and is included (and inseparable from) Utilities.

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e)   **Water Transportation Industry**

The Water Transportation industry (SIC 44) in the U.S. includes firms that transport freight and passengers on the open seas (the largest component), the inland waterways of the Great Lakes and that provide services such as lighterage, towing and canal operations. Freight transportation and incidental services provide a majority of the industry's revenues. In 1987 freight and incidental services constituted 89% of revenues.

Water transportation in the U.S. declined in economic importance over most of the 1980s and has been relatively flat in the past few years. In contrast, the Canadian water transport sector grew quickly through 1988 but by 1993 GDP was little further ahead of its 1981 level.

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Table A-19
Water Transportation Industry GDP

</div>

	Canada $1986, M	Share of GDP	U.S. $1987, B	Share of GDP
1993	1,091	0.21		
1992	1,184	0.28	8.3e	0.17
1991	1,383	0.28	8.2	0.17
1990	1,400	0.28	8.0	0.17
1989	1,460	0.29	7.8	0.16
1988	1,514	0.31	7.7	0.16
1987	1,463	0.31	8.0	0.18
1986	1,298	0.28	8.2	0.19
1985	1,275	0.29	8.4	0.20
1984	1,288	0.31	8.6	0.21
1983	1,298	0.33	8.5	0.22
1982	1,101	0.29	9.0	0.24
1981	1,056	0.27	9.7	0.25

Average Annual Growth, %
1981-1992	1.0		-1.4	

e - linear estimate, GDP figures have not been adjusted for passenger revenues
Source: Statistics Canada 15-001; Survey of Current Business, Nov. 1993; U.S. Industrial Outlook 1993.

f) Other Transportation Services

Other transportation services for both Canada and the U.S. are presented in Table A-20.

Table A-20
CANADA - Other Logistics Costs GDP

	Canada Other Transport Services 1986$, M	Share of GDP, %	Canada Highway & Bridge Maintenance 1986$, M	U.S.A. Other Transportation Services, $1987, B	Share of GDP %
1993					
1992	1,770e		69e	16.9e	0.34
1991	1,713e	0.35	71e	14.8	0.30
1990	2,066	0.33	88	15.0	0.31
1989	1,913	0.32	84	14.6	0.30
1988	1,473	0.30	88	13.8	0.29
1987	1,504	0.32	86	13.1	0.29
1986	1,425	0.32	77	12.5	0.28
1985	1,437	0.33	81	12.0	0.28
1984	1,354	0.32	86	11.0	0.27
1983	1,252	0.32	96	10.0	0.26
1982	1,107	0.29	85	9.3	0.25
1981	1,151	0.29	114	9.0	0.23
Average Annual Growth, %					
1981-1992	3.9		-4.6	5.7	

e - linear estimate
Source: Statistics Canada 15-001; Survey of Current Business, Nov 1993; U.S. Industrial Outlook 1993.

APPENDIX II

PRIVATE TRUCKING

Private carriers are defined as carriers whose principal activity is not for-hire trucking. Statistics Canada survey is based on 505 Canadian-domiciled private carriers in 1990 and 453 in 1991 (compared to the 1,350 for-hire carriers with having $1 million in revenues). Their principal activities in order of importance were the transportation of general freight, dry bulk, other transport, liquid bulk and forest products.

	1990	1991
Total Operating Revenues	$1.6 billion	$1.1 billion
Employment	29,342	27,185
Equipment (units)	32,798	35,060

INTERCITY BUS TRANSPORTATION

The Intercity Bus segment earns income from Baggage and Parcel express (BPX), as well as passenger transportation services. In 1980 BPX revenues totalled $45 million or 17% of total revenues and by 1990 BPX revenues had risen to $88.6 million or 22% of total revenues.

APPENDIX III

1990 Input Categories
108 TRUCK, BUS & OFF-HIGHWAY TIRES
109 OTHER TIRES, TUBES & REPAIR MATERIAL
110 CONVEYOR & TRANSMISSION BELTING
113 PLASTIC CONTAINERS & CLOSURES
134 ROPE & TWINE
156 WOOD CONTAINERS
167 WRAPPING & SACK PAPER
168 PAPER BOARD, INCL BOXBOARD
174 PAPER BAGS, BOXES, PLASTIC BAG
177 PAPER CONTAINERS FOR COMMERCIAL
192 IRON&STEEL RAILWAY CONST. MATERIAL
254 CONVEYORS, ELEVATORS & HOIST.
255 IND. TRUCKS & MAT. HANDLING EQUIPMENT
265 AIRCRAFT
266 AIRCRAFT ENGINES
267 AIRCRAFT PARTS & EQUIPMENT
268 AIRCRAFT SERVICES & REPAIRS
270 TRUCKS, ROAD TRACTORS & CHASSIS
274 TRAILERS & SEMI-TRAILERS
275 TRUCK & BUS BODIES
276 MOTOR VEHICLE ENGINES & PARTS
277 MOTOR VEHICLE ELECTRIC EQUIPMENT
278 OTHER MOTOR VEHICLE PARTS
279 LOCOMOTIVE & RAILWAY ROLLING STOCK
281 PARTS FOR RLWY&U.TRANS. ROLLING
282 SHIPS, BOATS & PARTS, EXCL PLEASURE
283 SHIP REPAIRS
322 GASOLINE
323 DIESEL & FUEL OIL, AVIATION FUEL
461 RENTAL OF AUTOMOBILES & TRUCKS

NOTE: The total of the above materials have been summed for each industry in the input matrix. The transportation industries assessed above have been omitted as have the vehicle assembling industries such as Shipbuilding, Motor Vehicles etc.

APPENDIX IV

SELECT INDUSTRY STATISTICS

CANADA - Gross Domestic Product at Factor Cost
Millions of 1986 Constant Dollars

Year	Transportation & Storage	Share	Transportation	Share	Year	Transportation & Storage	Share	Transportation	Share
1961	6,981	4.46	6,065	3.88	1977	15,387	4.39	12,744	3.64
1962	6,961	4.15	6,004	3.58	1978	16,120	4.46	13,481	3.73
1963	7,713	4.36	6,619	3.74	1979	18,030	4.81	15,110	4.03
1964	8,484	4.48	7,270	3.84	1980	17,349	4.54	14,635	3.83
1965	8,988	4.43	7,716	3.80	1981	17,103	4.31	14,536	3.66
1966	9,678	4.46	8,265	3.81	1982	16,156	4.22	13,615	3.56
1967	9,886	4.43	8,297	3.72	1983	17,340	4.39	14,769	3.74
1968	10,260	4.36	8,570	3.64	1984	19,362	4.62	16,661	3.98
1969	11,217	4.52	9,353	3.77	1985	19,774	4.51	17,034	3.88
1970	12,203	4.84	10,116	4.01	1986	20,253	4.48	17,493	3.87
1971	12,711	4.76	10,574	3.96	1987	21,660	4.59	18,539	3.93
1972	13,603	4.82	11,040	3.91	1988	22,756	4.62	19,297	3.92
1973	14,545	4.78	11,740	3.86	1989	22,033	4.37	18,593	3.69
1974	15,142	4.80	12,357	3.92	1990	21,770	4.33	18,183	3.62
1975	14,851	4.64	12,260	3.83	1991	21,251	4.27	17,442	3.51
1976	14,732	4.34	12,248	3.61	1992	21,916	4.35	17,798	3.53
					1993	22,544	4.36	18,022	3.48
Average Annual Growth, %									

CANADA - Gross Domestic Product at Factor Cost - Transportation & Storage Sector
Millions of 1986 Constant Dollars

Year	Air	Share	Railway	Share	Water	Share
1961	584	0.37	1,458	0.93	657	0.42
1962	539	0.32	1,391	0.83	688	0.41
1963	537	0.30	1,560	0.88	802	0.45
1964	601	0.32	1,808	0.95	800	0.42
1965	681	0.34	1,815	0.89	889	0.44
1966	836	0.39	1,893	0.87	1,029	0.47
1967	937	0.42	1,845	0.83	945	0.42
1968	984	0.42	1,956	0.83	917	0.39
1969	1,124	0.45	2,194	0.88	1,015	0.41
1970	1,228	0.49	2,594	1.03	1,053	0.42
1971	1,186	0.44	2,833	1.06	1,089	0.41
1972	1,413	0.50	2,980	1.06	1,026	0.36
1973	1,714	0.56	3,056	1.00	1,017	0.33
1974	1,910	0.61	3,300	1.05	993	0.31
1975	1,942	0.61	2,930	0.92	864	0.27
1976	1,863	0.55	2,895	0.85	932	0.27
1977	2,020	0.58	3,092	0.88	1,075	0.31
1978	2,131	0.59	3,171	0.88	1,070	0.30
1979	2,502	0.67	3,593	0.96	1,084	0.29
1980	2,259	0.59	3,427	0.90	1,165	0.30
1981	2,177	0.55	3,363	0.85	1,056	0.27
1982	2,144	0.56	2,693	0.70	1,101	0.29
1983	2,290	0.58	2,930	0.74	1,298	0.33
1984	2,631	0.63	3,665	0.88	1,288	0.31
1985	2,811	0.64	3,712	0.85	1,275	0.29
1986	2,921	0.65	3,917	0.87	1,298	0.29
1987	2,867	0.61	4,009	0.85	1,463	0.31
1988	3,005	0.61	4,252	0.86	1,514	0.31
1989	2,903	0.58	3,865	0.77	1,460	0.29
1990	2,816	0.56	3,732	0.74	1,400	0.28
1991	2,443	0.49	3,740	0.75	1,383	0.28
1992	2,350	0.47	3,860	0.77	1,184	0.24
1993	2,261	0.44	3,943	0.76	1,091	0.21
Average Annual Growth, %						

Note: share is based on the Total economy

CANADA - Gross Domestic Product at Factor Cost by Transportation & Storage Sector
Millions of 1986 Constant Dollars, cont.

Year	Trucking	Share	Other*	Share	Pipeline	Share	Storage & Warehousing	Share	Business Sector	Total Economy
1961	1,786	1.14	2,409	1.54	503	0.32	414	0.26	121,795	156,428
1962	1,882	1.12	2,396	1.43	598	0.36	358	0.21	130,896	167,573
1963	2,114	1.19	2,403	1.36	663	0.37	432	0.24	138,543	177,090
1964	2,242	1.18	2,514	1.33	752	0.40	463	0.24	148,651	189,443
1965	2,541	1.25	2,641	1.30	819	0.40	453	0.22	160,109	202,964
1966	2,625	1.21	2,833	1.31	911	0.42	502	0.23	171,161	216,770
1967	2,726	1.22	2,947	1.32	1,071	0.48	518	0.23	175,026	223,148
1968	2,815	1.20	2,934	1.25	1,202	0.51	488	0.21	184,611	235,312
1969	3,038	1.22	2,832	1.14	1,314	0.53	551	0.22	194,722	248,309
1970	2,891	1.15	2,838	1.12	1,503	0.60	585	0.23	197,017	252,299
1971	2,897	1.08	2,815	1.05	1,584	0.59	553	0.21	209,078	267,060
1972	2,943	1.04	2,879	1.02	1,963	0.70	600	0.21	222,037	282,176
1973	3,118	1.02	3,004	0.99	2,204	0.72	601	0.20	241,624	304,410
1974	3,111	0.99	3,130	0.99	2,154	0.68	631	0.20	250,168	315,621
1975	3,413	1.07	3,298	1.03	1,972	0.62	619	0.19	252,134	320,035
1976	3,376	1.00	3,442	1.01	1,898	0.56	587	0.17	269,291	339,251
1977	3,249	0.93	3,519	1.01	2,034	0.58	609	0.17	278,574	350,146
1978	3,614	1.00	3,701	1.02	2,019	0.56	620	0.17	288,043	361,078
1979	4,350	1.16	3,567	0.95	2,284	0.61	635	0.17	301,107	375,112
1980	4,197	1.10	3,750	0.98	2,038	0.53	677	0.18	307,193	381,992
1981	4,280	1.08	3,919	0.99	1,896	0.48	672	0.17	320,322	397,090
1982	4,201	1.10	3,685	0.96	1,858	0.49	684	0.18	304,834	382,575
1983	4,525	1.15	3,849	0.97	1,910	0.48	662	0.17	315,885	394,995
1984	5,254	1.25	3,808	0.91	2,050	0.49	651	0.16	337,825	418,717
1985	5,263	1.20	4,005	0.91	2,135	0.49	606	0.14	356,318	438,450
1986	5,385	1.19	3,972	0.88	2,126	0.47	635	0.14	368,542	451,845
1987	6,085	1.29	4,114	0.87	2,390	0.51	732	0.16	386,796	471,519
1988	6,418	1.30	4,108	0.83	2,798	0.57	662	0.13	406,051	492,588
1989	6,122	1.22	4,244	0.84	2,880	0.57	560	0.11	415,060	503,661
1990	5,925	1.18	4,311	0.86	2,970	0.59	616	0.12	412,308	502,691
1991	5,761	1.16	4,115	0.83	3,141	0.63	668	0.13	405,600	497,163
1992	6,435	1.28	3,969	0.79	3,482	0.69	635	0.13	410,909	503,638
1993	6,784	1.31	3,941	0.76	3,856	0.75	667	0.13	424,696	517,483
Average Annual Growth, %										

* Transportation minus the sum of Rail, Rail, Water and Trucking

Table A-1 presents the inflation adjusted (real) GDP of Canada measured at market prices (expenditure based) and at factor cost, and of the U.S.A. measured at market prices. A point of note is that the growth rate of each measure of GDP for Canada has been identical.

Table A-1
GROSS DOMESTIC PRODUCT (billions)

| | CANADA (Constant 86$) | | U.S. (Constant 87$) |
	Factor Cost	Market Prices	Market Prices
1993	517.5	573.4	5,136
1992	503.6	560.1	4,986
1991	497.2	556.0	4,861
1990	502.7	565.6	4,897
1989	503.7	565.8	4,838
1988	492.6	553.0	4,719
1987	471.5	526.7	4,540
1986	451.9	505.7	4,405
1985	438.5	489.4	4,280
1984	418.7	467.2	4,149
1983	395.0	439.5	3,907
1982	382.6	426.0	3,761
1981	397.1	440.1	3,843
Average Ann. Growth % 1981-1993	2.2	2.2	2.4

Source: Statistics Canada 15-201; Survey of Current Business

3

DISCUSSION PAPER #2

THE DISTRIBUTION AND STORAGE SECTOR:
THE SUPPLY & DEMAND OF TRANSPORTATION SERVICES

Prepared for the Distribution Service Industries Directorate,
Distribution and Construction Industries Branch,
Industry Canada

by Alan Jones

[Views, comments and opinions contained herein are those of the author, and
do not represent those of either Industry Canada or the Government of Canada]

November 1994

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INTRODUCTION

An efficient logistics system depends critically on a competitive yet profitable industrial structure which can distribute and store goods within an economy. Over time the industrial structure of a country changes; some industries grow and in this regard become increasingly more important in economic terms while others recede. In addition the way in which firms carry on business within the growing as well as declining sectors changes as well. The cost structure of firms and industries is not independent of such events and will reflect 'structural economic change'. Production and the changes that occur over time can be fully captured by the cost structure of an industry.

This is the second paper[1] that is concerned with the movement and storage of goods (i.e. logistics) in the Canadian economy. It undertakes to investigate demand and supply conditions in the Transportation and Storage sector in Canada and documents significant changes in the allocation of resources in and among the various Canadian industries over the 1971 to 1990 period. An inter-industry framework facilitates this type of analysis.

The main focus of this research is the cost structure of transportation supply as well as the cost structure of industries that are the consumers of these services. To address this issue both current dollar data and constant dollar data is utilized and cost shares or ratio analysis is relied upon.

Two explanatory points should be addressed. First, since unadjusted-for-inflation data is required to include labour costs in the cost

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[1] The first paper (The Economic Costs of Logistics: The Costs of Distributing and Storing Goods and Services (Canada and the U.S. Compared), Industry Canada, revised 1994)) addressed the aggregate net economic cost (benefit) of logistics to the Canadian and U.S. economies.

structure, the question of price effects arise. Since most of the analysis is expressed in terms of a ratio or share, price effects generally 'wash out'. A second potential concern is the use of an end-point analysis. The analysis is concerned with how certain cost variables are today (1990) as opposed to how they were yesterday (1971). If the share in total cost of a given variable is lower today relative to yesterday, the fact that it may have risen in the interim (and some undoubtedly do) or continually declined over time is as well interesting, and reflects the many different stimuli that impact a firm or industry, but does not negate the ultimate trend of a declining cost share.

The data set was obtained from the Input-Output Division at Statistics Canada and covers the period 1971-1990. It encompasses a pre- and ongoing deregulation environment for the Transportation sector. It also covers two major recessions and a cautionary flag should be raised concerning the performance of firms and hence industries in the terminal year (1990) of the analysis.

One potentially useful way in which to view the data and the analysis is in terms of an 'average firm' or 'benchmark'. Since the data on which this analysis is based is grouped according to industry, the indicated performance can be considered as an average - some firms will perform above the various metrics established in this paper and others will underperform. Further work may use such benchmarks as a point of comparison.

CONCLUSIONS

- the research suggests that productive and allocative inefficiencies may exist in certain elements of the transportation system in Canada;

SUPPLY

⇒ the business of providing transportation services is one of increasing cost and declining profitability;

⇒ the average cost of providing transportation services is lowest in the Pipeline and Trucking industries; Air and Railway services are high cost modes;

⇒ **labour costs:** generally the largest element of providing transportation services; labour costs rose more slowly than output in the Air, Rail, and Trucking industries in the 1971-1990 period;

⇒ **structure of cost:** the relative importance of labour in the overall cost structure of transportation services providers has decreased; increasingly producer services appear to be substituting for the services of labour;

⇒ the tax burden carried by industry is a substantial element of the high cost of production, but one that has not been increasing at a rapid pace;

DEMAND

⇒ aggregate transportation costs incurred by Canadian industry in relation to output declined in importance over the 1971-1990 period;

Manufacturing

⇒ the structure of industrial demand for transportation services remained basically unchanged - major users in 1971 continued to be major users in 1990;

⇒ a number of manufacturing industries faced increasing costs for transportation services relative to output in the 1971-1990 period; increased transportation demand intensity and increased transportation unit margins are indicative of potential distribution problems;

⇒ heavy and intensive transportation using industries supply domestic consumer or inter-industry markets; the movement of industry output to and from border points (for export & import) is less of a market of importance;

⇒ an increase in the share of Air Transport and Pipeline Transport costs together with a decline in the Trucking cost share of industry is consistently associated with increased transportation intensity;

Non-Manufacturing

⇒ non-manufacturing demand for transportation services declined relative to production in the 1971-1990 period;

⇒ all sectors, except for a very small rise in FIRE, experienced reduced transportation intensity;

⇒ Primary industries appear to have been the most affected by a rise in transportation intensity; seven of thirteen industries (especially Iron Mines and Non-Metal Mines) underwent a relative increase in demand for transportation;

⇒ Banking industries, the Accomodation and Food industry, Motion Picture and Video and Other Services industry exhibited increasing transportation intensity over time.

1)   TRANSPORTATION SERVICES SUPPLY

i) INTRODUCTION[2]

The supply of services by the Transportation and Storage sector[3] to Canadian industry constitutes a substantial element of real economic activity. In 1993, the Transportation and Storage Sector accounted for $22.5 billion ($1986) of Canadian gross domestic product, or 4.4% of **inflation adjusted economic** activity. This proportion was <u>down slightly</u> from 4.8% ($12.6 billion, $1986) in 1971.

Over the past nineteen years, the importance of each industry in the Transportation and Storage sector has changed (Figure 1). The supply of services by the Pipeline industry, Air and Trucking industries respectively, rose in relative importance. The Rail and Water industries as well as Storage and Warehousing (and the Maintenance industries) have declined in relative terms.

An alternative metric to gross domestic product is utilized for comparative purposes in this paper: the gross output or production of an industry (the terms gross output and production will be used synonomously throughout this paper although strictly speaking production is equal to shipments adjusted for inventories). Output is the aggregate value of all inputs utilized in production, both primary and intermediate (and therefore <u>includes</u> the value added contribution of an industry).

In 1990, the aggregate value of industrial output totalled $1.02 trillion of which the Transportation and Storage sector contributed $43.5 billion or 4.3%. This proportion was down from 4.9% in 1971[4].

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[2]   The Statistical Appendix at the end of the paper describes the Input-Output tables, how they are constructed and the data of relevance to the current study.

[3] The Transportation and Storage sector is comprised of Air, Rail, Water and Truck transportation services as well as Pipeline Transport services, the Storage and Warehousing industry and the Highway and Bridge Maintenance industry. The latter is not a focal point of this paper. Also included in the sector but not considered as an integral element of the logistics network are the Urban Transit System, Interurban and Rural Transit and Taxicab industries. The constituent industries of this sector are described in the Industry Definition Appendix at the end of the paper.

[4]   If the Pipeline Transport industry is removed, the share of gross output of the Transportation and Storage sector declined from 4.5% in 1971 to 3.9% in 1990. Consequently, the decline in share is the same with or without the inclusion of this industry.

Figure 1
The Changing Mix of Transportation Supply
(GDP shares, $1986)
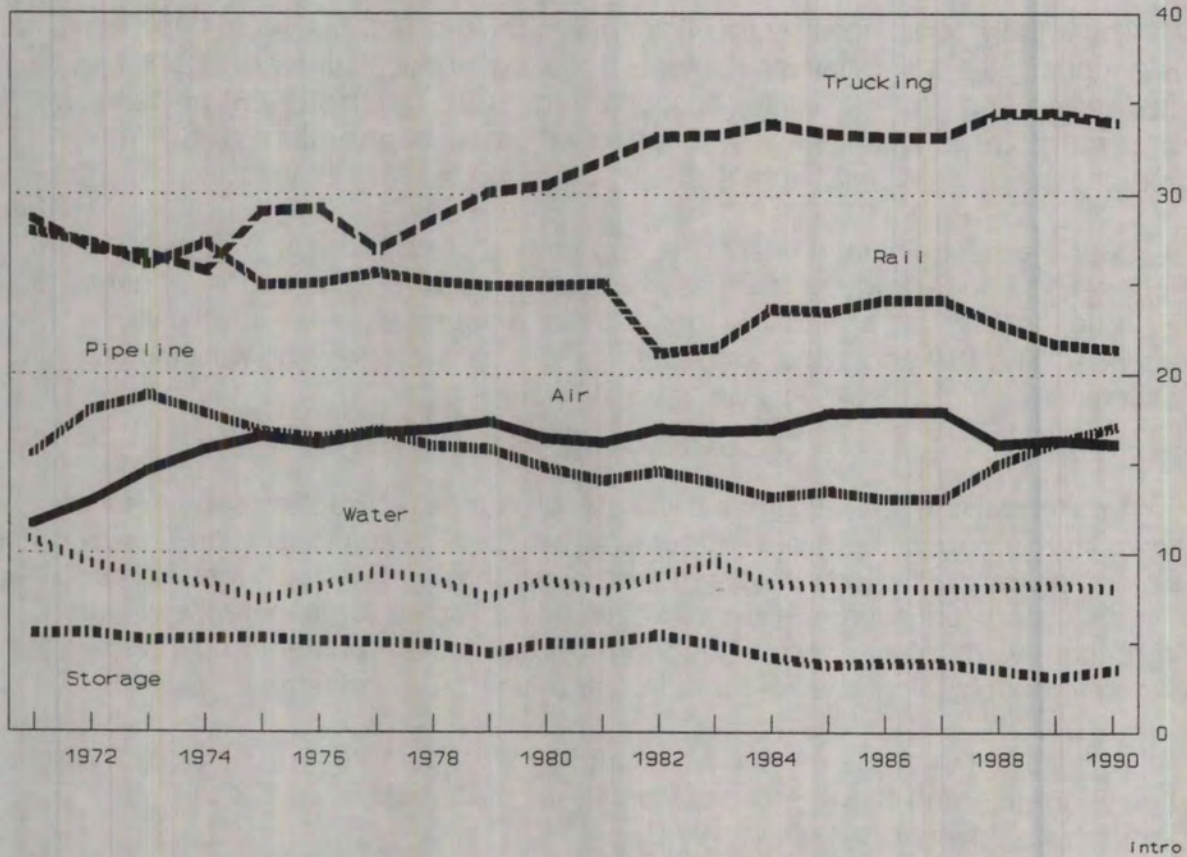
ii) TRANSPORTATION SUPPLY[5]: COST STRUCTURE

a) AVERAGE COSTS OF PRODUCTION

TO MOST SHIPPERS, TRUCKING IS THE LOWER COST ALTERNATIVE; PIPELINES EXHIBIT THE LOWEST COST OF ALL MODES TRANSPORTATION INDUSTRIES ...

Figure 2

Unit or average costs (total cost per unit of output) rose in all transportation and storage industries in the 1971-1990 period. The largest increases took place in the Pipeline Transport industry (35%), followed by Air Transport Services (15%) and the Other Transport industry (13%). Truck Transport experienced the smallest change in average costs in the eighteen year period (0.1%), while the Water Transport industry experienced a small increase of 2%.
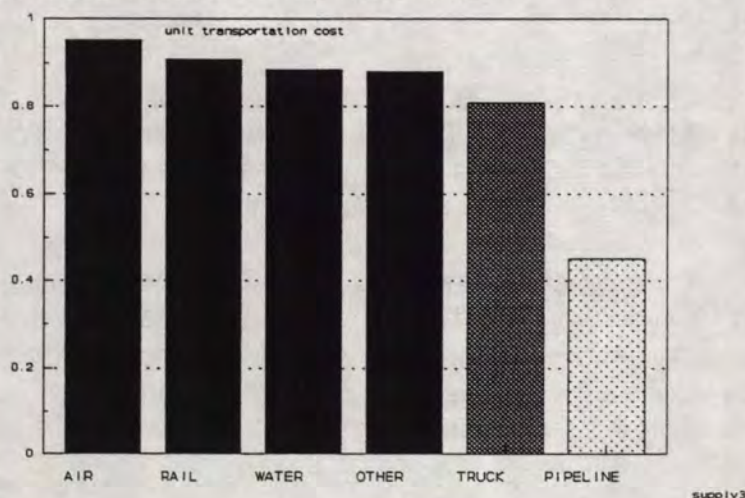
The cost of supplying one dollar's worth of transportation service is highest for the Air Services industry followed by the Water and Rail Transport industries. In 1990 it cost the Air Transport industry $0.95 to produce $1 of service, up from $0.83 in 1971. Rail Transport costs also rose substantially from $0.82 in 1971 to $0.89 in 1990. Water Transport unit costs moved marginally higher, from $0.90 to $0.92, over the period.

Pipeline Transport is the lowest cost producer of a transportation service at $0.45 per unit of output in 1990 followed by Truck Transport at $0.85.

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[5] The total cost of each industry is composed of the value of all intermediate inputs, the return to labour, and the net value of indirect taxes, government charges and subsidies. Only the surplus in the Input-Output framework is omitted to calculate cost.

b) LABOUR COSTS

Labour costs (i.e. wages, salaries and supplementary benefits), are the single largest cost component of each transportation industry except the Pipeline Transport industry.

In the 1971-1990 period a number of transportation sector industries became more labour intensive (i.e. Water, Other Transport Services and Pipelines), while four of the seven industries managed to reduce the labour component of total cost (i.e. Air, Rail, Trucking and the Storage industry).

Labour costs grew fastest in the Other Transport Services industry followed by the Pipeline industry (Table 1). In both cases labour costs rose faster than output. Air Transport and Trucking were next according to high labour cost growth, however the output of the two industries grew faster than labour costs. Labour costs in the Water Transport industry rose faster than output while the production of the Rail and Storage industries outpaced labour costs growth.

c) MAJOR NON-LABOUR COST BY INDUSTRY[6]

Table 1 presents the growth rates of the major non-labour components of cost used by the transportation services producing industries. The 1990 cost structure and relative importance of each component is presented in Table 2 (below).

Taxes, government charges and subsidies are discussed separately below.

---

[6] The current dollar values of each industry's cost have been divided among the major inputs by sector of origin, plus labour and other elements including net taxes. The Goods group is composed of the Manufacturing and Primary sectors; the Construction sector is reported on its own; FIRE includes expenditures on the Financial and Insurance industry, including Real Estate; TCU, the Transportation, Communications and Utilities expenditures; Other Services includes Retail and Wholesale, and Business and Miscellaneous Services; and the Other group consists of costs which cannot be classified by industry of origin and are mainly operating and office supplies and promotional costs.

Table 1
Growth of the Major Cost Components
of the Transportation & Storage Sector, 1971-1990 (current$)

GROWTH 1971-1990, %	AIR TRANSPORT	RAIL TRANSPORT	WATER TRANSPORT	TRUCK TRANSPORT	OTHER TRANSPORT	PIPELINE TRANSPORT	STORAGE & WAREHOUSING
PRODUCTION	11.9	6.0	7.1	9.9	14.3	9.7	8.1
GOODS	15.3	8.8	8.5	9.6	12.5	7.4	12.1
CONSTRUCTION	11.7	8.3	11.1	6.8	6.8	14.1	9.3
Finance, Insurance & Real Estate (FIRE)	12.5	9.7	8.9	10.3	15.5	12.7	10.6
Transportation, Communications & Utilities (TCU)	13.9	6.6	4.9	11.8	15.7	11.0	9.8
OTHER SERVICES	14.0	10.9	10.1	10.9	15.5	13.0	11.2
OTHER	9.2	3.3	6.8	8.7	10.9	8.9	10.2
LABOUR	10.8	5.5	7.5	9.0	16.2	11.8	6.8
NET INDIRECT TAXES, GOVT G&S, SUBSIDIES	13.4	11.1*	10.2	8.9	11.4	10.9	8.0

Source: Statistics Canada Input-Output division
*: growth rate is for 1971-1989; in 1990 subsidies to the Rail transport industries were large enough to offset the sum of indirect taxes and government receipts for goods and services.

Intermediate input demand, or the demand for the non-primary factors of production, includes all purchases of goods and services required to operate a business, such as telecommunications, accounting services, financial services to purchase capital equipment and the fuel to heat and light premises and operate machinery. Some elements of the business of providing transportation services are similar among modes. However for each mode there is a basic recipe, one which remains relatively constant over time but in which the relative importance of the ingredients may change.

The most striking feature of Table 1 is the **growth rate in the demand for intermediate inputs relative to output**. Generally the demand for such inputs as business services, communications and financial services have grown at rates in excess of industry output.

Table 2 (see Appendix I, page 31) reinforces this observation by presenting the share of each cost component for the transportation sector for the years 1971 and 1990. Following is a discussion of the cost structure of each transportation industry.

AIR TRANSPORT SERVICES

The supply of Air Transport services (which includes both passenger services and freight services) has increased at an average annual rate of 11.9% over the 1971-1990 (Figure 2). Value added however receded as a proportion of total output.

Air Transportion continues as the highest cost transportation service in Canada.

Purchased inputs from the Goods sector, followed by the Other Services group and the Transportation, Communications and Utilities (TCU) sector and Finance, Insurance and Real Estate (FIRE) are prominent in the production of Air Transport services. Each has increased in relative importance while labour inputs decreased in importance in the 1971-1990 period.

A significant amount (94%) of the Goods sector purchases are accounted for by the Aircraft & Parts industry (55%) and the Refined Petroleum and Coal Products (42%) industry. The Rubber Products industry and the Motor Vehicle industry, the next largest, supply less than 3% of the input costs of the Air Transport industry. This pattern changes little over time and is
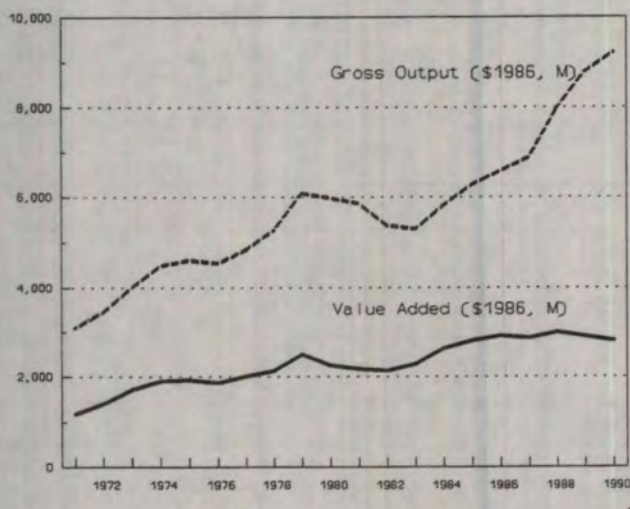
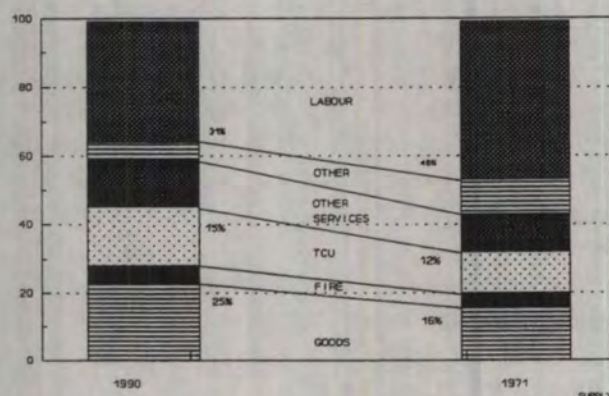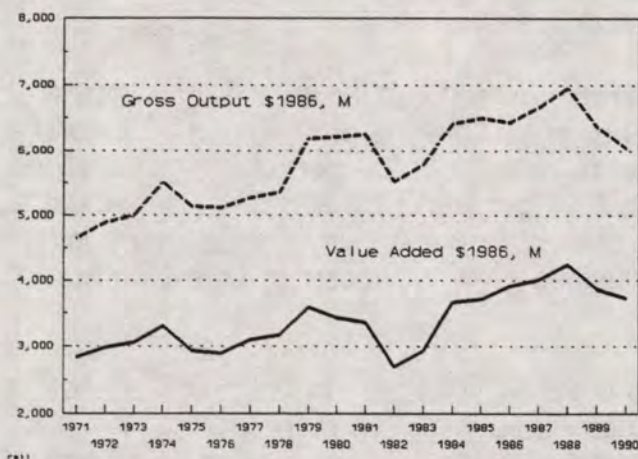**Figure 3**: Air transport supply 1971-1990

Figure 4
Air Transport Services
Major Cost Components

determined primarily by the annual purchase and servicing of aircraft.

The second major group of inputs is the Other Services group. Accommodation and Food Service industry, Wholesale industry, Miscellaneous Services and Business services industry are major sources of industry expenditures in this group. Individually, each of these sources accounted for a greater share of costs in 1990 than in 1971.

The third largest group of inputs is purchased from the TCU sector. Major purchases of services from intra-industry sources, the Other Transportation services industry and the Telecommunications industry account for a large portion of these costs.

Figure 5: Rail Transport Supply 1971-1990

All input groups except labour services and the purchases of Other inputs grew faster than the output of the Air Transport industry.
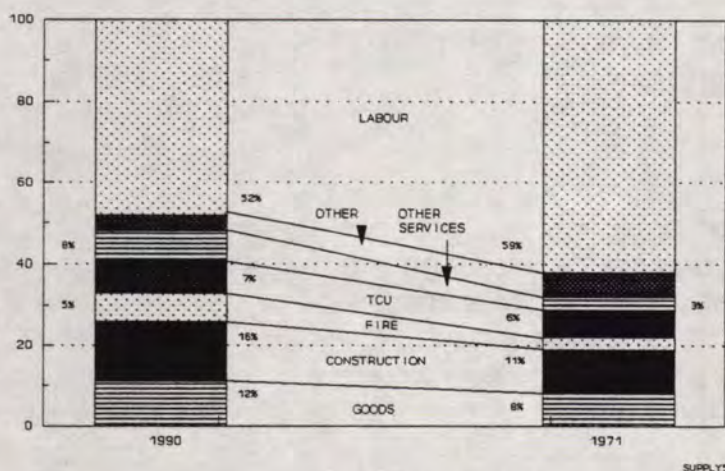
RAILWAY TRANSPORT SERVICES

The output of the Railway Transport industry grew by 6% over the 1971-1990 period, the lowest rate among the competing modes. As early as 1973, there was evidence of lower value added services.

Figure 6
Railway Transport Services
Major Cost Component

Unit costs rose from $0.82 in 1971 to $0.89 in 1990, an average annual increase of 7.8%. All major cost groups have increased in relative importance over the 1971-1990 period while relative labour costs declined.

The Construction sector (repair expenditures account for approximately 16% of total costs) followed by the Goods sector, constitute the largest shares of expenditures for the operations of Railway services. Next to construction expenditures, the Refined Petroleum industry, the Railroad Rolling Stock industry and the Primary Steel industry have been traditionally the largest sources of cost for the Railway Transport industry. Input demand from each of these three industries grew in excess of railway output in the 1971-1990 period.

The third group of major importance is the TCU sector. Major purchases of Telecommunications services and intra-industry purchases are made by the Rail Transport services industry. Telecommunications purchases grew faster than output in the 1971-1990 period. Of lesser relative importance but one that has grown substantially are the FIRE group and Other Services group; each has more than doubled in relative importance over time.

The purchase of input from each group except labour and the Other group, grew faster than Railway production in the 1971-1990 period.

WATER TRANSPORT SERVICES

Gross output of the Water Transport sector experienced the second lowest rate of growth over the 1971-1990 period. Value added advanced marginally as share of total output.

The demand for services from the TCU sector fell significantly in relative importance from 35% in 1971 to 23% in 1990. Conversely, the demand for labour by the Water
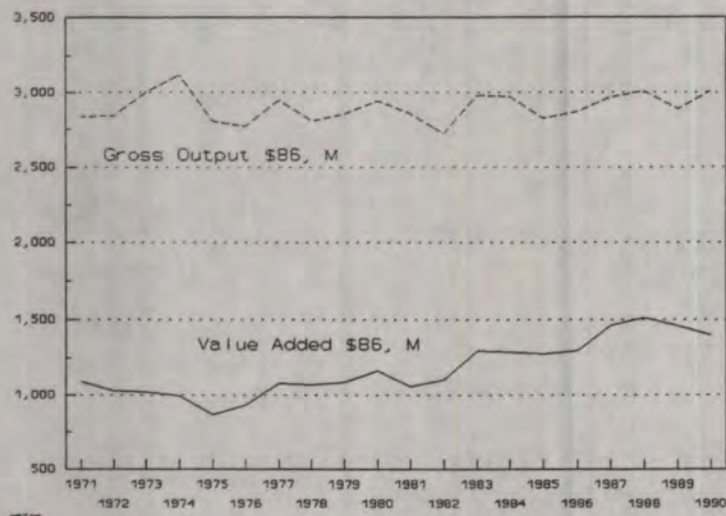
Figure 7: Water Services Supply 1971-1990

Transportion services industry
increased from 37% of industry
total costs to 39% in 1990.

Other Services costs, while a
small proportion, doubled in the period.

Intra-industry purchases are the
largest component of total costs for the
industry. In addition, the industry is a
significant user of inter-modal services,
especially, Other Transport services, rail
and trucking services. However, in the
1971-1990 period, costs represented by
this group grew more slowly than
production.

Fifteen percent of total costs in
1990 consisted of purchased from the
Goods sector. Expenditures on capital
equipment from the Shipbuilding and

Figure 8
Water Transport Services
Major Cost Component

Repair industry and fuel from Refined Petroleum industry traditionally make up the
largest components of cost purchased from the Goods sector.

An additional relatively large
increase in cost is represented by the
Other Services group.

The value of most major costs
by sector grew more rapidly than the
output of the Water Transport industry
in the 1971-1990 period.

TRUCK TRANSPORT SERVICES

The supply of for-hire trucking
services rose at an average annual rate

Figure 9
Trucking Services Supply, 1971-1990

of 10% between 1971 and 1990. Value added by the trucking industry rose by 9.3%.

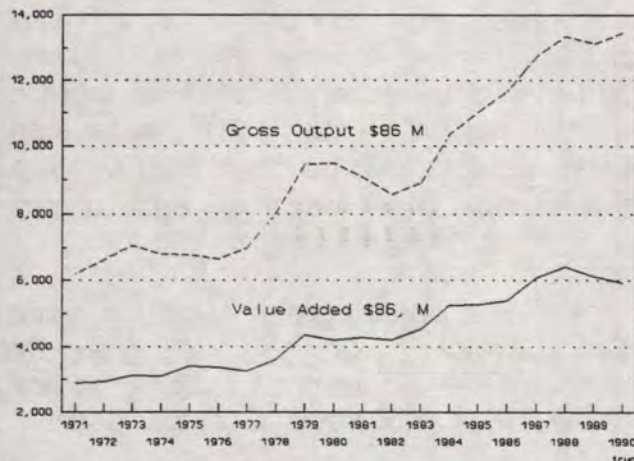The TCU sector followed by the Goods sector and Other Services sector are the major sources of inputs for the Trucking industry. Costs associated with the TCU sector and Other Services rose substantially in relative importance between 1971 and 1990 while labour costs were declining.

The demand for services from the TCU sector rose from 19% of total costs in 1971 to 27% in 1990. Intra-industry purchased inputs are the largest element of the TCU sector. Telecommunications inputs, aggregate inter-modal purchases and Utility costs are also significant cost centres. Each input class purchased from the TCU sector has grown substantially in excess of output.

Figure 10
Truck Transport Services
Major Cost Components

Goods sector input costs declined in relative importance over the period. Major purchases are made from the Refined Petroleum industry, Motor Vehicle and Parts industries, and the Battery and Rubber industries. Of the major expenditures, only the fuel portion has grown substantially faster than production. Other rapidly growing expenditures appear to be associated with repair costs from industries such as the Machine Shops, Other Machinery and Equipment industries and Electronics industries.

A third important group of input purchases that has grown relatively fast is from the Other Services group. From this group Retail and Wholesale industry purchases are substantial and have grown rapidly, as are Business Services. Health Services purchases have also grown at a rapid pace.

OTHER TRANSPORTATION SERVICES

Labour inputs increased in relative importance for the Other Transportation industry in the 1971-1990 period.

The only other major input group to also have experienced a relatively large increase in relative importance was the TCU group. Goods sector expenditures declined and there was a substantial reduction in Other costs.

Similar to the Trucking industry, the Other Transport industry makes major expenditures on intra-industry purchases, inter-modal purchases and from the Telecommunications and Utilities industries. All of these expenditures rose substantially faster than industry output.

Expenditures on Goods sector inputs declined significantly in relative importance between 1971 and 1990. Petroleum products and Rubber industry purchases are major inputs for the industry. Machine Shops, Other Machinery and Equipment and Motor Vehicle purchases are also substantial. All of the major input expenditures have grown much faster than output.

Figure 11
Other Transport Services
Major Cost Components

The Other Transport Services industry has been the fastest growing industry in the Transportation and Storage sector. The substantial relative decline in the Other group, which captures Operating and Office supplies costs, Promotional costs and Travel and Entertainment can be explained by the spreading out of such relatively small variable costs over the larger and rapidly expanding cost structure of the industry.

PIPELINE TRANSPORT SERVICES

Pipeline industry average costs are the lowest within the Transportation and Storage sector. However the industry experienced the largest increase in the 1971-1981 period. Over the 1971-1990 period, labour costs grew only slightly faster than total costs.

The largest category of expenditures incurred by the Pipeline industry are those for Transportation, Communications and Utilities services followed by Construction. TCU expenditures, which declined in relative importance over time, are dominated by intra-industry transportation services purchases. Also of major importance to the industry are expenditures on power, both electric and gas, Telecommunications and inter-industry purchases. Most major input purchases grew faster than output in the 1971-1990 period.

Growth in the pipeline industry has required significant outlays for new and repair construction. Construction grew by 15% annually, on average, while output grew by 9.9% annually.
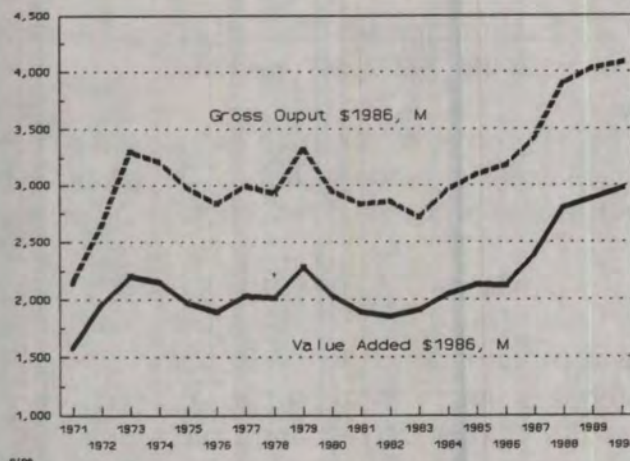
Figure 12
Pipeline Services Supply: 1971-1990
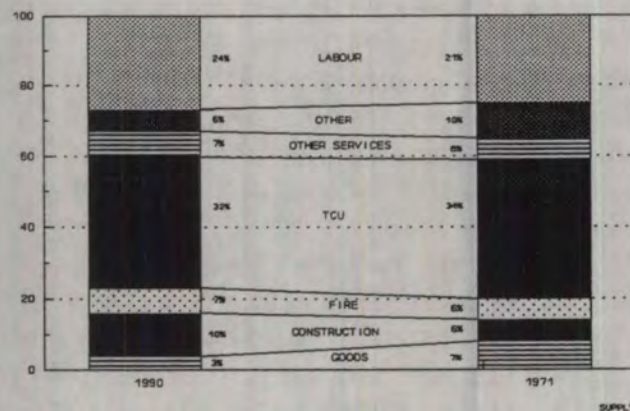
Figure 13
Pipeline Transport Services
Major Cost Components

STORAGE AND WAREHOUSING

Average costs in the Storage and Warehousing industry follow Pipelines and Trucking as the lowest in the Transportation and Storage sector as a whole. Labour which constituted two-thirds of the total cost in 1971 declined to forty-four percent by 1990.

The FIRE, TCU and Goods sectors are large in terms of inputs purchases by the industry and each has grown in relative importance over the eighteen year period. Other Services costs also increased substantially.
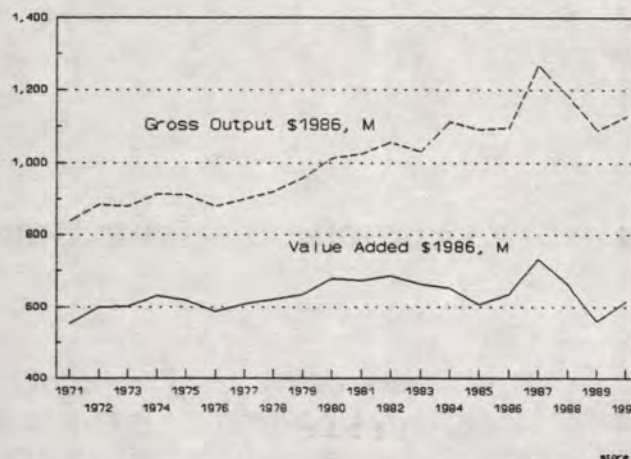
Figure 14
Storage & Warehousing Services
Supply 1971-1990
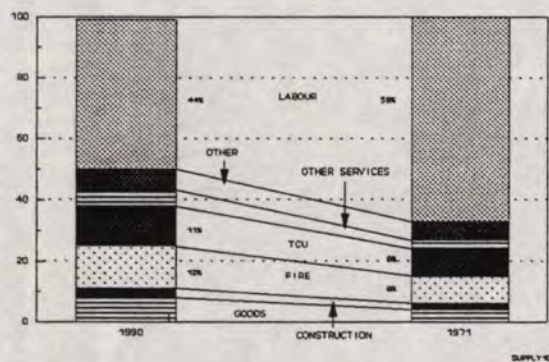
Figure 15
Storage & Warehousing Services
Major Cost Components

Expenditures on the Trust and Real Estate industry increased the fastest over the 1971-1990 period, followed by the Banking industry and Insurance industry.

Major input purchases by the industry from the TCU sector include intra-industry, inter-industry, power and telecommunications respectively. All have grown faster than industry output.

Purchases from the Goods sector doubled in relative importance over the 1971-1990 period. Key purchases from the Goods sector include the major one of fuel from the Refined Petroleum industry and crating and wrapping materials from the Other Converted Paper Products industry, Paper Box and Bag industry, Plastic Products industry, Misc. Textile Products, Pulp and Paper and the Printing and Publishing industries. All of the above inputs purchases grew faster than output.

Other Services advanced in relative importance as well. Although small compared to other groups of purchases, input expenditures from the Retail and Wholesale industries as well as Business Services industries grew relatively fast over the period.

INDUSTRY TAXATION, GOVERNMENT REVENUES AND SUBSIDIES[7]

Table 3 presents the components of cost that had been earlier reported as the total of indirect taxes, government revenues from goods and services and subsidies, and reports 1990 values. The growth rate of each component is reported in Table 4.

The average tax rate paid by the sector is highest for the Railway Trasport industry followed by the Pipeline industry and Storage and Warehousing industry. Railway services, Truck Transport and Water Transport receive respectively the largest subsidies.

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[7] Commodity indirect taxes are calculated on the producer price of an industry's output that is used as an intermediate inputs by other industries and principally consist of the federal excise taxes and import duties, provincial motor fuel taxes and provincial and municipal sales taxes; other indirect taxes include property taxes and certain fees and licensing charges and place of business taxes; Government sales of goods and services represent payments by industry including registration fees, licenses and similar charges, harbour and airport landing fees and municipal water charges.

Table 3
Other Cost Components
of the Transportation & Storage Sector, 1990 ($000, current)

	AIR TRANSPORT	RAILWAY TRANSPORT	WATER TRANSPORT	TRUCK TRANSPORT	OTHER TRANSPORT SERVICES	HIGHWAY & BRIDGE MAINT	PIPELINE TRANSPORT	STORAGE & WAREHOUSING
Intermediates	5,418,299	2,754,799	1,833,816	6,898,649	2,257,190	78,249	952,484	497,519
Taxes (Commodity & Indirect)	504,071	595,367	246,161	1,168,357	270,055	13,442	186,876	93,758
Government	158,034	1	11,198	1,001	22,922	100	1,631	26,983
Subsidies	9,693	767,433	58,977	90,622	12,116	0	9,006	167
Taxes/ Intermediates %	9.3	21.6	13.4	16.9	12.0	17.2	19.6	18.8

Except for the Other Transport services industry, all transportation modes, including Storage and Warehousing, have experienced relatively <u>high growth of commodity taxes</u>. The relatively high growth of commodity taxes is especially evident for the Rail, Water and Storage industries. The <u>growth of other indirect taxes</u> has been in most cases lower than commodity taxes but was higher than output growth in the Rail, Water, Other Transport and Pipeline industries.

Table 4
Growth of Other Cost Components
of the Transportation & Storage Sector, 1971-1990 (current$)

GROWTH OF COSTS 1971-1990, %	AIR TRANSPORT	RAIL TRANSPORT	WATER TRANSPORT	TRUCK TRANSPORT	OTHER TRANSPORT	PIPELINE TRANSPORT	STORAGE & WAREHOUSING
OUTPUT	11.9	6.0	7.1	9.9	14.3	9.7	8.1
COMMODITY INDIRECT TAXES	15.8	12.6	12.2	10.4	10.2	10.6	12.0
OTHER INDIRECT TAXES	10.4	8.2	9.6	6.2	14.0	11.2	7.0
GOVERNMENT GOODS & SERVICES	10.0	-20.0	3.9	11.8	na	na	7.4
SUBSIDIES	9.8	12.7	10.7	15.7	na	na	na

Source: Statistics Canada Input-Output division, Business Services Industries Branch, IC
NOTE: Some growth rates are unavailable since in the earlier year, neither revenues nor subsidies were being paid.
   * indicates a 1981-1989 growth rate

Government levies on industry for services provided have in general, grown slower than industrial production. Truck Transport, the exception, experienced significantly higher growth in government charges than industry growth. The Other Transport services industries has not traditionally incurred these charges but the Pipeline Transport industry began paying relatively small amounts in 1981.

The Rail industry, followed by the Water and Trucking industry, respectively benefit from the highest levels of transportation industry subsidies. Except for Air subsidies grew in excess of output.

The Storage and Warehousing sector received a small amount of subsidy in 1981 and by 1990 this changed very little. In general the benefit of subsidies to the Other Transport and Pipelines industries was small in the 1981-1990 period.

iii) PROFITABILITY[8]

Table 5 presents the level of profits per unit of output for the 1971-1990 period. While each mode has experienced a decline in profitability over the period, the impact has been asymmetrical with respect to time. While a number of industries experienced declining profitability throughout the period, some regained ground in the 1980s that had been lost in the 1970s, while others lost ground in the 1980s relative to the 1970s.

The Air Transport services industry experienced the largest decline in profitability in the 1971-1990 period followed by the Other Services Transport industry. The Rail, Trucking and Pipeline industries felt the bulk of the decline in profitability in the 1970s, regaining some of what they lost in the 1980s.

The Water industry enjoyed higher levels of profitability in the 1970s but by 1990 the industry had fallen below the 1971 level.

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[8] Profits, for the purpose of this analysis, are defined as the surplus in the Input-Output tables. Strictly speaking, this magnitude as it is constructed for the Input-Output tables, also includes the capital consumption allowance, and interest and miscellaneous investment income. It is impossible to separate accounting profits from the other magnitudes which are a return to capital. To wit, profitability as it is defined above may overstate the true level of industry profits.

Historically, the Pipelines industry has been the most profitable, and over time has managed to maintain relatively high profitability levels. In the 1981 to 1990 period some profitability lost in the previous decade was restored.

Conversely, Air, Rail and Water services have xperienced the lowest levels of profitability in the most recent period. Air and Rail underwent the largest erosion in profitability in the eighteen year period, while the profitability of the Water services industry is down marginally after almost two decades .

INDUSTRY	1971	1981	1990
Air	17.2	10.2	4.6
Rail	17.8	8.1	11.4
Water	9.5	11.3	7.9
Trucking	14.7	13.3	15.2
Other Services	17.9	17.6	11.1
Pipelines	66.9	53.0	55.4

Table 5
PROFITABILITY IN TRANSPORTATION SERVICES
Profit per Unit of Output, %

While Trucking has been able to maintain a relatively high level, the Other Transport services industry underwent a relatively large decline in profitability, most of which was experienced in the 1980s.

iv) SUMMARY

- growth

The supply of Transportation services to Canadian industry in the period 1971-1990 is characterized by two separate and opposite phases.

The earlier period, 1971-1981, witnessed rapid transportation and storage industry. Value added grew rapidly as well and marginally faster than production. This performance mirrored that of the business sector as a whole. However Transportation and Storage sector growth was slightly below that of the economy.
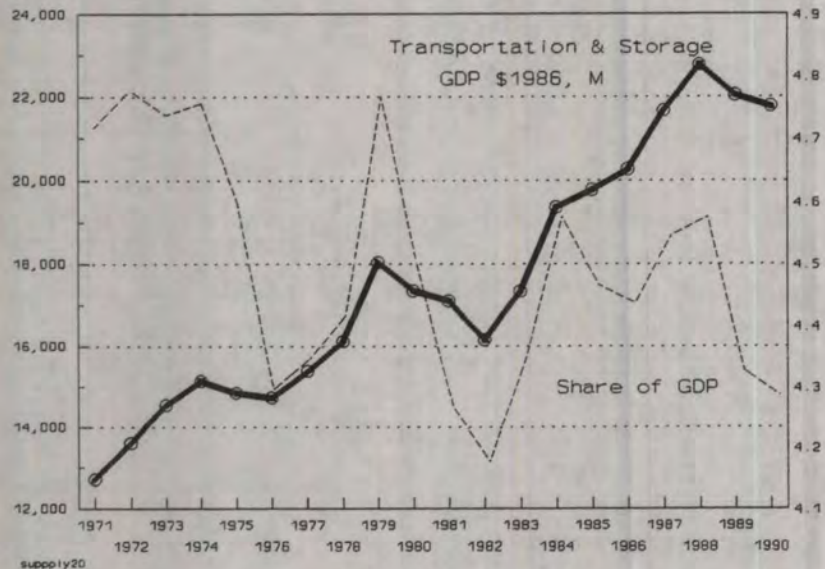
Figure 16: Transportation & Storage Sector
GDP and Share of Total GDP

The 1980s were characterized by much slower growth. The growth of Transportation and Storage production kept pace with economic growth but sectoral value added grew more slowly in the period 1981-1990.

As a result, there was a decrease in the intensity of transportation use in Canada over the 1971-1990 period [the ratio of transportation production (value added) to business sector production (value added) declined].

While industry in Canada used fewer transportation resources over the 1971-1990 period, transportation industries were using more intermediate resources relative to primary factors.

- costs and profitability

Transportation service industries have endured a prolonged period of declining profitability. Insofar as labour costs generally constitute the largest share of total costs, relatively high rates of increase in the remuneration of labour may explain a portion of the decline in profitability. However labour costs outstripped industry growth only in a small portion of the sector (i.e. the Water and Pipeline Transport industries and the Other Transport industry).

Transportation Services industries are characterized, for the most part, by (high) increasing costs. Table 6 summarizes the average experience of each transportation industry over the period 1971-1990.

Table 6
Growth in Transportation Industry Output & Costs

GROWTH 1971-1990, %	PRODUCTION	TOTAL COST	AVERAGE COST
AIR TRANSPORT	11.9	12.8	0.6
RAIL TRANSPORT	6.0	7.3	0.7
WATER TRANSPORT	7.1	6.8	-0.01
TRUCK TRANSPORT	9.9	10.5	0.2
OTHER TRANSPORT	14.3	15.5	1.0
HIGHWAY & BRIDGE MAINTENANCE	7.4	9.9	2.5
PIPELINE TRANSPORT	9.7	11.3	1.4
STORAGE & WAREHOUSING	8.1	8.5	0.6

In the 1970s total costs in the Transportation and Storage sector grew much faster than total revenues (except for the Storage and Warehousing industry), but in the 1980s, revenues grew faster than costs in all industries except the Storage and Warehousing industry and the Air Transport industry.

To illustrate the general cost position of the transportation sector in the 1971-1990 period, the experience of each industry may be generalized and simplified and presented diagrammatically as in Figure 18.

TRANSPORTATION INDUSTRY SUPPLY & DEMAND
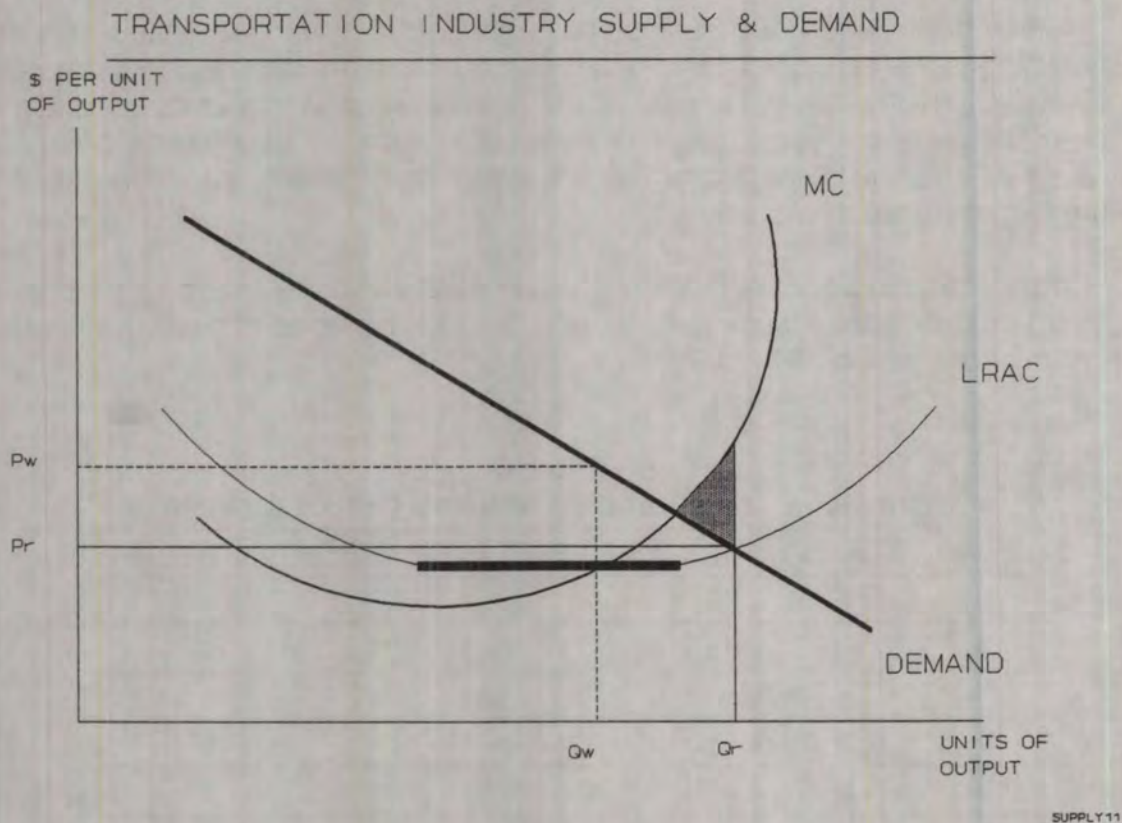
Figure 17

Average costs for most transportation industries were found to be rising over the period. This is illustrated by the long run average cost (LRAC) curve. At the same time, the rate of change in total costs (MC) has been greater than the rate of increase in revenues. Assuming that the demand faced by the industry is elastic (i.e. the demand curve is downward sloping and that there is a degree of substitutability among modes of transport in the movement of goods), then an industry such as the Air or Rail Transport industry appears to be producing too much at too low a price (that is, they are producing at point Qr and receiving a price Pr).

Consequently there is an efficiency loss due to over-production. This is represented by the shaded triangle in Figure 17. A more efficient solution would require a reduction in output and a rise in price such that long run average costs are at a minimum and equal to marginal cost (note the tenacity with which rail service

operators in Canada are petitioning for the abandonment of track). This combination, characterized by the points Qw And Pw, reflects the observed situation of the Water Transport industry (and Trucking).

- sources of Increasing Cost

In a number of transportation industries, a portion of the high cost environment may be explained by the growth of expenditures on service inputs relative to industry production. It would appear that some substitution of service inputs for labour has occurred. Nevertheless, some concern has been expressed by industry participants that the rising cost of inelastic inputs is driving declining profit levels. To address such concerns, **the real values of key industry inputs are presented in Tables 7 to 9** (Appendix 1, pages 32-34).

A major feature of the cost structure of all industries is the level of taxes. Commodity indirect taxes and Other indirect taxes are individual cost components that are within the top twenty factor costs faced by the sector (in the Pipeline Transport industry, other indirect taxes are not components of the top 20 costs). However in all cases (except in the Storage and Warehousing industry) taxes are growing more slowly than output). Government fees are a major component of cost only in the Air and Storage industries and in both cases having been growing more slowly than production.

Not only are the majority of the major cost components of all industries services, but most of these costs are growing faster than the output of the industry. In all industries, **telecommunications expenditures** have grown faster than production; as well, **business services** have risen in relative importance in all industries. The Truck, Storage, Air and Rail industries are experiencing significant growth in **insurance** costs and **financial services** provided by the banking and trust industries.

On the other hand, capital equipment costs, repair expenditures and fuel charges, major costs in the business of providing transportation services and traditionally thought to drive industry costs do not appear to have been instrumental in the 1971-1990 period. While substantial in numerous industries, the capital equipment purchases have grown steadily faster than industry production in the Air Transport and Rail Transport industries.   Fuel expenditures are a major cost component of all industries as well. However, the cost of each has risen at rates below the rate of growth of output.

Appendix I
Transportation Services Supply

Table 2
Cost Structure of the Transportation & Storage Sector, 1990 ($000 current)

	AIR TRANSPORT	RAILWAY TRANSPORT	WATER TRANSPORT	TRUCK TRANSPORT	OTHER TRANSPORT	PIPELINE TRANSPORT	STORAGE & WAREHOUSING
PRODUCTION 1990	9,209,104	6,042,403	3,641,445	14,728,599	4,993,294	3,325,357	1,326,513
AVERAGE COSTS	0.954	0.886	0.921	0.848	0.889	0.446	0.838
GOODS	2,150,160	641,311	351,910	1,526,868	207,904	51,064	81,858
CONSTRUCTION	32,572	841,792	71,420	41,506	7,987	142,424	25,448
FIRE	327,251	293,658	123,871	429,210	348,834	94,203	133,266
TCU	1,306,817	365,582	773,424	3,218,274	991,641	474,962	122,322
OTHER SERVICES	1,163,916	436,697	185,988	1,285,241	368,972	104,018	55,195
OTHER	437,583	175,759	192,737	397,550	331,852	85,813	79,430
LABOUR	2,698,263	2,768,505	1,319,904	3,952,793	1,863,892	352,521	492,985
NET INDIRECT TAXES, GOV'T G&S, SUBSIDIES	652,412	-172,065	198,382	1,078,736	280,861	179,501	120,574
SHARES OF TOTAL COST - 1990	AIR TRANSPORT	RAILWAY TRANSPORT	WATER TRANSPORT	TRUCK TRANSPORT	OTHER TRANSPORT	PIPELINE TRANSPORT	STORAGE & WAREHOUSING
GOODS	0.25	0.12	0.15	0.12	0.05	0.03	0.07
CONSTRUCTION	0.00	0.16	0.02	0.00	0.00	0.10	0.02
FIRE	0.04	0.05	0.04	0.03	0.08	0.06	0.12
TCU	0.15	0.07	0.23	0.26	0.22	0.32	0.11
OTHER SERVICES	0.13	0.08	0.06	0.10	0.08	0.07	0.05
OTHER	0.05	0.03	0.06	0.03	0.08	0.06	0.07
LABOUR	0.31	0.52	0.39	0.36	0.43	0.24	0.44
NET INDIRECT TAXES, GOV'T G&S, SUBSIDIES	0.07	-	0.06	0.09	0.06	0.12	0.11
SHARES OF TOTAL COST 1971	AIR TRANSPORT	RAILWAY TRANSPORT	WATER TRANSPORT	TRUCK TRANSPORT	OTHER TRANSPORT	PIPELINE TRANSPORT	STORAGE & WAREHOUSING
GOODS	0.15	0.07	0.11	0.14	0.08	0.07	0.04
CONSTRUCTION	0.00	0.11	0.01	0.01	0.01	0.06	0.02
FIRE	0.04	0.03	0.03	0.03	0.07	0.05	0.08
TCU	0.12	0.06	0.35	0.19	0.20	0.34	0.08
OTHER SERVICES	0.10	0.03	0.03	0.09	0.07	0.05	0.03
OTHER	0.10	0.06	0.06	0.04	0.16	0.09	0.05
LABOUR	0.43	0.59	0.37	0.40	0.29	0.21	0.59
NET INDIRECT TAXES, GOV'T G&S, SUBSIDIES	0.06	0.05	0.03	0.11	0.12	0.13	0.11

Source: Statistics Canada, Input-Output Division & Business Servicces Industry Branch, IC

Table 7
AIR AND RAILWAY TRANSPORTATION SERVICES: MAJOR COST COMPONENTS[*], $000 current

AIR TRANSPORT & SERVICES INCIDENTAL			RAILWAY TRANSPORT & REL. SERVICES		
MAJOR COST ELEMENT	DEMAND, 1990	GROWTH, % 1971-1990	MAJOR COST ELEMENT	DEMAND, 1990	GROWTH, % 1971-1990
PRODUCTION	9,209,104	11.9	PRODUCTION	6,042,403	8.0
AIRCRAFT & AIRCRAFT PARTS INDUSTRY	1,077,115	16.8	REPAIR CONSTRUCTION	841,100	8.3
REFINED PETROLEUM & COAL PRODUCTS	928,432	14.2	COMMODITY INDIRECT TAXES	368,665	12.6
AIR TRANSPORT & SERVICES INCIDENTAL	606,349	14.0	REFINED PETROLEUM & COAL PRODUCTS	341,899	10.6
ACCOMMODATION & FOOD SERVICE IND.	464,923	12.1	OTHER INDIRECT TAXES	226,702	8.2
COMMODITY INDIRECT TAXES	461,082	15.8	TRUST, OTHER FINANCE & REAL ESTATE	206,079	9.5
OTHER TRANSPORT & SERV. TO TRANSP.	437,986	14.8	WHOLESALE TRADE INDUSTRIES	182,711	9.2
WHOLESALE TRADE INDUSTRIES	347,251	14.8	MISC. SERVICE INDUSTRIES	169,549	14.0
TRUST, OTHER FINANCE & REAL ESTATE	256,387	13.5	TELECOMMUNICATION CARRIERS & OTHER	129,193	8.1
GOVERNMENT GOODS & SERVICES	158,034	10.0	RAILWAY TRANSPORT & REL. SERVICES	102,127	3.5
MISC. SERVICE INDUSTRIES	155,077	22.7	RAILROAD ROLLING STOCK INDUSTRY	96,082	6.3
OPERATING SUPPLIES	148,295	6.4	INSURANCE INDUSTRIES	54,280	8.9
ADVERTISING & PROMOTION	119,448	9.3	TRAVEL & ENTERTAINMENT	54,028	9.3
TELECOMMUNICATION CARRIERS & OTHER	117,654	11.4	OPERATING SUPPLIES	43,098	-1.9
TRAVEL & ENTERTAINMENT	109,536	14.9	OTHER BUSINESS SERVICE INDUSTRIES	37,963	11.6
PROFESSIONAL BUSINESS SERVICES	88,698	16.8	BANKS, CREDIT UNIONS ETC.	33,299	13.6
OTHER BUSINESS SERVICE INDUSTRIES	64,564	14.2	PRIMARY STEEL INDUSTRIES	32,808	9.1
OFFICE SUPPLIES	60,304	13.1	OTHER UTILITY INDUSTRIES NEC	32,359	14.2
TRANSPORTATION MARGINS	45,348	11.3	ELECTRIC POWER SYSTEMS INDUSTRY	31,350	11.0
INSURANCE INDUSTRIES	44,008	8.4	OFFICE SUPPLIES	28,809	5.9
OTHER INDIRECT TAXES	42,989	10.4	ADVERTISING & PROMOTION	28,271	7.5

Source: Statistics Canada Input-Output Division
[*] - exlcuding labour

Table 8
WATER & TRUCK TRANSPORTATION SERVICES: MAJOR COST ELEMENTS $000 current

WATER TRANSPORT & RELATED SERVICES	DEMAND $000 1990	GROWTH, % 1971-1990	TRUCK TRANSPORT INDUSTRIES	DEMAND $000 1990	GROWTH, % 1971-1990
PRODUCTION	3,641,445	11.5	PRODUCTION	14,728,599	9.9
WATER TRANSPORT & REL. SERVICES	604,844	4.1	TRUCK TRANSPORT INDUSTRIES	2,286,836	13.1
SHIPBUILDING AND REPAIR INDUSTRY	186,879	9.9	COMMODITY INDIRECT TAXES	923,925	10.4
REFINED PETROLEUM & COAL PRODUCTS	170,457	7.3	REFINED PETROLEUM & COAL PRODUCTS	879,401	12.9
COMMODITY INDIRECT TAXES	141,710	12.2	WHOLESALE TRADE INDUSTRIES	573,073	10.7
OTHER INDIRECT TAXES	104,451	9.6	RETAIL TRADE INDUSTRIES	276,022	9.7
TRUST, OTHER FINANCE & REAL ESTATE	81,378	9.8	OTHER INDIRECT TAXES	244,432	6.2
WHOLESALE TRADE INDUSTRIES	73,355	8.2	TRUST, OTHER FINANCE & REAL ESTATE	240,356	10.3
REPAIR CONSTRUCTION	70,000	11.5	MISC. SERVICE INDUSTRIES	221,195	11.6
TELECOMMUNICATION CARRIERS & OTHER	60,738	11.5	TELECOMMUNICATION CARRIERS & OTHER	206,472	10.3
CAFETERIA SUPPLIES	52,537	11.3	MOTOR VEHICLE PARTS & ACCESSORIES	205,432	5.0
TRAVEL & ENTERTAINMENT	46,506	10.4	RAILWAY TRANSPORT & REL. SERVICES	184,398	6.6
OFFICE SUPPLIES	38,497	10.2	OTHER TRANSPORT & SERV. TO TRANSP.	174,829	21.4
OTHER BUSINESS SERVICE INDUSTRIES	31,489	16.6	RUBBER PRODUCTS INDUSTRIES	160,628	6.7
OPERATING SUPPLIES	29,902	0.2	TRAVEL & ENTERTAINMENT	136,461	13.1
OTHER MACHINERY & EQUIPMENT IND.	29,041	8.1	STORAGE AND WAREHOUSING INDUSTRIES	128,148	9.0
MISC. SERVICE INDUSTRIES	25,400	11.1	INSURANCE INDUSTRIES	127,350	8.9
ADVERTISING & PROMOTION	25,295	7.4	OTHER BUSINESS SERVICE INDUSTRIES	119,782	12.8
PROFESSIONAL BUSINESS SERVICES	24,731	11.0	OFFICE SUPPLIES	117,872	11.7
INSURANCE INDUSTRIES	21,582	5.3	ADVERTISING & PROMOTION	93,315	11.0
BANKS, CREDIT UNION & OTH. DEP INST	20,911	11.6	PROFESSIONAL BUSINESS SERVICES	86,379	12.2

Source: Statistics Canada Input-Output Division

Table 9
PIPELINE AND OTHER TRANSPORT SERVICES & STORAGE AND WAREHOUSING: MAJOR COST ELEMENTS, $000 current

OTHER TRANSPORT & SERV	1990 DEMAND	GROWTH, % 1971-1990	PIPELINE TRANSPORT IND	1990 DEMAND	GROWTH, % 1971-1990	STORAGE & WAREHOUSING	1990 DEMAND	GROWTH % 1971-1990
PRODUCTION	4,993,294	14.3	PRODUCTION	3,325,357	9.7	PRODUCTION	1,326,513	8.1
TRUST, OTH.FIN. & REALESTATE	286,619	15.3	PIPELINE TRANSPORT IND	286,795	10.5	TRUST, OTH FIN REAL ESTATE	89,451	10.8
TRUCK TRANSPORT INDUSTRIES	277,804	13.6	OTHER INDIRECT TAXES	166,640	11.2	OTHER INDIRECT TAXES	62,103	7.0
OTHER TRANSPORT & SERV	258,128	18.8	REPAIR CONSTRUCTION	141,400	14.3	OPERATING SUPPLIES	41,134	9.2
COMMODITY INDIRECT TAXES	176,025	10.2	ELEC POWER SYSTEMS IND	98,253	10.8	BANKS, CREDIT UN. & OTH.	32,358	10.8
RAILWAY TRANSPORT & REL.	169,495	14.4	OTH BUSINESS SERV IND	62,818	13.8	COMMODITY INDIRECT TAXES	31,655	12.0
ADVERTISING & PROMOTION	137,499	23.1	TRUST, OTH FIN, REALESTATE	59,852	12.1	STORAGE & WAREHOUSING	27,890	11.7
REF PETROLEUM & COAL PROD	135,020	11.7	CRUDE PET. & NATURAL GAS	42,837	7.2	REF PETROLEUM & COAL	27,827	12.6
OTH BUSINESS SERVICE IND	123,611	23.4	OPERATING SUPPLIES	42,247	6.8	GOV'T GOODS & SERVICES	26,983	7.4
TELECOMM CARRIERS ETC	100,753	20.1	TELECOMM CARRIERS	32,462	11.4	REPAIR CONSTRUCTION	23,900	9.8
OPERATING SUPPLIES	96,339	5.5	BANKS, CREDIT UN & OTH.	31,305	15.0	OFFICE SUPPLIES	21,648	13.2
OTHER INDIRECT TAXES	94,030	14.0	TRAVEL & ENTERTAINMENT	27,455	12.0	RAILWAY TRANSPORT	21,477	7.8
WHOLESALE TRADE INDUSTRIES	76,529	13.4	COMMODITY INDIRECT TAXES	20,236	10.6	ELECTRIC POWER SYS	20,050	10.5
RETAIL TRADE INDUSTRIES	63,903	11.9	GAS DISTRIBUTION SYS IND	17,814	15.3	WHOLESALE TRADE IND	18,017	12.4
TRAVEL & ENTERTAINMENT	54,698	13.8	PROF BUSINESS SERVICES	17,731	10.5	OTH CONVERT PAPER PROD	17,658	12.4
PROF BUSINESS SERVICES	47,858	15.8	OTHER TRANSPORT & SERV	15,787	14.0	TELECOMM CARRIERS	13,547	9.2
ELECTRIC POWER SYS	47,526	17.2	OTHER UTILITY IND NEC	14,047	18.8	WATER TRANSPORT	13,175	9.5
OTH UTILITY INDUSTRIES NEC	44,483	20.2	MISC. SERVICE IND	11,690	12.4	INSURANCE INDUSTRIES	11,457	9.1
OFFICE SUPPLIES	43,316	14.3	POSTAL SERVICE IND	9,074	13.0	MISC. SERVICE IND	10,820	9.3
MISC. SERVICE INDUSTRIES	38,787	15.4	ADVERTISING & PROMOTION	8,864	14.0	TRAVEL & ENTERTAINMENT	9,533	10.3
BANKS, CREDIT UN.& OTH.	34,655	19.2	WHOLESALE TRADE IND	8,756	16.7	OTH BUSINESS SERV	9,513	12.6
INSURANCE INDUSTRIES	27,560	13.5	OFFICE SUPPLIES	7,247	11.5	RETAIL TRADE IND	8,641	11.5

Source: Statistics Canada Input-Output Division

2) THE DEMAND FOR TRANSPORTATION SERVICES

(i) Introduction

Transportation services account for a significant volume of economic activity in the Canadian economy. In 1990, Canadian industry consumed $41.7 billion[9] of transportation services or 4.1% of industrial output. Since 1971, the demand for transportation services has risen at an average rate of 9.1% annually.

Table 10
Industrial Demand for Transportation Services in Canada - 1971-1990

	TRANSPORTATION SERVICES DEMAND ($B, current)	TOTAL INDUSTRIAL OUTPUT ($B, current)	TRANSPORT INTENSITY
1990	41.7	1,022.5	0.041
1971	7.7	148.8	0.052
AVERAGE ANNUAL GROWTH %, 1971-1990	9.4	10.1	

Source: Statistics Canada Input-Output Division; aggregate data is not available in inflation adjusted dollars in the same base year for the period.

However, industrial output in Canada grew more rapidly over the past nineteen years and as a result, industry as a whole has become <u>decreasingly transportation services intensive</u> in Canada. In 1971 transportation services constituted 5.2% of industrial output, but by 1990 this ratio had fallen to 4.1%.

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[9] modes included are rail, truck, air, water and pipeline and storage and warehousing and consists of direct transportation costs and transportation margins.

The Distribution of Industrial Demand

The manufacturing sector accounts for the largest share of the demand for transportation services followed by intra-industry transportation services demand. The former declined over the 1971-1990 period while the latter increased.
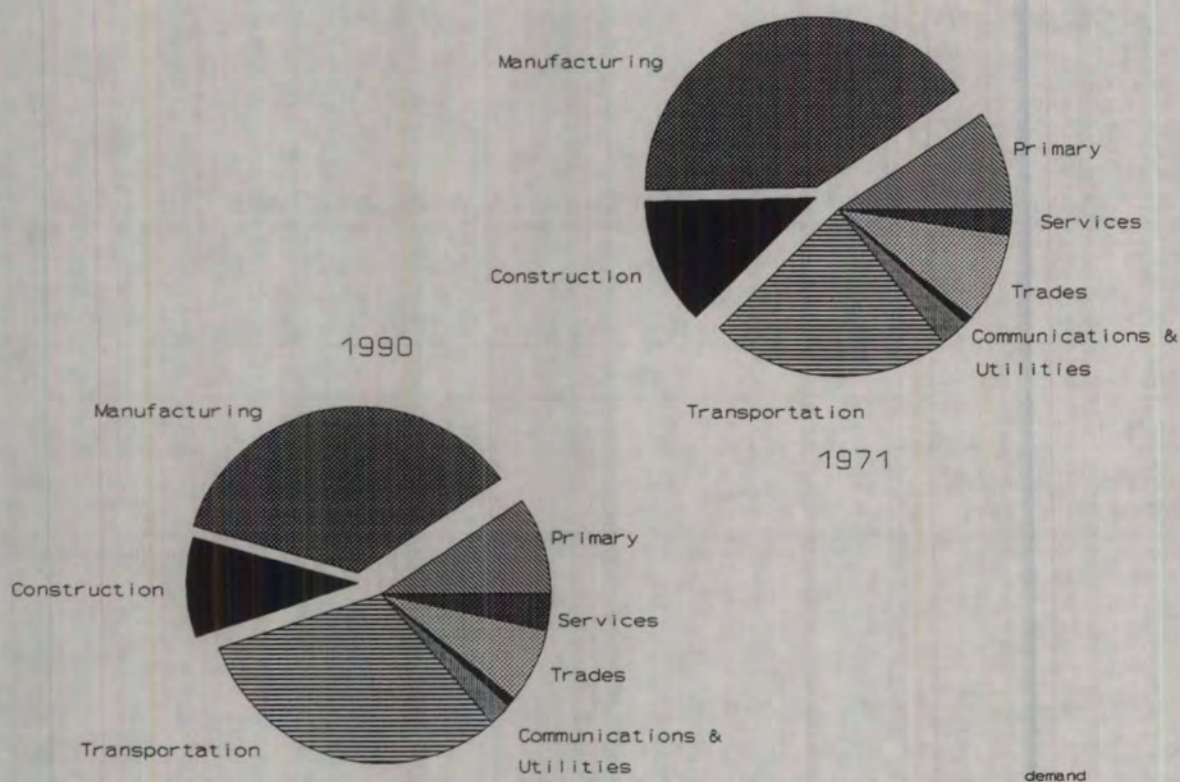
Figure 18
The Share of Demand for Transportation Services by Sector

While the Primary sector exhibited unchanged demand over time, the share of the Services industries increased as did the Finance, Insurance and Real Estate sector. Construction, Communications and Utilities and the Trades declined in their respective shares of total transportation services demand.

ii) THE DEMAND FOR TRANSPORTATION IN THE LOGISTICS NETWORK

Transportation services are reported in two ways in the Input-Output format. The first is the direct value of transportation services provided by the producing industry. These values represent the cost to the producer of the service, paid by the user. The second quantity is the transport margin. This value is the difference between the price paid by the purchaser of the service and the cost or price incurred by the producer of the service.

Table 12 presents both direct and margin demand for transportation services used in the transportation of goods. These costs include expenditures for rail, air, pipelines, water and trucking services, but also for storage and warehousing.

The direct costs for transportation services in Canada greatly exceeds those costs incurred as margins. The latest figures show that direct costs are four times as large as margin volume and have risen from a factor of 3.2 in 1971.

Table 12
Transportation Services Demand by Type of Cost - 1971-1990

	Direct, $B, current	Direct/ Total Output	Margin, $B, current	Margin/Total Output
1990	33.3	0.033	8.4	0.080
1971	5.9	0.040	1.8	0.012
Average Annual Growth, % 1971-1990	9.1		2.9	

Source: Statistics Canada Input-Output Division
Note: The values for transportation demand include only identifiable industries and does not include fictive industries.

3)   TRANSPORTATION SERVICES DEMAND BY SECTOR

A)   MANUFACTURING

i) MAJOR CONSUMING INDUSTRIES

The distribution of industrial demand for transportation services in the manufacturing sector changed little over the period 1971-1990.

Historically the <u>two largest consuming industries</u> of transportation services have been the Pulp and Paper industry and the Refined Petroleum & Coal Products Industry. Other volume users of transportation services include the Primary Steel industry, the Dairy industry and the Motor Vehicles industry.

Of the top 20 users of transportation services in the manufacturing sector in 1971, all but three were in the top twenty in 1990 (the Aircraft & Aircraft Parts industry, the Sash, Door & Other Millwork industry and the Non-Metallic Mineral Products industry were in the top 20 in 1990 displacing Other Electrical and Electronic Products, the Paper Box and Bag industry and the Man-Made Fibre Yarn & Woven Cloth industry; Apendix II, Table 14, page 57).

ii) TRANSPORTATION INTENSIVE MANUFACTURING INDUSTRIES[10]

Overall the manufacturing sector in Canada has become <u>less transportation intensive</u>. Transportation demand as a proportion of total production declined from 2.8% in 1971 to 2.4% in 1990.

Of those 20 industries exhibiting the greatest intensity of transportation use in 1971, only four did not appear in the top 20 ranking in 1990 (Table 15, Appendix 2). The <u>most intensive</u> transportation using industry has been the Ready-Mix Concrete industry. The Feed and Chemicals & Chemical Products and Pulp and Paper industries are as well transportation intensive.

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[10]   The intensity of transportation use is measured by the ratio of the constant dollar value of total purchased transportation inputs in production to aggregate industry output.

Further, of the sixteen industries which have been the most transportation intensive over the 1971-1990 period, the intensity of transportation use in eight industries increased.

In the Manufacturing sector as a whole, twenty-three of 94 industries (25%) were found to have increased their transportation demand intensity between 1971 and 1990. They are as follows[11]:

Primary Steel   Leather Tanneries
Dairy Products,   Concrete Products
Chemical & Chemical Products*, Cane & Beet Sugar*
Contract Textile Dye. & Finishing, Clay Products
Wooden Box and Coffin, Copper Roll. Cast. & Extrud.
Cement industry, Softdrinks
Ready Mix Concrete, Power Boiler & Structural Metals
Aircraft & Aircraft Parts, Footwear
Brewery Products Pulp and Paper
Non-Metallic Mineral Products Bread & Other Bakery Products*
Soap & Cleaning Compounds Distillery Products*
Floor Tile, Linoleum & Coated Fabrics,

In an era of declining transportation costs, sectors such as these are a signal of potential inefficiencies in the allocation of resources.

[11] Of those industries that have been isolated, four were found to have reduced their transportation demand intensity once Pipeline Transport is removed (indicated by an asterisk). However, the Refined Petroleum industry was found to have increased its transportation intensity with the removal of Pipeline Transport.

iii) DIRECT DEMAND AND TRANSPORTATION MARGINS

Inflation adjusted demand for transportation services by the manufacturing sector grew 3.1% annually on average in the period 1971-1990. Concurrently, production by manufacturing industries rose at an annual rate of 3.9%. The result has been a decreasing transportation intensive manufacturing sector. In 1971 transportation constituted 2.7% of manufacturing output but by 1990 this proportion had fallen to 2.2%.

Table 16 (Appendix II, page 59) presents the top 20 purchasers of direct transportation services and the top 20 industries paying the greatest amount in transportation margins for 1971 and 1990. There is little difference in the constitutent industries than in Table 11 which reported these magnitudes as a total. There has also been little change over time.

While the value of transportation margins are larger than direct transportation payments, industries which purchased direct transportation services in volume in 1971 were also volume purchasers of transportation in 1990. This is also the case when ransportation margin payments are considered.

The direct purchase of transportation services by the manufacturing sector rose by 3.4% annually over the 1971-1990 period, while <u>transportation margin expenditures experienced a growth rate of 2.9% annually.</u>

Table 17 (Appendix II, page 60) contrasts volume transportation services demand with unit margin payments. This presentation suggest that the price or unit margin that a particular industry pays is inversely related to the volume of demand for transportation service.

Aggregate transportation margins[12] relative to direct transportation purchased in the manufacturing sector rose from a factor of 2.3 in 1971 to 2.7 in 1990. No fewer than sixty industries experienced an increase in margin payments relative to direct transportation costs over the period.

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[12] Margin volumes are reported as an aggregate irrespective of the mode from which they originate.

iv) CHARACTERISTICS OF TRANSPORTATION DEMAND & SOURCES OF GROWTH

The following is concerned with those industries that HAVE INCREASED THEIR TRANSPORTATION DEMAND INTENSITY over the 1971-1990 period.

Many of these industries have a relatively low level of value added to output (a characteristic of manufacturing in general) and the majority produce large, bulk or otherwise unfinished commodities. Most of the Food Products sector is included but also representative of this group is Ready Mix Concrete, Primary Steel, Pulp and Paper and Refined Petroleum Products.

a) DEMAND COMPONENTS

The major sources of growth for the output of any industry are domestic consumer markets, international markets (imports and exports) or inter-industry markets.

MARKET ORIENTATION

Many of the industries identified supply more than 50% of their output to other industries (84% or 36 out of 43). However few are either consumer market or export market oriented (seven are export oriented and 9 are consumer market oriented).

> *Most heavy transportation using and transportation intensive industries supply a significant level of output for <u>inter-industry use</u>;*
>
> *The demand for <u>transportation services has in general outpaced production and intermediate input supply</u> to other domestic industries ...*
>
> *.. however the demand for transportation services has <u>not grown faster</u> than exports ...*

Table 18 (Appendix II, page 61) summarizes the relative importance of major markets to the high transportation using industries and transportation intensive industries.

b) SOURCES OF GROWTH

Only 15 (35%) of the industries in have grown faster than the aggregate output (2.5%) of the manufacturing sector.

Intermediate input supply to other domestic industries rose faster than the manufacturing aggregate in 33% of the cases identified and aggregate exports growth has been higher than the manufacturing average in only thirty-five percent (35%) of the industries.

INTERMEDIATE INPUTS

The growth of intermediate inputs supplied to manufacturing industries in Canada totalled $163 B ($1986) in 1990 and have grown at an average annual rate of 2.8% over the 1971-1990 period.

In the manufacturing sector as a whole 42 industries experienced transportation services demand growth in excess of intermediate input supply growth.

Twenty-five of the 43 industries (58%) of direct concern, experienced higher transportation demand growth than intermediate input demand growth.

EXPORTS

Manufacturing exports totalled $110.6 billion in 1990 and grew by 53.9% in the 1971-1990 period.

Many of the industries (15 of the 43 cases) which are transportation intensive, or that are heavy users of transportation services have in turn experienced export growth greater than the growth in transportation demand.

EXPORT MARGINS

Transportation services used in the export function are reported as a transportation margin. While manufacturing exports increased at an average annual rate of 5.3% in the 1971-1990 period, export transportation margins grew more slowly at 4.5% annually.

The result has been a declining unit transportation export margin over the nineteen year period.

Over the shorter intervals, it is evident that transportation margins on exports grew at rates in excess of export values. Only in the latest three year period did this trend reverse.

Export transportation margins by industry are not available. However the evidence is suggestive of potential cost inefficiencies (e.g. less than truck load shipment, substitution of high cost but faster transportation modes, discounting, etc.) if export growth rates are below the growth rate of export transportation margins. Many of the industries under consideration have experienced lower export growth than the growth rate of export transportation margins, but most of these industries are not major exporters. A number of major exporting exceptions are noted:

	Table 19 Manufacturing Exports and Export Margin Growth, %	
	Export Margins	Manufacturing Exports
1971-1981	5.2	5.2
1981-1986	5.6	6.7
1986-1990	2.9	3.9
1971-1990	4.5	5.3

- Pulp and Paper
- Non-ferrous Metals
- Sawmills etc.

(v) INDUSTRY ANALYSIS - THE DEMAND FOR TRANSPORTATION SERVICES

The foregoing evidence suggests that there is a group of manufacturing industries that are or may be experiencing relative cost problems directly attributable to the allocation of transportation services. A group of twenty-three manufacturing industries have been identified as having experienced increasing transportation intensity in the 1971-1990 period.

The dominant transportation charge for the majority of these industries is the margin component (the exceptions are Aircraft and Aircraft Parts and Clay Products). As well, margin expenditures have increased as a share of total transportation costs in twelve of the 43 industries.

Transportation demand by these industries is dominated by the trucking industry and pipeline industry. Table 21 (Appendix 2) presents the structure of transportation demand for those industries discussed above.

INCREASING TRANSPORTATION INTENSITY INDUSTRIES

a] Low Transportation Demand

Industries that have experienced increasing transportation demand intensity over the 1971-1990 period are well represented by the Food and Beverage sector. Many have experienced low or declining output growth (only 3 of the 15 outpaced the average for manufacturing as a whole) and most are not major exporters. In general their demand for transportation services is relatively low.

The **Softdrink industry** is a low growth, consumer market oriented industry that experienced relatively high transportation demand growth in the 1971-1990 period. The Truck Trtansport industry share of transport demand declined by over 50% and an even larger relative decline occurred for Railway services. The share of Air Transport services increased by over 50%.

The Bread & Other Bakery is a declining industry that experienced substantial growth in transportation services demand. The most substantial rise in costs occurred in the share of Pipeline services, where the cost share almost tripled. The greatest demand by mode is for Trucking but this cost share delined by almost 50%. The Rail share also declined. Air services demand and Other Transport services demand increased on a relative cost basis.

The Brewery Industry underwent low production growth over the 1971-1990 period but transportation demand increased substantially. Exports increased at an above average rate as well. The Trucking share of transportation services demand declined substantially while Pipeline costs increased substantially. Smaller cost share decreases occurred for Air and Water services while Other Transport service increased marginally.

The Distillery industry output is relatively equally distributed among consumer, export and interindustry markets. It has been on the decline over the 1971-1990 period. The cost share of both Air and Rail services increased while that of Trucking the largest component decreased. The largest increase in relative costs ocurred for the Pipeline industry.

The Cane and Beet Sugar industry experienced no growth over the 1971-1990 period. It supplies most of its output to the Softdrink and Distillery products industries. A relative decrease in transportation margin expenditures was accompanied by a substantial increase in relative pipeline expenditures and a smaller increase in the importance of trucking. Air and Rail services demand also increased.

The Leather Tanneries industry declined over the 1971-1990 period. Although it supplies much of its output to other industries such as Footwear, Clothing and Motor Vehicle Parts industries, it experienced relatively robust exports growth in the nineteen year period. An increase in the importance of pipeline services was accompanied by a decline in trucking services. Air services demand was the only mode showing some growth.

The Footwear industry is a consumer market oriented industry that is on the decline domestically but it has maintained low export growth. Transportation demand while increasing in intensity experienced a decline in growth in the 1971-1990 period. Trucking is the major provider of transportation services to the industry followed by rail and Pipeline services. The Trucking and Rail shares decreased over the period while Pipeline (and Air) services increased.

The **Soap and Cleaning Compounds industry** grew at an above average rate over the 1971-1990 period and experienced even higher transportation demand growth. The industry is both consumer market and intermediate markets oriented. The dominant transportation service used by the industry is Truck Transport services. The Trucking share however declined by almost 50% over the period. Concurrently, Pipeline and Railway services demand on the other hand increased substantially in relative importance.

The **Clay Products industry** experienced a slight decline in output over the 1971-1990 period. It services domestic consumer and interindustry markets such as Construction and Pulp and Paper. A significant and growing share of transportation sector costs were purchased from the Pipeline industry. The relative importance of Trucking and Rail services declined over the period. Air Transport services demand grew substantially.

The **Copper Rolling, Casting and Extruding industry**, which supplies domestic industries such as Communications, Wire and Cable industry, Electronic equipment and the Motor Vehicle Parts industries, underwent a relatively large decline in the 1971-1990 period. The importance of Trucking rose marginally while Pipeline transport increased in importance significantly. Air service demand, while relatively small, also rose substantially.

The **Power Boiler and Structural Metals industry** predominantly services interindustry markets. Little growth has been experienced since 1971. Pipeline services rose substantially in share of transportation costs while Trucking and Rail costs declined in relative importance. Air services share of transportation costs also rose substantially.

.The **Floor Tile, Linoleum and Coated Fabrics industry** sells a large share of output to industries such as Construction, Air Transport and Motor Vehicle Parts. In the period 1971-1990 the industry experienced a substantial decline in output. A decline in relative expenditures on transportation margins coincided with a large increase in the relative importance of Pipeline services. All modes of transport rose in relative importance except for Trucking services which declined.

The **Contract Textile Dyeing and Finishing Industry**, while not a heavy user of transportation services, experienced the fastest growth in demand for transportation services in the 1971-1990 period. The industry's major client is the Clothing industry. Superior export growth was also realized. Transportation Margins declined in substantially in relative importance with a concurrent and substantial increase in the relative importance of the Pipeline industry. The demand for all modes of

transportation, especially Air services, grew sharply over the period in excess of production.

Transportation demand by the **Wooden Box and Coffin industry** rose faster than production over the 1971-1990 period. Most of the industry's output is consumed by other industries especially the Other services industry and the wholesale sector. Transportation margin volumes rose slightly over the period as did the relative importance of the Pipeline industry. Trucking declined in importance.

The **Cement industry** is not a heavy user of transportation services and deals mainly with other industries such as the Ready Mix and Concrete Products industries. It experienced very little growth in the 1971-1990 period. The growth in demand for transportation services by the industry was on par with production. The relative importance of trucking, rail and most noteably pipeline services declined in relative importance (margins declined as well). The cost share of Air transportation services rose over the period.

The **Concrete Products industry** supplies much of its output to the construction sector. In the 1971-1990 period, the demand for transportation services rose faster than production. The relative importance of the Pipeline industry costs, as well as Air and Rail, rose while trucking costs declined over the period. Margin volumes declined marginally as well.

SUMMARY

All of the above industries experienced either low or declining growth in the 1971-1990 period. Two exceptions, Soap and Cleaning Compounds and Contract Textile Dyeing, grew substantially. All however, consumed transportation services at rates in excess of the growth in output.

A number of recurring features appear to be common to industries which have experienced increased transportation intensity:

1] Trucking services have declined in the share of transportation costs

    -- with the following exceptions

        Cane and Beet Sugar

Copper Rolling Casting & Extruding
Contract Textile Dyeing & Finishing

2] Pipeline services have increased, generally substantially

3] Air Transport services generally play a minor but growing role in the transportation demand by industry.

b] High Transportation Demand/Increasing Intensity

The **Pulp and Paper industry** is the largest transportation services consuming industry. It is export oriented and has experienced below average growth in production and export shipments over the 1971-1990 period. Transportation demand however has outpaced the growth of the industry and export growth. Transportation margin expenditures constitute the bulk of transport costs but these costs declined marginally in the 1971-1990 period. Water, Truck and Rail Transport services respectively, play the most important role in distribution, each declined in share of total cost. Air and Pipeline demand grew substantially as a share of total costs.

The **Dairy Products industry** is a consumer as well as interindustry markets oriented industry. It realized virtually no growth in output over the 1971-1990 period while export activity declined markedly. Transportation demand however rose rapidly especially for Air services. Truck and Water transport services use declined in relative importance while pipeline service increased.

The **Primary Steel industry** is the fourth largest consumer of transportation services and supplies most of its output to inter-industry markets. Although output failed to grow over the period, some increase in export activity was realized. A sizeable increase in the relative costs of Pipeline services was experienced while Truck and Rail costs declined. Air service constituted a larger share of costs in 1990 than in 1971.

The **Chemicals and Chemical Products industry** experienced robust growth in the 1971-1990 period with transportation demand outpacing growth of production. The industry supplies other industries such as Agriculture and the Refined Petroleum industry and exports grew vigorously over the period. Relative costs of Air Services rose while Rail and Trucking declined. Transportation margin volumes declined in relative importance. Pipeline transport services costs rose substantially as a share of total transportation costs.

The **Aircraft and Aircraft Parts industry** is a relatively heavy user of transportation services, especially Air and Trucking services. The industry is a major exporting industry and has experienced robust growth in output and exports over the 1971-1990 period. Transportation demand grew faster than both output and exports. The cost share of Air services increased substantially over the period. The relative importance of Trucking costs decreased substantially while Pipeline demand

increased. Transportation margin volume decreased substantially in relative importance.

The **Ready Mix Concrete industry** is interindustry oriented, the main recipient being the Construction sector. Transportation demand grew significantly faster than production. The relative importance of transportation margin volumes declined slightly in the 1971-1990 period. The Trucking share of costs declined substantially with a concommitant increase in relative Pipeline costs. Rail costs declined while Air costs rose in relative importance.

The **Non-Metallic Mineral Products industry** is interindustry oriented and has experienced below average growth. Transportation demand however outpaced the growth of output. The relative costs of Rail and Truck services declined over the 1971-1990 period while Air transport costs rose. The relative costs of Pipeline transportation services rose substantially.

Summary

High transportation costs growth and low production growth appears to be correlated in this group. Three of the seven industries experienced high output growth as well as high transportation costs growth.

Similar to the low or no growth industries, the high demand-increasing intensity industries experienced rising costs shares for Air services and Pipeline services (sometimes quite substantially) and declining costs shares for Rail and Trucking services.

MANUFACTURING - SUMMARY

The manufacturing sector has in general experienced decreasing transportation demand intensity. However a number of industries increased their demand for transportation relative to output or production in the 1971-1990 period.

The majority of manufacturing industries that experienced increased transportation demand intensity in the 1971-1990 period are <u>domestic market oriented,</u> supplying predominantly inter-industry markets (16); five others are domestic consumer market oriented. Only two of the twenty-three are export oriented, the Aircraft and Parts industry and the Pulp and Paper industry.

Low Demand

Margin expenditures which constitute a high proportion of transportation costs for these industries declined in relative importance in the 1971-1990 period. The major mode providing transportation services to this group is Trucking. However the relative importance of Trucking declined in most, increasing in the Cane & Beet Sugar industry Copper Rolling, Casting and Extruding industry and the Contract Textile Dyeing industry. On the other hand Air service demand increased in relative importance in all industries while Rail demand declined in each. The most dramatic change in relative importance for all industries was the increase in the demand for Pipeline services.

High Demand

The high transportation demand group which experienced increased intensity of transportation use also faced high relative margin expenditures that declined over the period [in the Dairy Products industry margin expenditures increased in relative importance]. The major transport mode utilized the most by each industry is trucking [except for the Aircraft and Parts industry which utilizes Air services first and trucking second], but all experienced a relative decline in the importance of trucking. Air increased in relative importance and Rail services demand decreased as a share of total transportation costs. Once again, the largest relative increase for all industries occurred in the demand for Pipeline services. One exception, the Cement industry, was noted.

4) CONCLUSIONS

- transportation supply

Evidence is presented that suggests that inefficiencies exist in the supply of transportation services - these inefficiencies impact negatively on the Canadian logistics network.

⇒ *Transportation service industries in Canada became less profitable throughout the 1970s and 1980s (in one circumstance aggregate industry profitability declined by 58% in the nineteen year period studied) - an exception to this observation is the (regulated) Pipeline Transport industry.*

⇒ *The increasing cost environment that is driving profitability downwards appears to be a function of purchased service inputs such as business services, financial services, telecommunications and insurance. The rapid increase in the costs of telecommunications services suggests the key role of communications as an element in the provision of logistics services.*

a determination of whether such cost escalations are due to rapid price of services escalation or the inability of firms to integrate producer services efficiently into day-to-day operations (or both), was outside the scope of this research.

⇒ *Taxes levied on production are a major cost centre for all transportation industries.*

⇒ *Given rising average costs of producing transportation services (and that costs are rising faster than revenues), transportation output may be in excess supply. This being the case, a decrease in output combined with an increase in price may help ensure a more profitable industry.*

- manufacturing transportation demand

⇒ *Numerous manufacturing industries in Canada of different size and scope experienced more rapid growth in transportation demand than in either output growth or demand for other intermediate inputs;*

⇒ *In general, high transportation margin expenditures are associated with high pipeline and trucking expenditures;*

⇒ *Trucking has traditionally accounted for the largest share of the demand for transportation services. As well, Trucking possesses the lowest unit costs of providing general freight transportation services. However in many cases the relative importance of trucking in transportation demand has declined.*

⇒ *Railway services, which are used to about one-quarter the extent of trucking services, also declined in relative importance over time. Railway services exhibit the second highest average cost of production and some substitution away from rail service has been witnessed.*

⇒ *The level of Air services demand is approximately the same as Rail services, and marginally more costly to provide. In every industry that showed some sign of transportation inefficiency, air services demand rose (the demand for Air Services by most industries constitutes a relatively small share of the total goods distribution costs).*

⇒ *The increase in demand for Air service may to some extent be attributed to faster delivery on long distance shipping and the perceived requirement by business for next day or just in time delivery service. The most dramatic change in the relative importance of air services to industry was found in the Hardware, Tool and Cutlery industry where the relative importance of air transportation costs rose by 1800%.*

⇒ *The largest change in industrial demand for Transportation and Storage sector services occurred for the Pipeline Transport industry.*

While a relatively inexpensive service to provide (on a current cost basis), unit costs have risen the fastest in the Pipeline Transport industry. The industry is responsible for the movement of predominantly gas and oil to the business premise for use in heating and the operation of equipment. Of the industries identified as having a problem, only in the Cement industry did the importance of Pipeline transport decline in relative importance. The largest change in relative importance was found in the Chemicals and Chemical Products industry.

⇒ The general rise in importance of pipelines may be attributable to a number of factors including, inelastic demand, direct marketing by pipeline operators or an increase in private trucking and distribution.

Appendix 2
Transportation Services Demand by Sector - Manufacturing

Table 14
Manufacturing - Top 20 Transportation Consuming Industries, $000, CONSTANT

1990 INDUSTRY	PRODUCTION	DEMAND	1971 INDUSTRY	PRODUCTION	DEMAND
PULP & PAPER	15,625,758	786,656	REFINED PETROLEUM & COAL	2,224,598	160,140
REFINED PETROLEUM & COAL	16,888,562	639,722	PULP & PAPER	2,906,748	129,649
MOTOR VEHICLES	27,910,870	432,545	NON-FERROUS SMELTING & REFINING	2,186,902	85,153
PRIMARY STEEL	7,326,283	345,343	PRIMARY STEEL	1,785,622	73,131
DAIRY PRODUCTS	6,490,436	315,679	MOTOR VEHICLE	4,019,841	72,890
INDUSTRIAL CHEMICALS NEC	7,423,465	310,165	MISC. FOOD PROD INDUSTRIES	1,441,283	60,995
NON-FERROUS SMELTING & REFINING	8,146,320	268,446	FEED	1,529,003	56,653
MISC. FOOD PROD INDUSTRIES	7,154,918	236,025	DAIRY PRODUCTS	1,529,003	55,384
SAWMILLS, PLANING & SHINGLE MILLS	8,309,644	231,887	INDUSTRIAL CHEMICALS NEC	989,750	47,239
CHEMICAL & CHEMICAL PROD NEC	3,857,816	201,954	SAWMILLS, PLANING & SHINGLE MILLS	1,420,678	44,974
PRINTING & PUBLISHING	10,331,463	180,825	MEAT & MEAT PRODUCTS (EXC. POULTRY)	2,171,272	36,630
MOTOR VEHICLE PARTS & ACCESSORIES	14,333,061	170,828	MOTOR VEHICLE PARTS & ACCESSORIES	1,934,894	33,893
FEED	2,522,495	158,038	PRINTING & PUBLISHING	1,599,870	33,495
AIRCRAFT & AIRCRAFT PARTS	5,422,685	145,289	STAMPED, PRESSED & COATED METALS	946,817	26,486
MEAT & MEAT PRODUCTS (EXC. POULTRY)	8,565,090	136,358	PAPER BOX & BAG	639,913	23,874
READY-MIX CONCRETE	1,735,703	129,090	OTHER MACHINERY & EQUIPMENT	1,409,678	21,366
OTHER MACHINERY & EQUIPMENT	7,889,765	94,196	CHEMICAL & CHEMICAL PROD NEC	542,455	19,173
STAMPED, PRESSED & COATED METALS	4,478,602	93,259	OTHER ELECT. & ELECTRONIC PROD	953,846	17,713
NON-METALLIC MINERAL PROD .	3,100,861	90,856	READY-MIX CONCRETE	333,780	17,581
SASH, DOOR & OTHER MILLWORK	2,022,223	76,883	MAN-MADE FIBRE YARN & WOVEN CLOTH	797,303	15,606

Source: Statistics Canada Input-Output Division

Table 15
Manufacturing - Top 20 Transportation Intensive Industries, $000, constant

1990 Industry	Demand	Production	Intensity	1971 Industry	Demand	Production	Intensity
READY-MIX CONCRETE	129,090	1,735,703	0.074	FEED	56,652	635,983	0.089
FEED	158,038	2,522,495	0.063	REFINED PETROLEUM & COAL PROD	160,126	2,224,598	0.072
CHEMICAL & CHEMICAL PROD	201,954	3,857,816	0.052	VEGETABLE OIL MILLS	7,993	137,842	0.058
PULP & PAPER	786,656	15,625,758	0.050	READY-MIX CONCRETE	17,577	333,780	0.053
DAIRY PRODUCTS	315,679	6,490,436	0.049	INDUSTRIAL CHEMICALS	47,215	989,750	0.048
NON-METALLIC MINERAL PROD.	90,856	1,887,011	0.048	PULP & PAPER	129,643	2,906,748	0.045
VEGETETABLE OIL MILLS	38,310	811357	0.047	ASPHALT ROOFING	2,360	54,122	0.044
PRIMARY STEEL	345,343	7,326,283	0.047	MISC. FOOD PROD	60992	1,441,283	0.042
CONCRETE PRODUCTS	42,641	965,287	0.044	BATTERY	3,349	81,476	0.041
CONTRACT TEXTILE DYE & FINISH	13,848	322,092	0.043	NON-METALLIC MINERAL PROD	15,217	371,227	0.041
INDUSTRIAL CHEMICALS	310,165	7,423,465	0.042	PRIMARY STEEL	73,122	1,785,622	0.041
CEMENT	35,282	893,607	0.039	NON-FERROUS SMELT & REFINE	85,148	2,186,902	0.039
CLAY PRODUCTS	8,022	210,896	0.038	OTHER WOOD IND	4,922	128,629	0.038
REFINED PETROLEUM & COAL	639,722	16,888,562	0.038	PAPER BOX & BAG	23,872	639,913	0.037
CANE & BEET SUGAR	17,465	464,961	0.038	DAIRY PROD	55,378	1,529,003	0.036
OTHER WOOD IND	42,991	1,199,938	0.036	CHEM & CHEM PROD	19,170	542,455	0.035
ASPHALT ROOFING	16,543	463,967	0.036	FISH PROD	14,329	406,530	0.035
WOODEN BOX & COFFIN	9,833	283,391	0.035	CANE & BEET SUGAR	7,838	224,663	0.035
BATTERY INDUSTRY	8,464	252,924	0.033	CONCRETE PRODUCTS	9,231	273,251	0.034
MISC. FOOD PRODUCTS	236,025	7,154,918	0.033	ALUMINUM ROLL,CAST.,EXTRUD	8,502	254,860	0.033

Source: Statistics Canada Input-Output Division

Table 16
Direct vs. Margin Demand for Transportation
Manufacturing - Top 20 Industries - $000 constant

MARGIN DEMAND	1990		1971	DIRECT DEMAND	1990		1971
PULP AND PAPER	646,758	PULP & PAPER	111,359	REFIN PETR. & COAL	486,508	REFINED PETROLEUM & COAL	146,234
MOTOR VEHICLES	312,699	NON-FERROUS SMELT & REFIN.	77,087	INDUST. CHEM NEC	178,424	MISC. FOOD PRODUCTS	22,847
DAIRY PRODUCTS	297,357	PRIMARY STEEL	64,589	PULP & PAPER	139,898	MOTOR VEHICLES	21,015
PRIMARY STEEL	276,908	MOTOR VEHICLES	51,862	MOTOR VEHICLES	119,846	PULP AND PAPER	18,284
SAWMILLS,PLAN. & SHING MILLS	210,276	DAIRY PRODUCTS	51,586	AIRCRAFT & PARTS	111,997	FEED	17,290
NON-FERROUS SMELT & REFIN	202,051	SAWMILLS, PLAN & SHING MILLS	42,295	MISC. FOOD PROD	78,397	INDUST. CHEMICALS NEC	14,175
PRINTING & PUBLISHING	163,182	FEED	39,362	CHEM & CHEMICAL PROD	72,136	PRIMARY STEEL	8,533
MISC. FOOD PRODUCTS	157,628	MISC. FOOD PRODUCTS	38,145	PRIMARY STEEL	68,435	NON-FERROUS SMELT & REFIN	8,061
REFINED PETROLEUM & COAL	153,214	INDUST. CHEMICALS NEC	33,040	NON-FERROUS SMELT & REFIN.	66,395	MOTOR VEH PARTS & ACCESS	6,671
MOTOR VEH PARTS & ACCESS	130,597	MEAT & MEAT PRODUCTS	31,154	FEED	52,273	OTH ELECT & ELECTRONIC PROD	6,565
CHEM & CHEMICAL PRODUCTS	129,818	PRINTING & PUBLISHING	30,655	MOTOR VEH. PARTS & ACCESS	40,231	FISH PRODUCTS	6,096
INDUST. CHEMICALS NEC	131,741	MOTOR VEH PARTS & ACCESS	27,218	FISH PRODUCTS	29,523	MEAT & MEAT PRODUCTS	5,467
READY MIX CONCRETE	121,676	STAMP, PRESS & COAT METALS	24,117	MEAT & MEAT PROD	22,533	DAIRY PRODUCTS	3,792
MEAT & MEAT PRODUCTS	113,825	PAPER BOX & BAG	22,734	SAWMILLS PLAN. & SHINGLE	21,611	AIRCRAFT & PARTS	3,576
FEED	105,765	OTHER MACH. & EQUIPMENT	18,897	STAMP, PRESS, & COAT METALS	20,600	VEGETABLE OIL MILLS	3,444
OTHER MACH. & EQUIPMENT	79,275	CHEM. & CHEMICAL PROD.	18,083	VEGETABLE OIL MILLS	19,918	FRUIT & VEGETABLES	3,345
STAMP, PRESS & COAT METALS	72,659	READY MIX CONCRETE	16,941	NON-MET. MIN PROD NEC	19,705	PHARMACEUTICAL & MEDICINE	2,935
SASH, DOOR & OTH MILLWORK	71,235	MAN-MADE FIBRE YARN ETC	14,210	OTH ELECT & ELECTRONIC PROD	18,495	HARDWARE, TOOL & CUTLERY	2,857
NON-METALLIC MIN. PROD.	71,151	REFINED PETROLEUM & COAL	13,892	DAIRY PRODUCTS	18,322	PRINTING & PUBLISHING	2,827
FRUIT	56,909	NON-METALLIC MIN. PROD.	12,890	PRINTING & PUBLISHING	17,643	TRUCK, BUS BODY & TRAILER	2,714

Source: Statistics Canada Input-Output Division

Table 17
MARGIN AND TOTAL TRANSPORTATION DEMAND
Manufacturing - Top 20 Industries

MARGIN DEMAND/ DIRECT DEMAND INDUSTRY	1990		1971	TOTAL TRANSPORTATION COSTS, $000, constant INDUSTRY	1990		1971
WOODEN BOX & COFFIN	19.4	READY MIX CONCRETE	26.63	PULP & PAPER	786,656	REFINED PETROLEUM & COAL	160,126
SOFTDRINKS	18.3	PAPER BOX & BAG	19.98	REFINED PETROLEUM & COAL	639,722	PULP & PAPER	129,643
READY MIX CONCRETE	16.4	WOODEN BOX & COFFIN	16.66	MOTOR VEHICLE	432,545	NON-FERR SMELT & REFIN	85,148
DAIRY PRODUCTS	16.3	CHEM & CHEMICAL PROD	16.64	PRIMARY STEEL	345,343	PRIMARY STEEL	73,122
SASH, DOOR & OTH MILLWORK	12.6	ALUM ROLL. CAST., EXTRUD	15.92	DAIRY PRODUCTS	315,679	MOTOR VEHICLE	72,877
OTHER WOOD	11.4	SAWMILLS, PLAN ETC MILLS	15.80	INDUSTRIAL CHEMICALS NEC	310,165	MISC. FOOD PRODUCTS	60,992
STEEL PIPE & TUBE	10.4	OTHER WOOD	15.75	NON-FERR SMELT & REFIN	268,446	FEED	56,652
SAWMILLS, PLAN & SHING MILLS	9.7	OTH CONVERT PAPER PROD	15.12	MISC. FOOD PRODUCTS	236,025	DAIRY PRODUCTS	55,378
PRINTING & PUBLISHING	9.3	SASH, DOOR & OTH MILL.	14.92	SAWMILLS, PLAN & SHING MILLS	231,807	INDUSTRIAL CHEMICALS NEC	47,215
LEATHER TANNERIES	8.7	WINE	14.78	CHEM & CHEMICAL PROD	201,954	SAWMILLS, PLAN ETC MILLS	44,973
CONCRETE PRODUCTS	8.5	LEATHER TANNERIES	14.16	PRINTING & PUBLISHING	180,825	MEAT & MEAT PRODUCTS	36,621
WINE	8.1	DAIRY PRODUCTS	13.60	MOTOR VEH PARTS & ACCESS	170,828	MOTOR. VEH PARTS & ACCESS	33,889
HOUSEHOLD FURNITURE	7.1	VENEER & PLYWOOD	13.14	FEED	158,038	PRINTING & PUBLISHING	33,482
OTHER CONVERTED PAPER PROD	7.0	CANE & BEET SUGAR	12.99	AIRCRAFT & PARTS	145,288	STAMP, PRESS & COAT MET	26,483
ORNAMENTAL & ARCH METAL PROD	6.9	COMMUN, ENE. WIRE & CABLE	12.56	MEAT & MEAT PRODUCTS	136,358	PAPER BOX & BAG	23,872
POWER BOILER & STRUCTURAL METALS	6.8	RUBBER PRODUCTS	12.49	READY MIX CONCRETE	129,090	OTHER MACH & EQUIP	21,363
FOOTWEAR	6.4	ASPHALT ROOFING	12.28	OTHER MACH & EQUIP	94,196	CHEM & CHEMICAL PROD	19,170
SOAP	6.3	CONCRETE PRODUCTS	12.26	STAMP, PRESS & COAT MET	93,259	OTHER ELECT & ELECT EQUIP	17,710
SHIPBUILDING	5.7	OFFICE, STORE & BUS MACH	12.18	NON-MET MIN PROD	90,856	READY MIX CONCRETE	17,577
BREWERY	5.5	CARPET, MAT & RUG	11.69	SASH, DOOR & OTH MILL.	76,883	MAN-MADE FIBRE YARN ETC	15,604

Source: Statistics Canada Input-Output Division

Table 18
IMPORTANCE OF MAJOR MARKETS TO
INCREASING TRANSPORTATION INTENSIVE INDUSTRIES - 1990

INDUSTRY	TRANSPORTATION DEMAND GROWTH, %	CONSUMER MARKET ORIENTATION, %	EXPORT MARKET ORIENTATION, %	INTER-INDUSTRY MARKET ORIENTATION, %
CONCRETE PRODUCTS INDUSTRY	4.6	7	5	48
CONTRACT TEXTILE DYEING & FINISH	11.1	2	6	54
WOODEN BOX & COFFIN INDUSTRIES	3.0	1	12	65
CEMENT INDUSTRY	1.9	0.3	16	45
SOFT DRINK INDUSTRY	6.4	75	2	69
FOOTWEAR INDUSTRY	-1.1	99	10	56
BREWERY	5.4	95	7	42
POWER BOILER & STRUCTURAL METALS	2.6	3	0.1	53
SOAP & CLEANING COMPOUNDS	4.7	63	10	68
BREAD & OTHER BAKERY PROD	3.8	77	1	45
DISTILLERY	-2.1	41	48	53
FLOOR TILE, LINO., & COAT FABRICS	-3.4	4	43	68
LEATHER TANNERIES	-3.0	1	34	75
CANE & BEET SUGAR	-3.1	14	5	26
CLAY PRODUCTS	-1.4	45	10	40
COPPER ROLL., CAST., & EXTRUD.	-4.0	0.1	25	69
PULP & PAPER	4.6	9	69	61
PRIMARY STEEL	1.9	0.1	22	67
DAIRY PRODUCTS	4.5	73	3	74
CHEMICAL & CHEMICAL PRODUCTS	7.5	7	26	62
AIRCRAFT & AIRCRAFT PARTS	8.2	2	81	51
READY-MIX CONCRETE	6.1	1	0.4	65
NON-METALLIC MINERAL PROD	3.6	6	24	54

Note: A consumer market oriented industry is defined as one in which the ratio of personal expenditures on industry outputs to the apparent market of the industry is high; export market oriented industries are ones in which the ratio of exports to production is high; interindustry oriented industries are ones for which interindustry supply to production is high.

Table 20
IMPORTANCE OF MAJOR MARKETS TO
TRANSPORTATION INTENSIVE INDUSTRIES - Growth 1971-1990 %

INDUSTRY	TRANSPORTATION DEMAND, $000 constant	INTERMEDIATE INPUTS GROWTH, %	PRODUCTION GROWTH, %	EXPORTS GROWTH, %
CONCRETE PRODUCTS INDUSTRY	42,641	1.9	0.7	-1.0
CONTRACT TEXTILE DYEING & FINISH	13,848	5.0	4.7	17.6
WOODEN BOX & COFFIN INDUSTRIES	9,833	2.9	0.8	1.4
CEMENT INDUSTRY	35,282	0.6	0.4	1.1
SOFT DRINK INDUSTRY	41,949	-0.7	0.6	4.6
FOOTWEAR	7,391	-1.7	-2.4	1.5
BREWERY	36,588	-0.2	1.2	3.9
SOAP & CLEANING COMPOUNDS INDUSTRY	46,304	-1.0	3.0	13.7
POWER BOILER & STRUCTURAL METALS	48,488	5.4	0.4	0.7
BREAD & OTHER BAKERY PROD	34,026	-0.3	-0.2	0.9
DISTILLERY	20,240	3.8	-1.9	-0.7
FLOOR TILE, LINOLEUM & COATED FABRICS	3,637	-2.5	-4.0	0.9
LEATHER TANNERIES	5,199	-0.3	-4.2	2.8
CANE & BEET SUGAR	17,465	-0.5	-	-1.0
CLAY PRODUCTS	8,022	-1.9	-3.4	-1.8
COPPER ROLL., CAST., & EXTRUD.	7,229	-2.0	-5.3	-3.6
PULP & PAPER	786,656	1.8	1.8	2.0
PRIMARY STEEL	345,343	0.5	0.0	3.3
DAIRY PRODUCTS	315,679	-0.6	0.5	-4.0
CHEMICALS & CHEMICAL PRODUCTS	201,954	4.5	4.0	6.3
AIRCRAFT & AIRCRAFT PARTS	145,289	8.2	5.7	6.7
READY-MIX CONCRETE	129,090	2.2	2.1	-2.1
NON-METALLIC MINERAL PRODUCTS	71,151	1.6	1.6	2.5

Note: A consumer market oriented industry is defined as one in which the ratio of personal expenditures on industry outputs to the apparent market of the industry is high; export market oriented industries are ones in which the ratio of exports to production is high; interindustry oriented industries are ones for which interindustry supply to production is high.

Table 21
Structure of Transportation Demand for Transportation Intensive Industries:
Share by Transportation Service, %

TRANSPORTATION INDUSTRY 1990	Dairy Products	Softdrinks	Distillery	Brewery	Leather	Footwear	Contract Textile Dye
AIR TRANSPORT & SERVICES INCIDENTAL	0.05	0.07	0.15	0.18	0.04	0.51	0.08
RAILWAY TRANSPORT & REL. SERVICES	0.38	0.13	0.41	0.28	0.07	1.39	0.26
WATER TRANSPORT & REL. SERVICES	0.03	0.01	0.31	0.02	0.00	0.04	0.02
TRUCK TRANSPORT INDUSTRIES	1.82	2.05	3.34	1.04	2.02	7.56	4.41
OTHER TRANSPORT & SERV. TO TRANSP.	0.01	0.02	0.04	0.05	0.02	0.10	0.04
HIGHWAY & BRIDGE MAINTENANCE IND.	0.00	0.01	0.02	0.03	0.00	0.06	0.02
PIPELINE TRANSPORT INDUSTRIES	1.97	2.01	21.37	9.97	5.68	2.52	28.77
STORAGE AND WAREHOUSING INDUSTRIES	0.78	0.04	8.21	0.09	0.17	0.25	0.10
TRANSPORTATION MARGINS	94.97	95.66	66.16	88.35	92.00	87.56	66.31
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1971	Dairy Products	25 SOFT	26 DISTI	27 BREWE	32 LEATH	33 FOOTW	39 CONTR
AIR TRANSPORT & SERVICES INCIDENTAL	0.01	0.03	0.03	0.19	0.02	0.14	0.05
RAILWAY TRANSPORT & REL. SERVICES	0.79	0.36	0.30	1.47	0.27	3.23	1.86
WATER TRANSPORT & REL. SERVICES	0.03	0.01	0.47	0.04	0.01	0.10	0.01
TRUCK TRANSPORT INDUSTRIES	3.89	5.71	5.97	7.56	3.43	13.86	9.78
OTHER TRANSPORT & SERV. TO TRANSP.	0.00	0.01	0.01	0.02	0.01	0.08	0.01
HIGHWAY & BRIDGE MAINTENANCE IND.	0.00	0.01	0.01	0.03	0.01	0.08	0.01
PIPELINE TRANSPORT INDUSTRIES	1.22	2.12	6.28	5.84	2.74	0.86	3.68
STORAGE AND WAREHOUSING INDUSTRIES	0.91	0.09	16.44	0.49	0.12	0.63	0.26
TRANSPORTATION MARGINS	93.15	91.65	70.49	84.36	93.40	81.02	84.35
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 21 cont
Structure of Transportation Demand for Transportation Intensive Industries:
Share by Transportation Service, %

TRANSPORTATION INDUSTRY 1990	Bread & Other Bakery Products	Cane & Beet Sugar	Wooden Box	Primary Steel	Copper Roll Cast & Extrude	Power Boiler & Struct Metals	Pulp & Paper
AIR TRANSPORT & SERVICES INCIDENTAL	0.15	0.19	0.10	0.14	0.12	0.18	0.11
RAILWAY TRANSPORT & REL. SERVICES	0.37	0.39	0.22	1.04	0.22	0.40	1.02
WATER TRANSPORT & REL. SERVICES	0.02	0.01	0.01	0.00	0.00	0.01	2.51
TRUCK TRANSPORT INDUSTRIES	4.02	4.94	2.15	1.73	10.71	4.43	1.20
OTHER TRANSPORT & SERV. TO TRANSP.	0.05	0.01	0.02	0.00	0.00	0.03	0.00
HIGHWAY & BRIDGE MAINTENANCE IND.	0.03	0.01	0.01	0.00	0.00	0.02	0.00
PIPELINE TRANSPORT INDUSTRIES	11.27	12.06	1.70	12.28	11.19	5.59	9.66
STORAGE AND WAREHOUSING INDUSTRIES	0.13	0.10	0.14	0.05	0.20	0.10	0.04
TRANSPORTATION MARGINS	83.97	82.30	95.65	84.76	77.56	89.25	85.45
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1971	Bread & Other Bakery Products	Cane & Beet Sugar	Wooden Box	Primary Steel	Copper Roll Cast & Extrud	Power Boiler & Struct Metals	Pulp & Paper
AIR TRANSPORT & SERVICES INCIDENTAL	0.08	0.01	0.03	0.01	0.02	0.03	0.01
RAILWAY TRANSPORT & REL. SERVICES	0.56	0.17	0.28	1.84	1.16	2.34	1.58
WATER TRANSPORT & REL. SERVICES	0.02	0.00	0.02	0.00	0.01	0.01	4.14
TRUCK TRANSPORT INDUSTRIES	7.66	3.53	4.44	3.64	9.31	7.61	2.37
OTHER TRANSPORT & SERV. TO TRANSP.	0.02	0.00	0.01	0.00	0.01	0.01	0.01
HIGHWAY & BRIDGE MAINTENANCE IND.	0.02	0.00	0.02	0.00	0.01	0.01	0.00
PIPELINE TRANSPORT INDUSTRIES	4.20	3.37	0.70	6.09	3.29	2.31	5.96
STORAGE AND WAREHOUSING INDUSTRIES	0.19	0.07	0.16	0.07	0.24	0.27	0.04
TRANSPORTATION MARGINS	87.25	92.85	94.34	88.33	85.94	87.40	85.90
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 21 cont
Structure of Transportation Demand for Transportation Intensive Industries:
Share by Transportation Service, %

TRANSPORTATION INDUSTRY 1990	Ready-Mix Concrete	Non-Metallic Min Prod	Aircraft & Aircraft Parts	Clay Products	Chem & Chem Products	Floor Tile etc.	Soap & Cleaning Cmp
AIR TRANSPORT & SERVICES INCIDENTAL	0.08	0.13	72.41	0.08	0.07	0.14	0.09
RAILWAY TRANSPORT & REL. SERVICES	0.19	1.04	0.21	0.18	0.16	0.35	0.18
WATER TRANSPORT & REL. SERVICES	0.00	0.01	0.01	0.00	0.00	0.03	0.01
TRUCK TRANSPORT INDUSTRIES	0.88	1.31	4.45	2.58	1.59	2.77	7.69
OTHER TRANSPORT & SERV. TO TRANSP.	0.00	0.02	0.01	0.01	0.01	0.05	0.02
HIGHWAY & BRIDGE MAINTENANCE IND.	0.00	0.01	0.01	0.00	0.00	0.03	0.01
PIPELINE TRANSPORT INDUSTRIES	3.27	14.14	1.70	47.10	26.11	13.67	3.91
STORAGE AND WAREHOUSING INDUSTRIES	0.02	0.05	0.06	0.04	0.03	0.11	0.09
TRANSPORTATION MARGINS	95.55	83.30	21.14	49.99	72.02	82.85	88.01
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1971	Ready-Mix Concrete	Non-Met Min Prod	Aircraft & Aircraft Parts	Clay Products	Chen & Chem Products	Floor Tile etc.	Soap & Cleaning Cmp
AIR TRANSPORT & SERVICES INCIDENTAL	0.01	0.01	23.25	0.04	0.03	0.04	0.03
RAILWAY TRANSPORT & REL. SERVICES	0.63	2.12	0.62	0.21	0.53	0.27	0.31
WATER TRANSPORT & REL. SERVICES	0.00	0.00	0.01	0.01	0.01	0.01	0.01
TRUCK TRANSPORT INDUSTRIES	2.50	3.21	18.00	5.02	4.09	3.43	13.63
OTHER TRANSPORT & SERV. TO TRANSP.	0.00	0.00	0.01	0.01	0.01	0.01	0.01
HIGHWAY & BRIDGE MAINTENANCE IND.	0.00	0.00	0.01	0.01	0.01	0.01	0.01
PIPELINE TRANSPORT INDUSTRIES	0.40	9.85	1.21	41.68	0.88	4.76	1.96
STORAGE AND WAREHOUSING INDUSTRIES	0.07	0.09	0.16	0.07	0.11	0.11	0.12
TRANSPORTATION MARGINS	96.38	84.71	56.73	52.95	94.33	91.37	83.92
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

**Table 21 cont
Structure of Transportation Demand for Transportation
Intensive Industries: Share by Transportation Service, %**

TRANSPORTATION INDUSTRY 1990	Cement	Concrete
AIR TRANSPORT & SERVICES INCIDENTAL	0.15	0.20
RAILWAY TRANSPORT & REL. SERVICES	0.35	0.46
WATER TRANSPORT & REL. SERVICES	0.01	0.00
TRUCK TRANSPORT INDUSTRIES	1.52	1.80
OTHER TRANSPORT & SERV. TO TRANSP.	0.02	0.01
HIGHWAY & BRIDGE MAINTENANCE IND.	0.01	0.01
PIPELINE TRANSPORT INDUSTRIES	26.63	5.78
STORAGE AND WAREHOUSING INDUSTRIES	0.05	0.05
TRANSPORTATION MARGINS	71.28	91.70
	100.00	100.00
1971	Cement	Concrete
AIR TRANSPORT & SERVICES INCIDENTAL	0.03	0.02
RAILWAY TRANSPORT & REL. SERVICES	1.45	0.28
WATER TRANSPORT & REL. SERVICES	0.02	0.00
TRUCK TRANSPORT INDUSTRIES	3.99	4.22
OTHER TRANSPORT & SERV. TO TRANSP.	0.01	0.00
HIGHWAY & BRIDGE MAINTENANCE IND.	0.01	0.00
PIPELINE TRANSPORT INDUSTRIES	36.90	2.96
STORAGE AND WAREHOUSING INDUSTRIES	0.18	0.05
TRANSPORTATION MARGINS	57.40	92.46
	100.00	100.00

4] NON-MANUFACTURING DEMAND FOR TRANSPORTATION

INTRODUCTION

The input-output tables distinguish 46 non-manufacturing industries including the Primary sector, Construction and the broadly defined Service sector.

Together, these sectors accounted for $6.4 billion of transportation services in 1990 or 15.3% of the total industry demand. This proportion was down from $1.3 billion or 17.2% in 1971.

i] THE PRIMARY SECTOR

The Primary sector is composed of a group of thirteen industries including Agriculture and Services Related to Mineral Extraction. Over the 1971-1990 period about half of the industries that comprise this sector experienced low or negative output growth.

The Primary sector possesses the same degree of transportation intensity as the Manufacturing sector and like Manufacturing, it has become less transportation intensive over time. In the aggregate, the transportation intensity of the Primary (manufacturing) sector has fallen from 2.9% (2.8%) in 1971 to 2.4% (2.4%) in 1990.

Table 23 presents Primary sector demand for transportation services, production and transportation intensity for the years 1971 and 1990.

The greatest demand for transportation services in 1990 originated in the Logging and Forestry industry and Agriculture. This was also the case in 1971.

In terms of intensity (transportation demand relative to production), the Logging and Forestry industry was most intensive in 1990 followed by Iron Mines. Little change has been observed over time.

Table 22
Primary Sector
OUTPUT GROWTH, %, 1971-1990

Industry	1971-1990
COAL MINES	5.5
GOLD MINES	5.2
SALT MINES	4.3
QUARRIES & SAND PITS	2.8
SERVICES INCIDENTAL TO MINERAL EXTRACTION	2.4
LOGGING & FORESTRY	2.3
NON-METAL MINES	1.8
FISHING & TRAPPING	1.7
AGRICULTURE	1.4
CRUDE PETROLEUM & NATURAL GAS	1.4
OTHER METAL MINES	0.3
IRON MINES	-1.7
ASBESTOS MINES	-5.6

Table 23
Primary Sector: Transportation Demand and Intensity, $000, constant

INDUSTRY	1990 TRANSPORTATION DEMAND	PRODUCTION	INTENSITY	1971 TRANSPORTATION DEMAND	PRODUCTION	INTENSITY
AGRICULTURE	390,823	23,919,694	0.016	86,792	4,946,852	0.018
FISHING & TRAPPING	34,710	1,692,500	0.021	6,327	219,830	0.029
LOGGING & FORESTRY	749,958	7448,962	0.101	164,380	1,338,130	0.123
GOLD MINES	17,892	2,555,,278	0.007	667	77,496	0.009
OTHER MINES	103,709	4,170,438	0.025	19,679	1,516,022	0.013
IRON MINES	74,717	1,222,368	0.061	15,613	520,852	0.030
ASBESTOS MINES	4,836	271,451	0.018	3,251	227,684	0.014
NON-M	20,788	980,231	0.021	2,254	191,683	0.012
SALT MINES	4,132	251,624	0.016	456	39,161	0.012
COAL MINES	37,377	1,781,221	0.021	1,960	100,841	0.019
CRUDE PETROLEUM	54,823	21,620,735	0.003	6,582	1,930,284	0.003
QUARRIES & SAND PITS	52,510	1,107,965	0.047	7,239	208,863	0.035
INCIDENTAL SERVICES	128,604	3,391,909	0.038	19,388	401,422	0.048
TOTAL	1,674,879	70,414,376	0.024	334,586	11,719,120	0.029

Table 23 ranks Primary Sector industries by transportation intensity. Over the 1971 to 1990 period seven of the thirteen industries used an increasing quantity of transportation services relative to production.

Tables 24 and 25 contrast the cost structure of increasing and decreasing transportation intensive Primary sector industries.

INCREASING TRANSPORTATION INTENSITY INDUSTRIES

Most Primary sector industries that experienced an increase in transportation intensity consume a large proportion of their transportation requirements as Railway services. Each (except Salt Mines and Non-Metal Mines) experienced a relative increase in Railway services costs in total costs. Although Air Transport services play a relatively minor role for most Primary sector industries, many of the same industries experienced a rise in Air Transport costs. Water services play a minor role as well (except in the cases of Quarries and Sand Pits and Iron Mines). Water Transport costs are relatively high but declined over the 1971-1990 period).

Although the cost share of Trucking services declined for each industry, Trucking Services constitute a major proportion of the transportation costs of only the Other Mines industry.

Pipeline Transport is a major source of costs for the increasing transportation intensity Primary sector industries. In the 1971-1990 period Pipeline costs rose for each Primary industry except the Iron Mines industry.

DECREASING INTENSITY INDUSTRY

Generally those industries that experienced decreasing transportation demand intensity reduced the largest costs shares over time. For example in 1971, 45% and 21% of the transportation costs of the Crude Petroleum industry was composed of Air Transport services and Pipeline Transport services. In 1990 these services constituted respectively 26% and 20% of transportation services costs.

Little in the way of common trends can be seen to distinguish decreasing transportation intensive industries from increasing transportation intensive industries in the Primary sector.

Further evidence presented in Table 26 suggests that those industries that have experienced increasing transportation intensity have as well experienced growth in costs of other major inputs in excess of output growth.

Table 24
PRIMARY SECTOR: INCREASING TRANSPORTATION INTENSIVE INDUSTRIES
TRANSPORTATION COST SHARE

1971	QUARRIES & SAND PITS	OTHER	IRON MINES	ASBESTOS MINES	NON-METAL MINES	SALT MINES	COAL MINES
AIR TRANSPORT & SERVICES INCIDENTAL	0.01	7.36	11.50	2.12	2.44	2.39	0.09
RAILWAY TRANSPORT & REL. SERVICES	16.76	14.05	15.83	54.90	1.21	17.60	54.79
WATER TRANSPORT & REL. SERVICES	61.27	0.01	45.54	0.00	0.01	0.04	0.00
TRUCK TRANSPORT INDUSTRIES	0.97	19.84	0.22	1.42	1.18	0.24	0.11
OTHER TRANSPORT & SERV. TO TRANSP.	0.12	0.01	0.09	0.00	0.01	0.03	0.00
HIGHWAY & BRIDGE MAINTENANCE IND.	0.00	0.01	0.00	0.00	0.01	0.03	0.00
PIPELINE TRANSPORT INDUSTRIES	0.30	2.60	7.61	1.24	60.05	23.45	9.04
STORAGE AND WAREHOUSING INDUSTRIES	0.10	0.21	0.09	0.53	0.14	1.56	0.15
TRANSPORTATION MARGINS	20.47	55.91	19.11	39.78	34.96	54.67	35.81
	100	100	100	100	100	100	100
1990	QUARRIES & SAND PITS	OTHER	IRON MINES	ASBESTOS MINES	NON-METAL MINES	SALT MINES	COAL MINES
AIR TRANSPORT & SERVICES INCIDENTAL	0.198058	8.087051	9.470402	3.66005	1.914566	3.194579	0.342457
RAILWAY TRANSPORT & REL. SERVICES	21.74633	19.90763	41.92352	57.56824	0.452184	5.275895	60.31784
WATER TRANSPORT & REL. SERVICES	52.93468	0.005785	25.13886	0	0.00481	0.024201	0.005351
TRUCK TRANSPORT INDUSTRIES	0.302799	18.85757	0.046843	1.095947	0.370406	0.024201	0.045483
OTHER TRANSPORT & SERV. TO TRANSP.	0.013331	0.015428	0.002677	0	0.009621	0.048403	0.010702
HIGHWAY & BRIDGE MAINTENANCE IND.	0.007618	0.007714	0.001338	0	0.00481	0.024201	0.005351
PIPELINE TRANSPORT INDUSTRIES	2.656637	7.69075	1.481591	4.735318	70.41562	46.4666	12.84747
STORAGE AND WAREHOUSING INDUSTRIES	0.062845	0.242988	0.056212	0.227461	0.062536	0.290416	0.109693
TRANSPORTATION MARGINS	22.0777	45.18509	21.87856	32.71299	26.76544	44.6515	26.31565
TOTAL	100	100	100	100	100	100	100

Table 25
PRIMARY SECTOR: DECREASING TRANSPORTATION INTENSIVE INDUSTRIES
TRANSPORTATION COST SHARE

1971	AGRICULTURE	FISHING & TRAPPING	LOGGING & FORESTRY	GOLD MINES	CRUDE PETROLEUM	INCIDENTAL SERVICES
AIR TRANSPORT & SERVICES INCIDENTAL	0.46	0.01	0.30	11.47	45.02	25.90
RAILWAY TRANSPORT & REL. SERVICES	1.29	3.95	3.09	7.82	4.47	8.77
WATER TRANSPORT & REL. SERVICES	0.30	31.75	20.41	0.03	0.10	0.01
TRUCK TRANSPORT INDUSTRIES	4.50	27.17	73.72	0.48	0.82	43.27
OTHER TRANSPORT & SERV. TO TRANSP.	2.68	0.00	0.05	0.02	0.08	0.01
HIGHWAY & BRIDGE MAINTENANCE IND.	0.05	0.00	0.00	0.03	0.09	0.01
PIPELINE TRANSPORT INDUSTRIES	5.16	0.63	0.09	3.53	21.33	1.20
STORAGE AND WAREHOUSING INDUSTRIES	9.00	2.14	0.50	0.73	0.59	0.55
TRANSPORTATION MARGINS	76.55	34.35	1.84	75.90	27.50	20.30
TOTAL	100	100	100	100	100	100

1990	AGRICULTURE	FISHING & TRAPPING	LOGGING & FORESTRY	GOLD MINES	CRUDE PETROLEUM	INCIDENTAL SERVICES
AIR TRANSPORT & SERVICES INCIDENTAL	3.72	0.92	0.68	8.94	25.90	25.28
RAILWAY TRANSPORT & REL. SERVICES	0.73	2.37	1.05	3.78	2.04	7.21
WATER TRANSPORT & REL. SERVICES	0.33	18.35	18.44	0.01	0.05	0.01
TRUCK TRANSPORT INDUSTRIES	3.93	39.05	77.79	0.08	0.48	42.20
OTHER TRANSPORT & SERV. TO TRANSP.	2.92	0.01	0.00	0.03	0.13	0.03
HIGHWAY & BRIDGE MAINTENANCE IND.	0.09	0.00	0.00	0.01	0.07	0.02
PIPELINE TRANSPORT INDUSTRIES	6.91	3.45	0.34	8.71	19.75	2.71
STORAGE AND WAREHOUSING INDUSTRIES	7.67	4.13	0.52	0.27	0.30	0.40
TRANSPORTATION MARGINS	73.69	31.72	1.17	78.17	51.28	22.14
TOTAL	100	100	100	100	100	100

Table 26
Primary Sector: Increasing Transportation Intensity Industries
Growth of Major Cost Components, 1971-1990

COST COMPONENT GROWTH, %, 1971-1990	OTHER MINES	IRON MINES	ASBESTOS MINES	NON-METAL MINES	SALT MINES	COAL MINES	QUARRIES & SAND PITS
Primary	3.3	6.3	-2.8	13.8	14.4	9.0	12.6
Manufacturing	7.2	8.4	3.1	10.1	8.5	13.5	11.0
Construction	5.6	2.0	1.6	10.1	8.2	16.3	1.9
TCU	10.2	7.2	4.5	11.6	12.0	15.5	11.3
Trade	7.9	10.0	6.6	11.7	9.4	16.6	12.1
FIRE	11.9	7.3	9.6	11.3	12.0	16.0	11.8
Services	10.4	8.1	7.6	13.7	13.0	15.9	12.6
Unallocated	4.7	-0.7	-5.6	10.3	10.4	11.5	6.6
Labour	5.7	5.0	1.8	9.8	9.1	12.4	8.3
Capital	9.3	-2.5	-1.9	8.8	7.9	19.9	9.4
Tax, Subsidy, govt & non-comp	8.9	-3.5	ERR	11.0	10.6	20.9	10.8
Production	7.7	4.4	1.4	9.9	9.4	14.6	9.7

ii] CONSTRUCTION

The Construction Sector is composed of 9 industries, only one of which experienced more rapid growth than the industrial average (2.2%) in the 1971-1990 period (Table 27).

The Residential Construction industry, followed by Non-Residential Construction and Repair Construction are the largest consumers of transportation services.

The Construction sector used somewhat fewer transportation services per unit of production than either the Primary or Manufacturing sectors in 1990. As was the case for the latter two sectors, the Construction sector became less transportation intensive between 1971 and 1990.

Table 27 Construction Sector OUTPUT GROWTH, %, 1971-1990	
Industry	1971-1990
REPAIR CONSTRUCTION	1.2
RESIDENTIAL CONSTRUCTION	2.4
NON-RESIDENTIAL BLDG. CONSTRUCTION	1.3
ROAD, HIGHWAY & AIRSTRIP CONST.	-0.4
GAS & OIL FACILITY CONSTRUCTION	0.2
DAMS & IRRIGATION PROJECTS	-1.0
RAILWAY & TELEPHONE TELEGRAPH CONST	1.0
OTHER ENGINEERING CONSTRUCTION	0.2
CONSTRUCTION, OTHER ACTIVITIES	-1.4

The Road, Highway and Airstrip Construction industry followed by the Residential Construction industry were the most intensive users of transportation services in 1990. In 1971, the Dams and Irrigation Projects industry followed by Road, Highway and Airstrip Construction used transportation services most intensively.

Table 28
CONSTRUCTION SECTOR
TRANSPORTATION DEMAND & INTENSITY, $000, constant

| | 1990 | | | 1971 | | |
Industry	Transportation Costs	Production	Intensity	Transportation	Production	Intensity
REPAIR CONSTRUCTION	243,189	12,838,669	0.019	38,945	2,267,900	0.017
RESIDENTIAL CONSTRUCTION	659,716	29,468,716	0.022	133,283	4,985,000	0.027
NON-RESIDENTIAL BLDG. CONSTRUCTION	313,873	19,065,449	0.017	79,392	3,731,090	0.022
ROAD, HIGHWAY & AIRSTRIP CONST.	170,941	4,395,548	0.039	48,736	1,315,990	0.037
GAS & OIL FACILITY CONSTRUCTION	110,230	6,435,215	0.017	27,359	1,128,306	0.024
DAMS & IRRIGATION PROJECTS	89,066	5,023,317	0.018	57,860	1,137,753	0.051
RAILWAY & TELEPHONE TELEGRAPH CONST	34,952	2,393,863	0.015	11,623	415,362	0.028
OTHER ENGINEERING CONSTRUCTION	93,130	4,967,625	0.019	48,693	1,520,896	0.032
CONSTRUCTION, OTHER ACTIVITIES	7,491	416,283	0.018	5,112	188,662	0.027
TOTAL	1,722,588	85,004,685	0.020	451,003	16,690,959	0.027

Two Construction Sector industries experienced a rise in transportation intensity in the 1971-1990 period: Repair Construction and Road, Highway and Airstrip Construction. Table 30 presents the cost share for each Transportation industry in the total transportation costs for each Construction industry.

Trucking Services are the major transportation cost component for both of these industries and over the 1971-1990 period the Trucking share rose in each.

· Table 30 also shows that the costs of numerous other input categories have escalated rapidly in the two Construction industries that experienced increased transportation intensity.

Table 29
Construction Sector
GROWTH OF MAJOR COST COMPONENTS
INCREASING TRANSPORTATION INTENSITY
INDUSTRIES, %, 1971-1990

COST COMPONENT GROWTH %, 1971-1990	REPAIR	ROAD, HIGHWAY & AIRSTRIP
Primary	10.8	7.3
Manufacturing	9.8	5.8
Construction	5.8	10.8
TCU	10.2	7.2
Trade	10.8	7.2
FIRE	13.6	10.9
Services	13.8	11.7
Unallocated	7.6	7.5
Labour	9.0	6.2
Capital	11.8	3.8
Tax, subsidy, govt & non-comp	10.5	8.8
Production	9.7	6.7

Table 30
CONSTRUCTION SECTOR
TRANSPORTATION COST SHARE

1990 INDUSTRY	REPAIR	RESIDENTIAL	NON-RES BLDG.	ROAD, HIGHWAY & AIRSTRIP	GAS & OIL FACILITY	DAMS & IRRIGATION PROJECTS	RAILWAY & TELEPHONE TELEGRAPH	OTHER ENGINEERING	OTHER ACTIVITIES
AIR TRANSPORT & SERV	0.60	0.26	6.76	1.52	16.16	7.23	7.73	2.60	1.54
RAILWAY TRANSPORT & SERV	2.02	0.26	1.93	3.37	10.95	2.01	4.79	4.20	4.26
WATER TRANSPORT & SERV	0.01	0.01	1.82	0.00	0.01	10.03	0.02	12.92	0.04
TRUCK TRANSPORT	16.01	5.21	6.06	29.25	12.19	46.36	0.09	7.87	71.61
OTHER TRANSPORT & SERV	0.07	0.02	0.02	0.01	0.01	0.02	0.05	0.03	0.11
HIGHWAY & BRIDGE MAINTENANCE	0.02	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.05
PIPELINE TRANSPORT	0.60	0.28	0.43	2.12	0.64	0.45	0.27	0.20	4.78
STORAGE AND WAREHOUSING	0.23	0.15	0.19	0.31	0.54	0.38	0.15	0.27	0.68
TRANSPORTATION MARGINS	80.45	93.80	82.78	63.42	59.49	33.51	86.88	71.90	16.94
	100	100	100	100	100	100	100	100	100

1971 INDUSTRY	REPAIR	RESIDENTIAL	NON-RESIDENTIAL BLDG.	ROAD, HIGHWAY & AIRSTRIP	GAS & OIL FACILITY	DAMS & IRRIGATION PROJECTS	RAILWAY & TELEPHONE TELEGRAPH	OTHER ENGINEERING	OTHER ACTIVITIES
AIR TRANSPORT & SERV	0.46	0.01	0.30	11.44	7.35	11.49	2.12	2.44	2.37
RAILWAY TRANSPORT & SERV	1.29	3.94	3.09	7.80	14.05	15.83	54.80	1.21	17.50
WATER TRANSPORT & SERV	0.30	31.72	20.39	0.03	0.01	.45.53	0.00	0.01	0.04
TRUCK TRANSPORT	4.50	27.14	73.65	0.47	19.84	0.22	1.42	1.18	0.24
OTHER TRANSPORT & SERV	2.68	0.00	0.05	0.02	0.01	0.09	0.00	0.01	0.03
HIGHWAY & BRIDGE MAINTENANCE	0.05	0.00	0.00	0.03	0.01	0.00	0.00	0.01	0.03
PIPELINE TRANSPORT	5.15	0.63	0.09	3.52	2.60	7.61	1.24	60.04	23.32
STORAGE AND WAREHOUSING	9.00	2.13	0.50	0.73	0.21	0.09	0.53	0.14	1.55
TRANSPORTATION MARGINS	76.51	34.31	1.84	75.72	55.90	19.10	39.70	34.95	54.35
	100	100	100	100	100	100	100	100	100

iii] COMMUNICATIONS, UTILITIES AND TRADES

The three sectors, Communications, Utilities and Distributive Trades experienced relatively robust growth over the 1971-1990. Except for Gas Distribution and Retail Trade, these industries grew considerably in excess of of the aggregate industry average.

This group of industries does not individually consume a large quantity of transportation services. Noteable exceptions however are the two distributive trades industries.

Except for the Gas Distribution industry, all of the industries listed in this group experienced a decline in transportation intensity over the 1971-1990 period (Table 32).

Table 31
COMMUNICATIONS, UTILITIES & TRADES
OUTPUT GROWTH, %, 1971-1990

Industry	Growth, %
TELECOMMUNICATION BROADCASTING IND.	3.6
TELECOMMUNICATION CARRIERS & OTHER	4.8
POSTAL SERVICE IND	2.6
ELECTRIC POWER SYSTEMS IND	3.2
GAS DISTRIBUTION SYSTEMS IND	1.9
OTHER UTILITY IND NEC	5.6
WHOLESALE TRADE	3.1
RETAIL TRADE	2.2

The Gas Distribution industry purchases almost all of its transportation services in the form of Pipeline services. Over the 1971-1990 period the proportion of Pipeline services costs increased slightly. Air Transport services, while a small proportion of the transportation bill for Gas Distribution increased (Table 33).

Table 32
COMMUNICATIONS, UTILITIES AND TRADES
PRODUCTION, TRANSPORTATION COSTS & INTENSITY, $000, constant

Industry	TRANSPORTATION COSTS, 1990	PRODUCTION	INTENSITY	TRANSPORTATION COSTS, 1971	PRODUCTION	INTENSITY
TELECOMMUNICATION BROADCASTING	21,427	3,341,497	0.006	5,169	378,105	0.014
TELECOMMUNICATION CARRIERS & OTHER	19,759	16,652,375	0.001	2,210	1,929,236	0.001
POSTAL SERVICE	248,418	3,203,504	0.078	82,731	481,569	0.172
ELECTRIC POWER SYSTEMS	130,545	17,114,941	0.008	19,056	2,050,094	0.009
GAS DISTRIBUTION SYSTEMS	12,794	1,963,521	0.007	1,471	344,534	0.004
OTHER UTILITY NEC	7,859	1,344,107	0.006	424	61,830	0.007
WHOLESALE TRADE	779,542	41,368,817	0.019	206,730	6,136,744	0.034
RETAIL TRADE	498,435	47,344,106	0.011	109,760	8,719,481	0.013

Table 33
TELECOMMUNICATIONS, UTILITIES & TRADES: TRANSPORTATION COST SHARES

1990	TELECOMM BROADCASTERS	TELECOMM CARRIERS	POSTAL SERVICE	ELECTRIC POWER SYSTEMS	GAS DISTRIBUTION SYSTEMS	OTHER UTILITIES	WHOLESALE TRADE	RETAIL TRADE
AIR TRANSPORT & SERVICES INCIDENTAL	60.3	3.6	47.9	0.3	0.9	0.8	1.6	3.7
RAILWAY TRANSPORT & REL. SERVICES	12.4	5.6	23.4	4.9	0.4	2.6	13.0	8.1
WATER TRANSPORT & REL. SERVICES	0.1	0.3	0.4	0.0	0.0	0.2	8.5	0.8
TRUCK TRANSPORT INDUSTRIES	8.5	0.3	27.4	9.6	0.0	8.0	20.3	23.0
OTHER TRANSPORT & SERV. TO TRANSP.	0.2	0.7	0.0	0.0	0.0	0.6	16.0	20.1
HIGHWAY & BRIDGE MAINTENANCE IND.	0.1	0.4	0.0	0.0	0.0	0.3	0.1	0.3
PIPELINE TRANSPORT INDUSTRIES	4.7	15.6	0.2	8.0	97.0	23.7	3.5	16.7
STORAGE AND WAREHOUSING INDUSTRIES	0.7	1.0	0.2	0.1	0.1	0.7	28.7	16.6
TRANSPORTATION MARGINS	12.9	72.4	0.4	77.1	1.4	63.1	8.2	10.6
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1971	TELECOMM BROADCASTERS	TELECOMM CARRIERS	POSTAL SERVICE	ELECTRIC POWER SYSTEMS	GAS DISTRIBUTION SYSTEMS	OTHER UTILITES	WHOLESALE TRADE	RETAIL TRADE
AIR TRANSPORT & SERVICES INCIDENTAL	54.9	0.4	34.9	0.1	0.3	0.4	1.2	5.0
RAILWAY TRANSPORT & REL. SERVICES	14.7	4.2	13.6	6.8	0.8	4.2	12.5	12.5
WATER TRANSPORT & REL. SERVICES	0.1	0.3	1.6	0.0	0.0	0.3	9.8	0.7
TRUCK TRANSPORT INDUSTRIES	15.8	1.0	49.2	7.8	0.2	40.1	25.8	23.0
OTHER TRANSPORT & SERV. TO TRANSP.	0.1	0.2	0.0	0.0	0.0	0.3	8.1	17.5
HIGHWAY & BRIDGE MAINTENANCE IND.	0.1	0.3	0.0	0.0	0.0	0.3	0.0	0.2
PIPELINE TRANSPORT INDUSTRIES	1.7	9.1	0.0	34.9	95.2	1.2	1.0	7.8
STORAGE AND WAREHOUSING IND	1.1	1.3	0.2	0.0	0.1	1.2	35.3	19.2
TRANSPORTATION MARGINS	11.2	83.1	0.4	50.3	3.3	51.7	6.2	14.0
TOTAL	99.7	99.8	100.0	100.0	100.0	99.8	99.9	99.8

iv] FINANCE, INSURANCE AND REAL ESTATE

The three FIRE industries experienced robust growth over the period 1971-1990. Each grew in excess of the industrial average.

Transportation costs incurred by each of these industries is small relative to total production. The largest consumption is recorded by the Trust, Other Finance and Real Estate (the result of Real Estate demand).

Table 33
FIRE
OUTPUT GROWTH, %, 1971-1990

BANKS, CREDIT UNION & OTH. DEP INST	3.3
TRUST, OTHER FINANCE & REAL ESTATE	3.4
INSURANCE IND	3.4

Although small, transportation demand rose marginally relative to production in both the Banking industry and the Trust, Other Finance & Real Estate industries.

Table 34
FIRE:
TRANSPORTATION DEMAND & INTENSITY, $000, constant

	1990			1971		
	Transportation Demand	Production	Intensity	Transportation Demand	Production	Intensity
BANKS, CREDIT UNION & OTH. DEP INST	20,763	13,443,386	0.002	2,060	1,466,979	0.001
TRUST, OTHER FINANCE & REAL ESTATE	196,145	49,286,310	0.004	23,388	6,929,632	0.003
INSURANCE IND	7,356	9,299,088	0.001	1,392	1,642,516	0.001

Each of these industries exhibit identical patterns of transportation costs. In each case Air Transport services rose in relative importance over the 1971-1990 period. Other Transport service as well as Pipeline services also rose. Declining in importance was rail water and Trucking services.

Table 35
FIRE: TRANSPORTATION COST SHARES

1990	BANKS, CREDIT UNION & OTH. DEP INST	TRUST, OTHER FIN & REAL ESTATE	INSURANCE IND
AIR TRANSPORT & SERVICES INCIDENTAL	14.05	2.87	22.19
RAILWAY TRANSPORT & REL. SERVICES	18.86	7.17	24.46
WATER TRANSPORT & REL. SERVICES	0.73	0.19	2.04
TRUCK TRANSPORT INDUSTRIES	5.06	8.87	3.68
OTHER TRANSPORT & SERV. TO TRANSP.	1.83	0.48	5.14
HIGHWAY & BRIDGE MAINTENANCE IND.	1.02	0.26	2.85
PIPELINE TRANSPORT INDUSTRIES	43.75	70.73	26.47
STORAGE AND WAREHOUSING INDUSTRIES	3.03	0.66	6.06
TRANSPORTATION MARGINS	11.67	8.78	7.11
TOTAL	100.00	100.00	100.00
1971	BANKS, CREDIT UNION & OTH. DEP INST	TRUST, OTHER FIN & REAL ESTATE	INSURANCE IND
AIR TRANSPORT & SERVICES INCIDENTAL	1.94	0.83	4.50
RAILWAY TRANSPORT & REL. SERVICES	28.38	21.47	34.74
WATER TRANSPORT & REL. SERVICES	1.31	0.28	2.17
TRUCK TRANSPORT INDUSTRIES	14.29	10.22	11.32
OTHER TRANSPORT & SERV. TO TRANSP.	1.02	0.22	1.68
HIGHWAY & BRIDGE MAINTENANCE IND.	1.11	0.23	1.84
PIPELINE TRANSPORT INDUSTRIES	26.44	47.38	10.63
STORAGE AND WAREHOUSING INDUSTRIES	5.43	2.46	8.85
TRANSPORTATION MARGINS	19.08	16.19	22.62
TOTAL	100	100	100

v] SERVICES

Most Service industries experienced output growth in excess of the industrial average in the 1971-1990 period. Noteable in this regard was the Other Business Service industry and Amusement and Recreation industry.

Except for the Accommodation and Food Service industry, the level of transportation services costs is relatively low for the Service industries. In turn Service industries have generally become less transportation intensive. Exceptions are the Hospital industry, the Motion Picture and Video industry and the Miscellaneous Services industry.

The output of the Hospitals industry declined over the 1971-1990 period while transportation costs relative to output more than doubled. Smaller increases were witnessed for the other two increasing intensity industries.

Table 36
SERVICE INDUSTRIES
OUTPUT GROWTH, %, 1971-1990

	OUTPUT GROWTH % 1971-1990
OTHER BUSINESS SERVICE INDUSTRIES	6.8
PROFESSIONAL BUSINESS SERVICES	3.3
ADVERTISING SERVICES	4.4
EDUCATIONAL SERVICE INDUSTRIES	2.9
HOSPITALS	-1.3
OTHER HEALTH SERVICES	3.2
ACCOMMODATION & FOOD SERVICE	1.7
MOTION PICTURE & VIDEO INDUSTRIES	3.1
OTHER AMUSEMENT & RECREATIONAL	4.8
LAUNDRIES & CLEANERS	0.7
OTHER PERSONAL SERVICES	3.8
PHOTOGRAPHERS	4.6
MISC. SERVICE INDUSTRIES	2.6

Table 37
SERVICE INDUSTRIES
TRANSPORTATION DEMAND & INTENSITY, 1971-1990

	Transportation Demand, 1990	Production	Intensity	Transportation Demand, 1971	Production	Intensity
OTHER BUSINESS SERVICE INDUSTRIES	47,776	15,213,905	0.003	2,997	850,815	0.004
PROFESSIONAL BUSINESS SERVICES	35,307	14,459,972	0.002	4,081	1,740,393	0.002
ADVERTISING SERVICES	17,137	2,243,520	0.008	1,779	210,137	0.008
EDUCATIONAL SERVICE INDUSTRIES	56,927	1,638,954	0.035	14,907	254,229	0.059
HOSPITALS	4,000	317,462	0.013	507	94,915	0.005
OTHER HEALTH SERVICES	25,144	14,103,315	0.002	3,971	1,832,351	0.002
ACCOMMODATION & FOOD SERVICE IND.	289,408	23,685,139	0.012	40,035	3,734,468	0.011
MOTION PICTURE & VIDEO INDUSTRIES	20,734	2,040,198	0.010	2,101	277,450	0.008
OTHER AMUSEMENT & RECREATIONAL	32,816	5,350,775	0.006	4,696	537,946	0.009
LAUNDRIES & CLEANERS	17,677	1,530,452	0.012	4,902	363,362	0.013
OTHER PERSONAL SERVICES	24,838	5,080,645	0.005	3,931	583,826	0.007
PHOTOGRAPHERS	3,391	407,745	0.008	401	47,601	0.008
MISC. SERVICE INDUSTRIES	61,415	9,333,877	0.007	4,495	1,097,491	0.004

Table 38
SERVICE INDUSTRIES: TRANSPORTATION COST SHARES

1990	OTHER BUS. SERV	PROFESS BUS SERV	ADVERT	EDUCATION SERV	HOSPITAL	OTHER HEALTH SERV	ACCOMM & FOOD SERVICE	MOTION PICTURE & VIDEO	OTHER AMUSE & RECREAT.	LAUND. & CLEAN.	OTHER PERS SERV	PHOTO-GRAPHERS	MISC. SERV
AIR TRANSPORT & SERV	0.20	0.05	0.02	0.00	0.01	0.04	0.01	0.18	0.09	0.00	0.01	0.01	0.06
RAILWAY TRANS & SERV	0.31	0.18	0.09	0.01	0.01	0.15	0.03	0.17	0.23	0.05	0.07	0.22	0.17
WATER TRANS & SERV	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK TRANSPORT IND	0.29	0.60	0.52	0.03	0.00	0.06	0.03	0.04	0.23	0.23	0.12	0.27	0.24
OTHER TRANS & SERV	0.01	0.02	0.01	0.85	0.00	0.03	0.20	0.38	0.25	0.00	0.38	0.00	0.32
HIGH. & BRIDGE MAINT.	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPELINE TRANS IND	0.08	0.06	0.26	0.10	0.65	0.16	0.15	0.15	0.06	0.12	0.07	0.17	0.08
STOR. & WAREHOUSING	0.02	0.02	0.01	0.00	0.00	0.02	0.00	0.01	0.01	0.00	0.01	0.01	0.01
TRANSPORT MARGINS	0.09	0.06	0.09	0.01	0.33	0.52	0.58	0.06	0.13	0.58	0.34	0.32	0.12

1971	OTHER BUS SERV	PROFESS BUS SERV	ADVERT	EDUCATIONSERV	HOSPITAL	OTHER HEALTH SERV	ACCOMM& FOOD SERV	MOTION PICTURE & VIDEO	OTHER AMUSE & RECREAT.	LAUND & CLEAN	OTHER PERS SERV	PHOTO-GRAPHERS	MISC. SERV
AIR TRANSPORT & SERV	0.00	0.00	0.00	0.11	0.07	0.11	0.02	0.02	0.02	0.00	0.45	0.00	0.26
RAILWAY TRANS & SERV	0.01	0.04	0.03	0.08	0.14	0.16	0.55	0.01	0.17	0.55	0.04	0.17	0.09
WATER TRANS & SERV	0.00	0.32	0.20	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.61	0.00
TRUCK TRANSPORT IND	0.04	0.27	0.74	0.00	0.20	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.43
OTHER TRANS & SERV	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HIGH. & BRIDGE MAINT.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPELINE TRANSP IND	0.05	0.01	0.00	0.04	0.03	0.08	0.01	0.60	0.23	0.09	0.21	0.00	0.01
STOR. & WAREHOUSING	0.09	0.02	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01
TRANSPORT. MARGINS	0.77	0.34	0.02	0.76	0.56	0.19	0.40	0.35	0.54	0.36	0.27	0.20	0.20

SUMMARY -

NON-MANUFACTURING DEMAND FOR TRANSPORTATION

The non-manufacturing sector became less transportation intensive over the 1971-1990 period.

The Primary sector which is similar to the Manufacturing sector in terms of transportation intensity appears to have been affected the most by rising transportation demand;

> The demand for transportation services rose faster than production in seven of thirteen primary industries

Other major industrial sectors (Construction, Communications, Utilities, FIRE and the Distributive Trades) have relatively low transportation requirements. If any industries increased in transportation intensity, the increase was modest.

The Service sector consumed a larger share of Canadian transportation services in 1990 than in 1971. However this was due to the faster rate of decline in demand in other sectors.

STATISTICAL APPENDIX I

This work is based upon the current and constant dollar, annual Input-Output tables produced by Statistics Canada for the period 1971-1990.

The Link level Use matrix is a square matrix reporting the demand and supply relationships between and among industries (not commodities and industries as is usually the case) in the Canadian economy. There are 154 identifiable industries at the link level, arrayed in a square.

The basic concepts of importance in this study are the inputs and output of industries measured in dollar values. The column industry in the matrix purchases (demand) from the row industry (supply) a quantity of inputs that it requires to carry on its business.

There are two general input classes, primary inputs and intermediate inputs. Primary inputs are the traditional factors of production, labour and capital (including taxes if they have been separated). The return to the primary factors of production is commonly referred to as value added. Intermediate inputs are the goods and services purchased by one industry from another for use in its production process.

In the Input-Output accounts, the total of all inputs equals output. For the purpose at hand, the Use matrix fully reports inter-industry relationships or the supply and demand requirements of all industries. Therefore the sum of all column entries amounts to the output or production of the column industry. The sum of all row entries equals the supply to industry by the row industry.

The focus of this report is the supply of and demand for transportation services by industry. The Use matrix reports the demand for transportation services in the movement of goods and services by industry establishments in two ways; as a direct purchase and as a transportation margin.

Industries generally purchase transportation services for use as part of their total production process. For example the intra-establishment transfer of commodities for further processing may require the purchase of transportation services. Also, the provision of inter-modal transportation services requires the purchase of the services of various transportation modes (e.g. a trucking firm may purchase railway or air services). These direct purchases of transportation services by each industry is presented in the Input-Output tables by mode of service. This quantity, while an input

in the production process of the industry is the cost at which the service is provided by the producer of the service.

The cost structure of the Input-Output tables is valuated at producer prices. To equate the remuneration for a service received by the producing establishment with that paid by the purchaser establishment, a fictive industry has been created. The transport margin associated with the purchase of a good or service, is the additional transportation cost incurred by the purchaser in excess of producer price. This cost, the transport margin (a markup), is not identified by mode of transportation. A similar circumstance surrounds the transport of goods destined for export. Export margins are reported by industry but not according to the mode of transport.

TRANSPORTATION INDUSTRY DEFINITION APPENDIX II

INPUT - OUTPUT CODE & INDUSTRY NAME	SIC	INDUSTRY DESCRIPTION

118 AIR TRANSPORT & SERVICES INCIDENTAL	451 452	AIR TRANSPORT INDUSTRIES
		  Scheduled and non-scheduled air transport, charter and specialty air transport,
		
		SERVICE INDUSTRIES INCIDENTAL TO AIR TRANSPORT
		  Airport operations, aircraft rental, servicing and other incidental services

119 RAILWAY TRANSPORT & REL. SERVICES	453	Railway transport and services incidental to railway transport

120 WATER TRANSPORT & REL. SERVICES	454 455	WATER TRANSPORT INDUSTRIES
		  Freight, passenger, ferry, marine towing, ship chartering and other water transport industries
		
		SERVICE INDUSTRIES INCIDENTAL TO WATER TRANSPORT
		  Marine cargo handling, harbour & port operation, marine salvage, piloting, marine shipping agencies, and other service industries incidental to water transport

121 TRUCK TRANSPORT INDUSTRIES	456	General freight, used goods moving & storing, bulk liquids, dry bulk materials, forest products and other truck transport industries
125 OTHER TRANSPORT & SERV. TO TRANSP.	4573-4575 4589 4592 & 4599 996 9991	- School bus operations, charter and sightseeing services and limousine service to airports and stations industries - Other Transportation industries nec - Freight forwarding industry and other service industries incidental to transportation nec. - Travel services - Parking lots and Parking garages
126 HIGHWAY & BRIDGE MAINTENANCE IND.	4591	Highway, street and bridge maintenance
127 PIPELINE TRANSPORT INDUSTRIES	4611 4612 4619	Natural gas pipeline transport industry Crude oil transport industry Other pipeline transport industries
128 STORAGE AND WAREHOUSING INDUSTRIES	471 479	GRAIN ELEVATOR INDUSTRY OTHER STORAGE & WAREHOUSING INDUSTRIES

4

DISCUSSION PAPER #3

MANUFACTURERS INVENTORY MANAGEMENT & IMPLICATIONS FOR LOGISTICS IN CANADA -

EVIDENCE OF STRUCTURAL CHANGE

Prepared for the Distribution Service Industries Directorate, Distribution and Construction Industries Branch, Industry Canada

by Alan Jones

[Views, comments and opinions contained herein are those of the author, and
do not represent those of either Industry Canada or the Government of Canada]

November 1994

SUMMARY

§ *This paper has investigated the historical inventory management behavior of Canadian manufacturers. Statistical and econometric techniques have been employed in an analysis of the inventory -sales ratio;*

§ *Declining manufacturers' inventory-to-sales ratios over time have been documented. Confirmation of a major structural change in inventory management in the aftermath of the 1982 recession, identified by U.S. research, was made for the Canadian case and attributed to changes in management techniques;*

§ *This phenomenon, obfuscated by the business cycle, becomes most clear by the 1990 recession when the typical run-up of inventories failed to ocurr;*

§ *Changed inventory practices, the adoption of JIT and other quick response techniques, made possible by relatively large scale use of computed software and hardware, are suggested as enabling mechanisms;*

§ *Such practices have in turn permitted manufacturers to adjust inventories to changing demand more quickly and with less volatility and appropriating productivity gains in the process;*

§ *More efficient inventory management on the part of Canadian manufacturers has positive implications for Canadian logistics in general; lower inventory holding costs combined with less than offsetting transportation cost increases may translate into real gains to both producers and consumers of goods alike.*

INTRODUCTION

Previous work that assessed the aggregate economic costs to the Canadian economy of holding inventories, illustrated rising inventory levels in the economy but suggested that inventory management techniques used by firms may have changed[1]. On the surface, some evidence appeared to suggest that there may have been a shift of inventory holding behavior and therefore the costs of holding inventories, from the manufacturer to the distributive trades (i.e. retailers and wholesalers).

Recent work published in the U.S. more rigorously investigated the inventories management issue and concluded that instead of a shift in costs, a definitive structural change had occurred in the early 1980s in the U.S. economy that involved inventory management[2]. A declining inventory-to-sales ratio which was shown to be dependent upon major economic variables provided evidence that inventory management practises have indeed changed. This conclusion was in contrast to earlier work that summarized inventory holding behavior as a trendless activity over the past forty years[3].

Evidence in respect of the Canadian experience is presented in this paper in support of the structural change hypothesis. It complements a number of other avenues of research into the state of logistics activities in the Canadian economy. An historical perspective on inventory management behavior of Canadian firms is presented that parallels research produced in the U.S. Old theory and practises appear to have given way to new business techniques. Just-in-time, lean manufacturing techniques and other inventory management practises appear to have finally exerted a real influence on economic activity.

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[1] Jones, A., 1994

[2] Sneddon Little, 1992

[3] Blinder and Macinni, 1991.

1. EVOLVING INVENTORY MANAGEMENT PRACTISES

Logistics activities include both the movement of goods through the supply chain and their storage, either in finished form or in some intermediate assembled form (including raw material).

Business in Canada has increasingly directed resources of time, labour and capital toward improved inventory management techniques in an attempt to increase the efficiency and productivity of manufacturing and distribution and decrease the size of inventory holding and the associated costs. Efficiency gains in the supply chain may be obtained by reallocation of resources used for the management of inventories. However new inventory management practises are not independent of other activities including the manufacturing process, retailing, and distribution activity[4].

Just-in-time manufacturing techniques have been championed

LOGISTICS, SUPPLY CHAINS & TECHNOLOGY

Retailers are lowering their inventories by ordering smaller more frequent, non-standard product quantities and reducing their bulk-orders. The challenge for the manufacturer/distributor is to improve transportation, storage, order processing, packaging and distribution operations.

Allergan Inc., a supplier of specialty therapeutic products to pharmaceutical wholesalers, pharmacies, hospitals and clinics, maintains a 36,000 sq. ft. distribution facility in Markham, Ont. filling orders from one end of the country to the other. The focus of the company, through the use of radio frequency scanning equipment, hand-held printers and a state-of-the-art computer and barcoding system, has shifted to logistics. The company achieved a perfect inventory count in each of the past three years while achieving cost, labour and time savings in other critical areas.

Source: Canadian Packaging, 1993

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[4] The potential gains through improved supply chain management may have much wider consequences for the economy as a whole. The down-side of such gains may be reduced employment associated with inventory management and supply chain management in general. As such, these benefits may potentially inhibit renewed economic growth in the lee of the latest recession. Changes in organized activity in an economy such as those being witnessed may in part account for the disappearance of jobs in the latest recession and one reason for the popular notion of `growth without jobs'.

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for many years - for retailers, quick response strategies are equivalent ways to reduce inventory storage costs. In addition, bar coding and the associated hardware, combined with supplier/retailer interdepedencies (e.g. EDI, point-of-sale computer systems) have increased the effectiveness of managing inventories while reducing order cycle time and improving customer service.

The current question concerns the degree to which new management techniques are being adopted in Canada. Has the organization of economic activity, in particular inventory management,

> **Efficient Consumer Response**
>
> **Coca-Cola Canada** invested $17 million in technology to reduce costs and develop new marketing approaches. Combined with the introduction of super-quick assembly lines, consolidated production and streamlined inventory holdings, satellites are transmitting orders for Coke products directly from the supermarket floor to the company's regional warehouses. Scanners at the checkout assist in determining who is buying what at each store.
>
> **Grand & Toy,** an office supply chain, recently spent millions on information and computer technology to increase consumer responsiveness. The company can now deliver 'live' reports on warehouse inventory to each of its 114 stores.
>
> *Source: Marketing, February, 1994*

changed in a measureable way? There has been little evidence to date to show that the new techniques have been widely enough adopted in Canada to make a difference.

From time to time, the popular press provides anecdotal examples of the use of new business practises designed to reduce inventory holdings and improve overall profitability (see inserts for examples). Yet the economics literature dealing with inventory management practises[5] has not been totally successful in dealing with inventory management. It was held that inventory investment has been a trendless activity for more than 40 years. Inventory investment is a substantial element of macroeconimic activity and it has been estimated that in the U.S. that changes in aggregate inventory investment account for a large proportion of changes in gross national product (as well as one-third of its variance). However at the micro level, inventory management has been relegated to a role of a buffer stock or one for which

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[5]   Blinder and Maccini (1992) provide a thorough review of the economics literature dealing with inventory management.

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production smoothing is made possible. The new techniques and the old micro explanations appear at odds.

Research appears to support the hypothesis that inventory management efficiency gains are making a difference and that the magnitude of this change is quite dramatic. Contrary to some influential economic research, a paper published by Sneddon Little (1992) suggests that not only has the impact of new inventory management practises been substantial but that a clear structural change in economic activity may be observed in the data in the early 1980s.

2. THE STYLIZED FACTS

Figure 1 presents annual data for inventory holdings of the major segments of the Canadian economy. The main message conveyed by the data is that among the two major segments of the economy (i.e. the manufacturing sector and the distributive trades), manufacturing inventories were trendless over the 1981 to 1993 period, while in the distributive trades (i.e. Retail and Wholesale), the level of inventories rose.
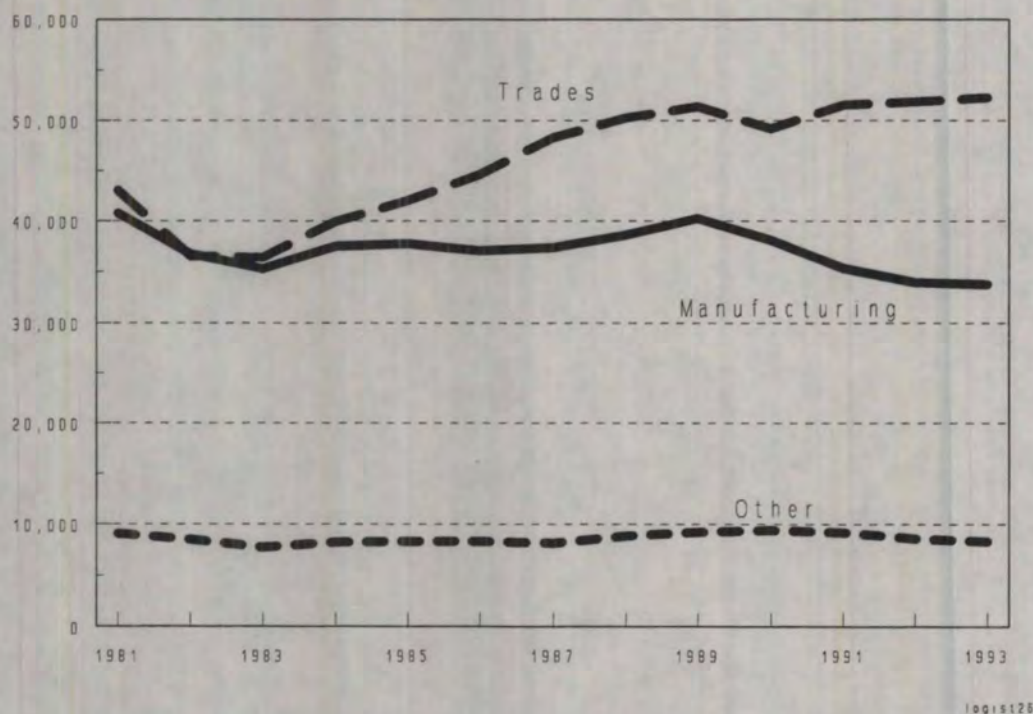
Figure 1
Canada: Inventory Holdings by Major Sector ($M, 1986)

Inventory is a more volatile element of business than is sales or shipments. Table 1 below presents the mean, variance and standard deviation of inventories holdings with a comparison to shipments for the period 1971-1994.

Using the two measures of variability, the variance (the average of the squared deviations from the mean) and the standard deviation (the square root of the

variance), it is readily seen that the volatility of inventories exceeds that for shipments.

Manufacturing inventories are divided into the durable and non-durable groups in Figure 2.

Durables account for a somewhat greater share of manufacturing inventories and are also more volatile.

Figure 3 presents the manufacturing inventory data by stage of completion (raw materials, goods in progress and finished goods).

The data show that raw materials and finished goods are of comparable magnitudes and both are highly cyclical. As expected, peaks in finished goods inventories lag peaks in raw materials.

Goods-in-progress inventories are typically one-half the size of the former two. In addition there is less cyclicality in the data for goods in progress.

INVENTORY-TO-SALES RATIO

Table 1
Summary Statistics for Inventories & Shipments
1971:1-1994:6, $M, Constant

Inventories	Total	Durables	Non-Durables	
Mean	35.5		19.0	16.5
Standard Deviation	3.4	2.3	1.3	
Variance	11,356.0	5,304.0		
1,597.6				

Shipments				
Mean	19.3		9.4	9.9
Standard Deviation	3.0	2.1	1.1	
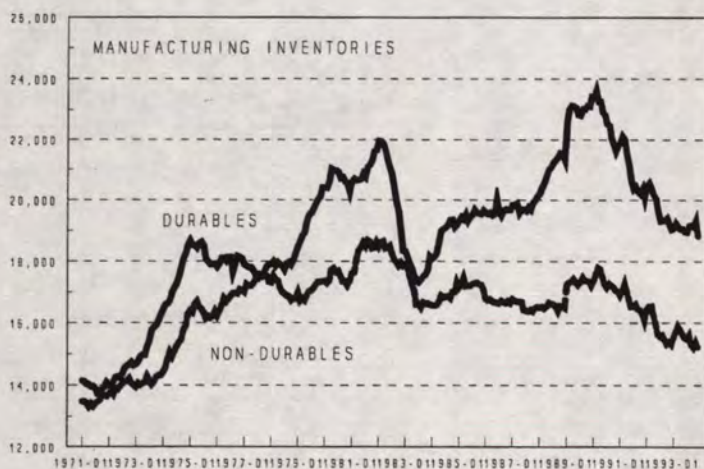
Figure 2
Manufacturing Inventories by Type of Good
1971:1-1994:6

Figure 4 presents manufacturing inventory-to-sales ratios for period 1971 to 1994 on a monthly basis. Both manufacturing shipments and inventories are expressed in seasonally adjusted terms and have been adjusted for inflation.

The data is indicative of an historical or long term declining trend. However more recently a number of changes appear to have occurred in this trend.

Two characteristics of Figure 4 are noteworthy. First,

Figure 3
Manufacturing Inventories by Stage of Completion
1971:1-1994:6

the historically negative trend appears to have gained momentum in the post-1981 period. Furthermore, unlike other business cycles, the run-off of inventories after the 1982 period continued until inventories relative to sales reached an all time low in the more recent periods.

Second, the run-up of inventory holdings in the 1989-1990 recession appears much less pronounced than in previous recessions.

Figure 4
Manufacturing Inventory-to-Sales Ratio
1971:1-1994:6
(vertical lines indicate recessionary periods)

Additional information may be obtained by disaggregating the data presented in Figure 4. Figures 5 and 6 present inventory/sales ratios for manufacturer durable goods and non-durable goods for the 1961-1994 period. The data makes more clear the apparent cause of the trends discussed above.

First it is clear that it has been the non-durable goods manufacturing sector that has provided the

impetus for the long run
declining trend associated with
inventory management.
Durables on the
other hand had been virtually
trendless before the 1982

Figure 5
Durables Manufacturing Inventory-to-Sales Ratio
1971:1-1994:6

Figure 6
Non-Durables Manufacturing
Inventory-to-Sales Ratio
1971:1-1994:6

period. However it appears to be the influence of
`changed' inventory management of durable goods
producers that has had a major impact in the post 1982
period and which has not permitted inventory stocks to
run-up to levels consistent with historical practises.

3. EXPLAINING INVENTORY MANAGEMENT: THE ANALYTICAL APPROACH

The research presented below seeks to has two objectives in regard to inventory management behaviour. First the decline in the inventory-to-sales ratio is modelled or explained by formulating a dependency on other variables, also decision variables for the firm. Second the hypothesis of structural change in inventory management in the early 1980s is tested.

The first objective then is to explain the inventory-to-sales ratio and its declining trend by postulating its dependence on other measureable variables. The model proposed by Sneddon Little (1992) is outlined below and the variables utilized (with minor modifications) are reviewed.

In keeping with previous work dealing with inventory management, previous period or lagged values of the dependent variable are used in the model[6]. This follows from the observation that the inventory-to-sales ratio generally adjusts to changing economic conditions slowly. Consequently the higher the inventory-to-sales ratio in the current period, the higher it may be expected in the following period.

In addition, it is often observed that inventories change more slowly than do sales. Therefore the recent performance of the growth of sales[7] may be expected to have a negative impact on the current inventory-sales ratio. In addition, unexpected changes in the growth of sales[8] should be negatively related to the inventory-to-sales ratio. That is, a sudden increase in sales over and above those planned for, would cause inventories to be drawn down and thus the inventory-to-sales ratio would decrease.

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[6] The dependent variable (the right hand side variable) is the inflation adjusted inventory-to-sale ratio; lagged values of this variable are formed and used as one of the independent variables (left hand side variables).

[7] Sales growth is measured as the change in shipments from the previous period. Lagged changes in sales were used to represent a backward looking expectations sales variable.

[8] Unexpected changes in sales were measured following Sneddon Little (1992) as the change in the growth of sales from the previous to the current period. Repeatedly this variable returned a positive coefficient when a negative sign was expected. A second measure, the variance of sales over the previous year performed much better and was retained.

It is generally accepted that the real cost of holding inventory exert a major influence on inventory management. The real interest rate, a measure of this cost to the firm, is measured as the nominal rate of interest net of inflation. Previous research (Akhtar, 1983; Sneddon Little, 1992) argue that the components of the real rate of interest should be used instead of the single variable since both are `observable' by a firm's decisionmaker. Consequently inventory holdings by firms are expected to be negatively related to interest rates[9], while inflation[10] might be expected to have a positive effect on inventory holding (i.e. while inflation is running at relatively high rates, firms may be able to increase their stocks of inventory and in a later period sell them at prices high enough to offset the carrying costs).

The key element of the Sneddon Little (1992) model is the incorporation of a particular technological change variable to permit the measurement of new inventory management techniques. The variable is constructed as the ratio of investment in information processing equipment to GDP (adjusted for inflation) and is lagged four periods (alternatively, the stock of information processing equipment may be used). Neither is the value of investment in information processing equipment nor its stock values, available for Canada in the public domain. However a number of alternative approaches are possible. First, since the above measure is not a direct measurement of investment in new inventory management techniques, a more general measure such as the stock or investment in machiery and equipment may be just as indicative of changes in technology. Furthermore Sneddon Little recognizes the most widely used indicator of technological change in economic models, a time trend, and found that it produced roughly similar results. This latter alternative is used in the present study.

The period considered begins at the first month of 1972 and runs to the sixth month of 1994. All data is seasonally adjusted and expressed in inflation adjusted terms where appropriate. The variables and their source are summarized in Appendix 2.

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[9]   Short term interest rates were measured in turn by the 30 day and 90 day corporate paper rate. In addition, the effectiveness of both the level and the period-to-period change was used. The results reported are for the change variable using the 90 day paper rate.

[10]   Inflation is measured as the percent change in the CPI (excluding food and energy).

EMPIRICAL RESULTS

The model reported below seeks to explain the behavior of the inventory-to-sales ratio over time. Inventory-to-sales ratios on a monthly basis are regressed on (explained by) the previous period inventory-to-sales ratio, interest rates and inflation (both expressed as growth rates), unexpected and current period changes in sales and technological change. The model reported below presents results for the Canadian manufacturing sector. Results for the U.S. are reproduced from Sneddon Little (1992) for comparative purposes.

Table 2
On the Determinants of Manufacturers' Inventory-to-Sales Ratio

	Canada 1972:1-1994:6			U.S.A. 1968:1-1990:4		
	Total Manufacturing	Durables	Non-Durables	Total Manufacturing	Durables	Non-Durables
Constant	0.170 (7.21)	0.153 (6.44)	0.157 (5.42)	0.26 (6.42)	0.77 (7.04)	0.18 (3.98)
Lagged Dependent	0.901 (63.75)	0.912 (62.61)	0.905 (53.65)	0.86 (37.84)	0.68 (16.07)	0.86 (25.02)
Change in Interest Rate	-0.003 (-1.35) [(-3.05) (-1.92)]	-0.006	-0.003 (-2.32)	-0.0029 (-1.15)	-0.004 (-2.51)	-0.002
Inflation	0.005 (5.38) [0.0020]	0.007 (4.34)	0.007 (5.03)	0.0036 (3.17)	0.0043 (1.51)	(2.79)
Unexpected Sales	-0.002 (-0.78) [-0.0070 (-8.04)]	0.0008 (0.48)	-0.007 (-1.16)	-0.0074 (-13.74)	-0.0067 (-11.94)	
Changes in Sales	-0.0001 (-19.94) [0.028 -0.0090]	-0.0002 (-27.38)	(-8.96)	-0.0001 (-10.57)	-0.016 (-16.09)	(-5.64)
Technological Change	-0.0002 (-7.21) [0.0457 -0.009 (-3.04) (-4.39)]	-0.0002 (-4.61)		-0.0002 (-5.12)	-0.0123 (-5.05)	
R²	0.9902	0.9901	0.9899	0.980	0.931	0.977

D-W	1.9824		1.9056	1.7942	1.94	2.30	1.85
rho	-0.192	-		-0.135			
	(-3.13)		-	(-2.18)			

t-statistics are presented in parenthesis;
U.S. Data Source: Sneddon Little (1992)

Each equation has a high degree of explanatory power and the observed values for the dependent variable is closely tracked by the predicted value (Figure 7 for the manufacturing sector as a whole).
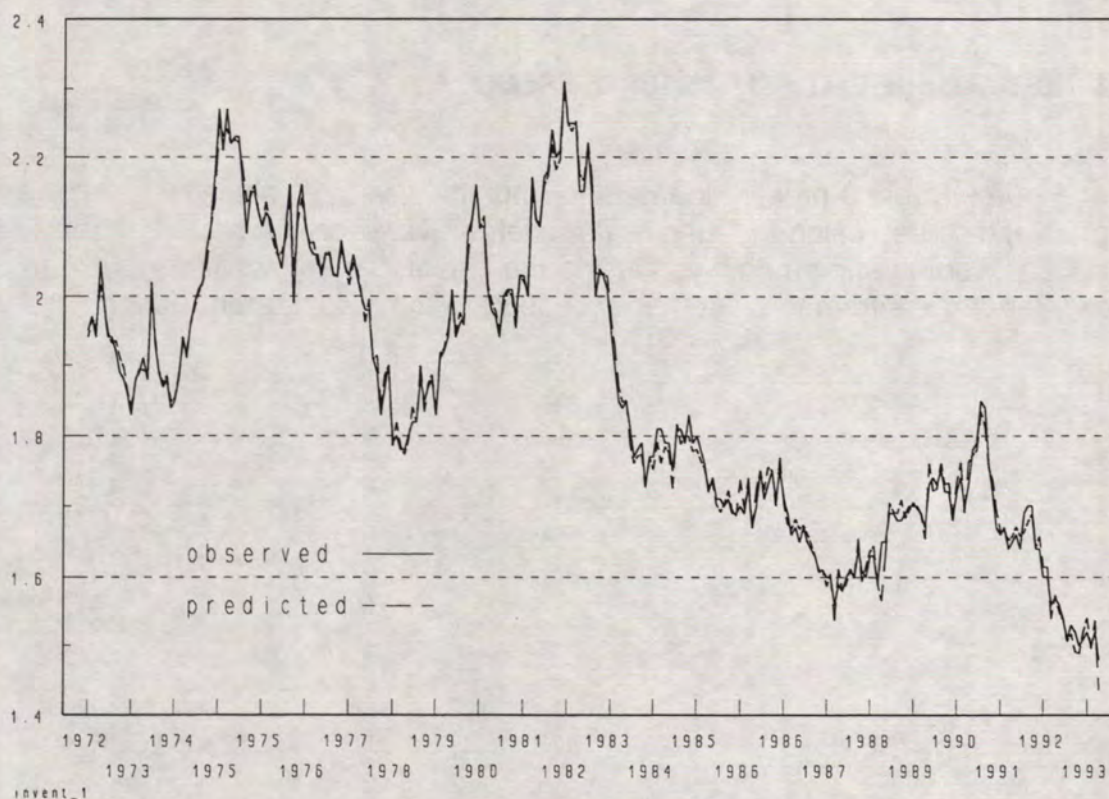
Figure 7 - Manufacturing
Observed and Predicted Values of the Inventory-Sales Ratio

The Canadian experience reflected in the parameter estimates of the model appear similar to that for the U.S. Interest rates, the growth of sales and the

unexpected change in sales reduce the inventory-sales ratio (i.e. they are negatively signed). Inflation and lagged values of the inventory-to-sales ratio have a positive effect on the dependent variable.

Technological change, while statistically significant and negative, has not had as large an affect in Canada as in the U.S. The negatively signed impact of technology and innovative inventory management on the inventory-sales ratio in Canada compared to the U.S. will of course diverge due to the former being measured as a simple time trend and the latter as the ratio of information processing investment to GDP[11].

DOES THE DATA SUPPORT A STRUCTURAL BREAK?

Figures 8 and 9 present the data for monthly inventory-sales ratios as well as the predicted values using the empirical model for two separate periods. The first period runs from the first month of 1972 to the eleventh month of 1983, while the second period runs from the last month of 1983 to the most current period[12].

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[11] The U.S. research by Sneddon Little reports results using a time trend. Parameter estimates for

the influence of a trend variable are comparable to those reported for Canada.

[12] The method used to choose the break point in the data is presented in Appendix 3.
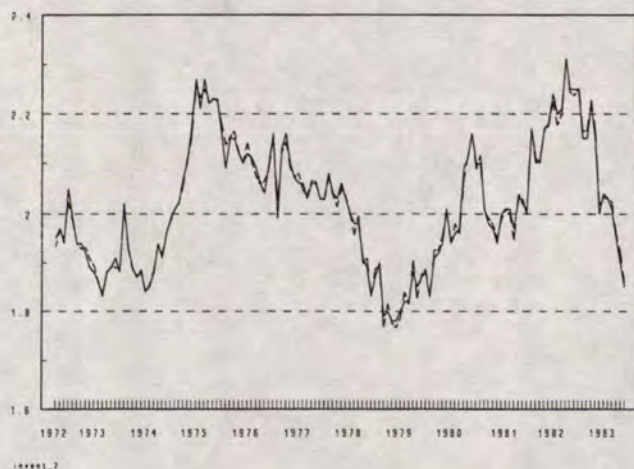
Figure 8
Manufacturing Inventory-to-Sales Ratios
Observed and Predicted Values
1972:1-1983:12

Table 3 presents the parameter estimates for the manufacturing sector based on the separate time series.

An hypothesis of a structural break being present in the data can be tested in a number of ways. Sneddon Little (1992) for example, first chooses the point based on `the appearance of the data' or the minimization of the sum of the squared reiduals of the

Table 3
Regression Results for the Separate Data Sets

	Canada Total Manufacturing	
	1972:1- 1983:12	1984:1- 1994:6
Constant	0.254 (6.53)	0.171 (4.05)
Lagged Dependent	0.846 (35.76)	0.921 (44.70)
Change in Interest Rate	-0.003 (-1.20)	0.004 (-1.39)
Inflation	0.009 (5.84)	0.0004 (0.40)
Unexpected Sales	-0.005 (-1.20)	0.0005 (-0.23)
Changes in	-0.0001	-

regression and then determines whether or not the coefficients in each of the seperate regressions are the same or constitute statistically separate periods (this may be carried out using a Chow test). Such a technique brings into question the robustness of the statistical procedure in choosing the break point.

Following the work of Perron (1989), Christiano (1992) and Zivot and Andrews (1992), I choose the break point using a more statistically robust method. The procedure involves the utilization of a trend stationary data generating process for

which an t-statistic is generated using each data point as a potential break point. The maximum (absolute) value of the t- statistic is chosen and tested for statistical significance. Based on this test procedure the null hypothesis of a statistically significant break point at 1983:12 cannot be rejected (Appendix 3 details this procedure more thoroughly).

Between the two periods, the interest rate and inflation parameter estimates (known for their misbehavior in models such as this), receded in importance as an explanatory variable, as did the expected sales variable. The change-in-sales variable and exogenous time trend maintained their levels over the two periods[13].
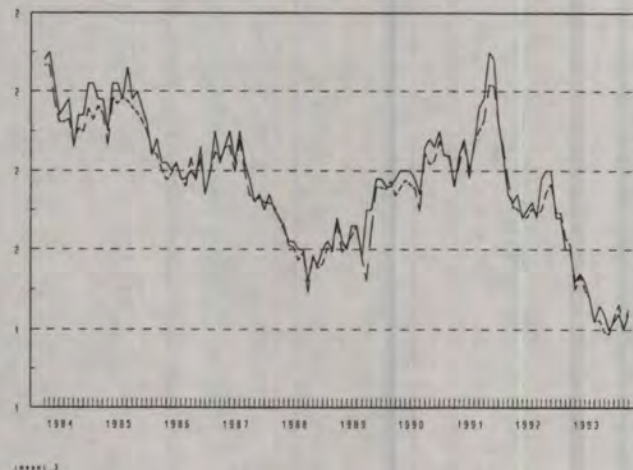
Figure 9
Manufacturing Inventory-to-Sales Ratios
Observed and Predicted Values
1984:1-1993:4

	Table 4	
Summary Statistics for Inventories & Shipments		
Changes in the Mean, Standard Deviation and Variance		
1971:1-1983:11 to 1983:12-1993:8		
	Total	Durables
Inventories		
Non-Durables		
Mean	0.07	0.14
0.00		
Standard	-0.46	-0.33-
0.56		
Deviation		
Variance	-0.70	-0.55-
0.81		
Shipments		

A re-examination of the volatility of the data, broken into the two data sets provides further evidence in support of a structural change hypothesis.

In the manufacturing sector as a whole the average level of shipments rose by 31% from the first to the second period, while the average level of inventories rose by only 7%. At the same time, the standard deviation of inventory holdings declined by 46% and the variance declined by 70%. Smaller declines were evident in the standard deviation and variance of shipments data as well (Table 4).

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[13] Results for the Durables and Non-durables sectors are presented in Appendix 1.

The average level of shipments and inventories rose in the durables group between the two periods, while the volatility of inventories declined. However in the non-durables group the average level of inventories was unchanged while both measures of the volatilty of inventories was down significantly.

One conclusion that may be drawn is that in the process of reducing their inventory-to-sales ratios (i.e. the average manufacturer is holding less inventory), manufacturers have also been able to reduce the volatility of inventory holding (run-ups and run-downs) relative to economic stimuli (e.g. interest rates, inflation, expected and unexpected changes in sales). Consequently it would appear that the process of changed inventory management techniques by firms involves less volatility in the level of inventory holding[14].

IMPROVED INVENTORY CONTROL

Evidence has been provided suggesting that that not only has the inventory-to-sales ratio declined (that firms are holding fewer inventories) but it also appears that there has occurred a concommitant decline in the volatility of inventory holding. The latter hypothesis may be more formally investigated by estimating the `speed of adjustment' of inventory management.

To test the hypothesis of improved inventory control, a simple model[15] of inventory investment (INV) is formulated which depends on sales (S_t) in the current period, the change in sales from the previous period $(\Delta S_t = S_t - S_{t-1})$ and the lagged value of the inventory stocks $(INVSTK_{t-1})$:

$$INV = \alpha + \beta\,(S_t) - \delta\,(\Delta S_t) - \gamma\,(INVSTK)_{t-1}$$

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[14] Bechter and Stanley (1992) argue that although there has been a decline in the average ratio of
inventories to sales in the U.S., improved inventory control implies a faster adjustment of inventories to changes in sales and therefore increased volatility in inventory management. This
finding is not confirmed by Sneddon Little (1992).

[15] Bechter and Stanley (1992) briefly discuss this model and its merit relative to more complicated alternatives.

α, β, γ and δ are parameters to be estimated. The parameter, γ, is of major interest since it provides an estimate of the `speed of adjustment' of inventories to sales.

Table 4
Parameter Estimates for the Improved Inventory Control Hypothesis

	α	β	γ	δ	R^2	DW
1972:1-1983:12	0.003 (4.25)	-0.116 (3.06)	-0.778 (9.22)	0.0413 (1.76)	0.4252	2.0745
1984:1-1994:6	0.008 (4.41)	0.0006 (0.01)	-0.667 (8.09)	-0.031 (-0.80)	0.3417	2.0527
1972:1-1994:6	0.010 (8.46)	-0.065 (-1.82)	-0.656 (-11.34)	0.008 (0.40)	.3448	2.0715

Note: the absolute value of t ratios are presented in parenthesis; the model has been adjusted for first order autocorrelation .

Estimates of the parameter γ are negative and highly significant in both periods. A reduced speed of adjustment from the first to more current period is implicit in the estimates. Consequently it would appear that the adjustment process in which inventory-to-sales ratios have declined has not added increased volatility in the process. This results reinforces the observation reached earlier.

Appendix 2, Table B presents results of the above regression model for the manufacturing data disaggregated into the durables and non-durables groups. In both cases and especially for the durables group, the estimate for the parameter γ declined.

BROADER IMPLICATIONS

In the post 1981-1982 recessionary period manufacturers appear rather widely to have adopted leaner manufacturing techniques and just-in-time inventory control. This profound change in inventory management may have had wider implications for the economy as a whole.

Declining inventory-to-sales ratios imply that firms are holding less inventory relative to sales over time. This would further suggest that fewer workers are required to stock, manage and move inventories in and out of storage facilities. The fact that wide adoption of such management practices appear to have taken hold after the recession, layoffs that occurred during the recessionary period may not have returned in part due to these changes in manufacturing and inventory management practises. Consequently, we might expect the decline in employment growth in the manufacturing sector in the 1980s to be highly correlated with the decline in the inventory-to-sales ratio. In fact, labour productivity in the manufacturing sector reflects just such a relationship.

In the 1971-1982 period, the decline in the inventory-to-sales ratio and labour productivity growth exhibited a very low degree of correlation (-0.095). However, in the 1983-1993 period, these two variables were highly correlated (-0.848).

Next, labour productivity in the manufacturing sector is regressed on the inventory-to-sales ratio to determine whether a statistically significant relationship is present. The result for the period 1971-1993 using annual data is:

$$Q/L = 1.13 - 0.15 \text{ (IS)} + 0.02 \text{ } t + e \qquad\qquad R^2 = 0.947$$
$$(-2.87)$$

where Q/L is labour productivity (GDP per person-hour worked), IS is the real inventory-to-sales ratio and t is time (t statistics are bracketed). The result shows a statistically significant inverse relationship between labour productivity and the inventory-to-sales ratio (i.e. decreases in the inventory-to-sales ratio are positively related to labour productivity).

A final experiment involves the transformation of inputs in the manufacturing sector into output. It is of interest to determine the relationship of inventory stocks as well as the inventory-to-sales ratio. Using a general form for production, inventory stocks are introduced as is the inventory-to-sales ratio:

$Q = f(x_i, I \text{ } (I/S))$

where q is output, the x_i are inputs, I is the stock of inventories and I/S is the inventory-to-sales ratio. The results of the estimation using a second order expansion of the form ( ) for empirical implementation are presented in Table 5.

The estimates for the parameters of the production function for each of the inventory models (with constant returns to scale) are as expected (Table 5). Q is increasing in K, L, and I but decreasing in I/S according to the first order terms (i.e. a_1, a_2 a_3). The second orders terms reflect diminshing returns to K, L and I and increasing returns to I\S. The cross-terms (i.e. the c_is) do not exhibit a strong statistical relationship in either model. Nevertheless in both models they suggest that capital and labour are substitutes. Both labour and capital appear to be complementary to inventory stocks but are each substitutes with the inventory-to-sales variable.

Table 5
Inventories in the Manufacturing Process

Parameter Estimate	with I	with I/S
a_0	0.074 (2.4)	0.067 (4.6)
a_1	0.458 (3.1)	0.556 (11.6)
a_2	0.542 (3.6)	0.444 (9.2)
a_3	0.097 (0.3)	-0.661 (-8.4)
b_1	-4.504 (-0.7)	-8.280 (-2.7)
b_2	-2.735 (-1.9)	-1.567 (-4.8)
b_3	(-10.370) (-2.3)	-2.078 (-1.2)
c_1	-5.646 (-1.0)	-0.059 (-0.1)
c_2	13.742 (1.8)	-2.559 (-0.9)
c_3	8.960 (1.6)	-1.562 (-1.3)
R_2	0.8994	0.9806
DW	1.3903	1.8254

Note: The production technology is characterized by the following equation:
$$Q = a_0 + a_1 H + a_2 K + a_3 I + b_1 H^2 + b_2 K^2 + b_3 I^2 + c_1 HK + c_2 HI + c_3 KI$$
IS replaces I in the second equation.

Summary & Conclusions

The adoption of inventory management practises, including just-in-time as well as computerized process to allow for more the efficient flow of information, has been documented on a piecemeal basis for more than a decade. This paper utilizes statistical and econometric techniques to investigate the hypothesis that the cumulative affect of such changed management practises has had a structural economic impact.

The determinants of the inventory-sales ratio of manufacturers in Canada are investigated to determine whether or not the numerous changes in inventory management techniques adopted in this sector since the late 1970s has had an impact both on statistical grounds as well in respect of production in general and productivity in the sector. The procedure follows quite closely that of Sneddon Little (1992) and tests for structural change in the inventory management of manufacturers. It would appear that a statistically signifcant structural break in the data occurred at the point 1983:12.

In support of this finding, it was found that the volatility of inventory holdings declined between the two periods with a change in the speed of adjustment (investment) that did not offset or counteract other gains.

Finally a statistically significant relationship was found between the declining inventory-sales ratio and increased productivity in the manufacturing sector.

In general it may be concluded that real gains are being realized by Canadian manufacturers as a result of changes in the manner in which they deal with the problem of holding inventories. Leaner inventory holdings translate into lower costs, not only in capital investment but labour costs as well. Such changes in organized activity should position Canadian manufacturers to be better able to compete domestically as well as internationally.

Appendix 1

Table A

| | Canada Durables Manufacturing | | Non-Durables Manufacturing | |
	1972:1-1983:12	1984:1-1994:6	1972:1- 1983:12	1984:1-1994:6
Constant	0.1886	0.2342	0.0923	0.2062
	(5.65)	(5.72)	(3.65)	(3.94)
Lagged	0.9085	0.9013	0.9400	0.8830
Dependent	(51.60)	(49.90)	(61.97)	(29.56)
Change in	-0.0044	0.0014	0.0020	-0.0010
Interest Rate	(-1.75)	(0.47)	(1.35)	(-0.50)
Inflation	0.0056	0.0005	0.0040	0.0020
	(3.18)	(0.31)	(4.69)	(1.38)
Unexpected	-0.0004	-0.0006	-0.0040	-0.0140
Sales	(-0.01)	(-0.47)	(-1.17)	(-2.13)
Changes in	-0.0003	-0.0002	-0.0002	-0.0002
Sales	(-39.84)	(-24.23)	(-19.44)	(-11.92)
Technology	-0.0003	-0.0003	-0.00022	-0.0002
Change	(-3.12)	(-4.28)	(-4.43)	(-2.89)
R^2	0.9838	0.9797	0.9828	0.9577
Durbin-	1.9488	1.8933	2.0597	1.7516

APPENDIX 2

Table B
Parameter Estimates for the Improved Inventory Control Hypothesis

DURABLES	α	β	γ	δ	R^2	DW
1972:1-1983:12	0.003 (3.76)	-0.102 (-3.79)	-0.724 (-8.75)	0.025 (1.52)	0.4630	2.0691
1984:1-1994:6	-0.001 (-0.86)	0.010 (0.26)	-0.633 (-7.79)	-0.042 (-1.65)	0.3483	2.1094
1972:1-1994:6	0.001 (1.09)	-0.041 (-1.62)	-0.615 (-10.72)	-0.013 (-0.82)	0.3565	2.0935
NON-DURABLES						
1972:1-1983:12	0.003 (3.02)	0.010 (0.26)	-0.880 (-10.09)	-0.064 (-1.41)	0.4504	2.0327
1984:1-1994:6	-0.002 (-1.54)	-0.025 (0.23)	-0.823 (-9.69)	-0.012 (-0.18)	0.4176	1.9915
1972:1-1994:6	0.001 (0.66)	-0.032 (-0.51)	-0.813 (-13.51)	0.026 (0.66)	0.4067	2.0254

Note: the absolute value of t ratios are presented in parenthesis; the model has been adjusted
for first order autocorrelation .

APPENDIX 3

BREAK POINT SELECTION METHODOLOGY

The first step in the process of testing for a structural break in the inventory-sales ratio is to model the time series as a linear trend stationary process of the form:

$$X_t = \alpha_0 + \alpha_1 t + \alpha_2 X_{t-1} + \sum_{j=1}^{P} \gamma \Delta X_{t-j} + e_t \qquad (a)$$

where X_t is the current value of the inventory-sales ratio, X_{t-1} are its one period lagged values, ΔX_{t-j} are changes in the lagged values, t is a time trend and e_t is a disturbance term. The coefficients α_0, α_1, α_2 and γ are to be estimated. The data generating process for the inventory-sales ratio indicated the use of four lags in the series[16].

The occurrence of an unknown structural break in a time series may be modelled by a dummy variable that permits a shift in the intercept of the series or one that allows for a change in its slope. Since there is no reason to expect one or the other on *a priori* grounds, I model each separately as well as concurrently.

To determine potential break point dates I generate a t-statistic testing the hypothesis $\alpha_2=1$ for each t= 1,... 403 in successive models that (i) allows for a change in the intercept, (ii) allows for a change in the slope and (iii) permits both parameters to change. The models may be written as follows:

$$X_t = \alpha_0 + \alpha_1 t + \alpha_2 X_{t-1} + \beta_1 D1 + \sum_{j=1}^{P} \Delta X_{t-j} + e_t \qquad (b)$$

$$X_t = \alpha_0 + \alpha_1 t + \alpha_2 X_{t-1} + \beta_2 D2 + \sum_{j=1}^{P} \Delta X_{t-j} + e_t \qquad (c)$$

$$X_t = \alpha_0 + \alpha_1 t + \alpha_2 X_{t-1} + \beta_3 D3 + \beta_4 D3t + \sum_{j=1}^{P} \Delta X_{t-j} + e_t \qquad (d)$$

where D1=1 if $t>t_b$, zero otherwise (t_b is the break point in the data), D2=$t-t_b$ if $t>t_b$ and zero otherwise, D3=0 if $t<t_b$ and one otherwise.

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[16] The optimal lag structure is chosen by minimizing the Akaike (1974) and Schwarz (1978) criterion, as well as the standard error of the estimates while maintaining significant t-statistics on the lag terms.

For each t_b, $t=2,...$ t-j, a t-statistic is generated in each model. The smallest of the t-statistics (largest in absolute value) produced in this manner is selected for each model and tested. The standard t-statistic for testing $\alpha_2=1$ in (1) is used for comparison to the critical value but since the conventional critical values are no longer valid (due to a break in the data), finite sample critical values are generated by Monte Carlo methods (Zivot & Andrews (1992) Appendix B).

First, a pseudo sample of size equal to the actual size of the series is constructed using the optimal ARMA(p,q) model with iid $N(0, \sigma_2)$ innovations, where σ_2 is the estimated innovation variance of the optimal ARMA(p,q) model. Then for each $j=2,...,T-1$, and optimal k, (see footnote 16), the t-statistic is computed . The test statistic is determined to be the minimum t statistics over all T-2 regressions. This procedure is repeated 5,000 times and the critical values for the finite-sample distributions are obtained from the sorted vector of replicated statistics.

Appendix 4
Summary of Model Variables & Data Sources

Dependent Variable	Independent Variables				
inventory/ sales ratio	lagged inventory/ sales ratio	change: short term interest rate	change: inflation rate	Unexpected sales	technological change
the real value of the inventory/ sales ratio	lagged dependent variable	90 day corporate paper	CPI excluding food & energy	variance of sales	time trend
Source: Statistics Canada CANSIM Matrix 179	179		2230		
D99668	D99668	D14017	P484496	na	na

BIBLIOGRAPHY

Akaike, H., A New Look at the Statistical Model Identification, IEEE Transactions on Automatic Control, AC-19, 1974, 716-723;

Akhtar, M.A., 1983, Effects of Interest Rates and Inflation on Aggregate Inventory Investment in the United States, The American Economic Review, p 319-328;

Bechter, D.M. and S. Stanley, Evidence of Improved Inventory Control, 1992, Federal Reserve Bank of Richmond Economic Review, January/February, Vol. 78/1

Blinder, Alan, S. and Louis J. Maccini, 1991, Taking Stock: A Critical Assessment of Recent Research on Inventories, Journal of Economic Perspectives, Winter, p 73-96;

Christiano, L.J., Searching for a Break in GNP, Journal of Business and Economic Statistics, July 1992, p. 237-250;

Jones, Alan, 1994, The Economic Costs of Logistics: Canada & the U.S. Compared, unpublished, Industry Canada;

Mosser, P.C., 1991, Trade Inventories and (S, s), Quarterly Journal of Economics, p 1267-1286;

Perron, P., The Great Crash, The Oil Price Shock and the Unit Root Hypothesis, Econometrica, November 1989, p 1361-1401;

Rudebusch, G. D., The Uncertain Unit Root in Real GNP, The American Economic Review, March 1993, p 264-272;

Sneddon Little, Jane, 1992, Changes in Inventory Management: Implications for the U.S. Recovery, New England Economic Review, Nov.-Dec., p 37-65 ;

Schwarz, G., Estimating the Dimensions of a Model, The Annals of Statistics, 6, 1978, 461-464;

Tanner, E. and Peter Liu, Is the Budget Deficit "Too Large"?: Some Further Evidence, Economic Enquiry, July 1994, p 511-518;

Zivot, Eric and D.W.K. Andrews, Further Evidence on the Great Crash, the Oil-Price Shock and the Unit-Root Hypothesis, Journal of Business and Economic Statistics, July 1992, p 251-270;

5

STUDY # 4

CUSTOMER DRIVEN LOGISTICS

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for

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Introduction

Logistics has traditionally been viewed as one of the least interesting functions carried out by a firm. This is no longer the case. Today logistics forms an integral part of the strategies employed by firms competing in an unforgiving global business environment. Competitive advantages are gained by enterprises' success in meeting customer demands through vehicles such as reduced order-cycle times and improved order-fill rates. Modern organizations must be able to adjust to changing customer requirements quickly, reliably, and with flexibility.

This paper has been prepared as an overview of the current trends and issues in supply chain management. The economic competitiveness of Canadian industry is increasingly influenced by their performance in supply chain activities. The Canadian economy has opened up to new competitive pressures which are altering business practices and placing a new emphasis on activities involved in the distribution of goods. Before any national policies are adopted on how to improve the competitiveness of Canadian industries, through focusing on supply chain management, it is necessary to achieve an understanding of a highly complex subject area which crosses many of the functional operations within a firm. I will first define supply chains and then describe the business environment which has led to the customer-driven logistics strategies used by many firms today. The current issues and trends in logistics, and an overview of Canada's performance in these areas, will be examined.

Supply Chains: Supply chains involve both distribution channels, for the transfer of ownership, and logistics activities for the physical movement of goods. The term logistics, as defined in this paper, refers to the business activities and services used to move goods from their points of origin to markets at the least cost and in the optimum time. This process includes services used for the transportation, storage and distribution of goods. Distribution channels may be described as the path goods take as their title transfers from producer to consumer.[1] Traditionally supply chains have included suppliers, distributors and retailers, although in recent years these functional distinctions have become less clearly defined.[2]

The impact of supply chains on the competitiveness of Canadian products may be measured as a function of the cost of supply chain activities and/or the service provided to

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[1] Ernst & Young, pg.1

[2] The Bay Consulting Group, in their paper, "Structural Change in Canada's Wholesale Industries" (1994) pg.3, give a few examples of firms which perform more than one of the functions within the distribution channel. They note Black & Decker, Grand & Toy, and Canadian Tire Corp.

customers by the supply chains in terms of efficient customer responses. In the new economy these cost and service capabilities are being affected by issues such as deregulation, free trade, electronic commerce, strategic alliances, out-sourcing, supplier rationalization, the opening of new distribution channels and others. The current business environment has been the catalyst for the emergence of supply chain management as a critical success factor for many organizations.

Business Environment:

Restructuring of the global economy has re-defined the environment in which Canadian industry operates. It has forced firms to evaluate and adjust their business practices for the delivery of products and services in an effort to remain competitive. Characteristics of the new global economy include a worldwide lowering of tariffs, a globalization of production, the creation of large trading blocks, and the rapid pace at which technological advancements occur.

Trade: The traditional pattern of trade has been interrupted and supply-chain managers have had to redesign their systems (especially their physical distribution systems) to reflect a "North American" approach with a greater focus on north-south trading patterns. The gains to be made from a freer flow of trade are being recognized throughout the world, as evidenced through the union of large trading blocks and the general lowering of tariffs. The implementation of NAFTA has been a focal point in determining the pattern of trade for Canadian industry. In Canada, trade accounts for approximately 25% of GDP and over 75% of this trade is done with the U.S. Canadian firms have had to respond to increased competition in terms of price and customer service. Companies are recognizing that it is important to develop business strategies based on a continental approach and they are re-structuring their operations accordingly.

Deregulation: The 1987 National Transportation Act was introduced as a measure through which the Canadian government hoped to create a more efficient, healthy transportation system in Canada. The carriers, representing each major mode of transportation; rail, water, air, and road have been exposed to greater competition since deregulation began. The result for Canadian carriers has been a declining demand for services and severe price competition. Canadian shippers have had the opportunity to purchase transportation services at more internationally competitive rates, although some would still argue that further deregulation is needed. Many areas of transportation services continue to be heavily regulated. At the current time, the federal government is reviewing its national transportation policy and further action is expected in 1995.

The U.S. transportation industry restructured earlier than the Canadian transportation industry due, in large part, to the earlier implementation of deregulation. This advantage,

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along with others such as an arguably more favourable tax structure, has better prepared the U.S. to take advantage of "continental" markets resulting from a freer flow of trade brought on by NAFTA. Producers in the U.S. may therefore have a competitive advantage based on their greater choice of which mode of transportation to employ and whether to use Canadian or U.S. carriers. Competitiveness, resource constraints and international trade are the main forces which have inspired Transport Canada to reduce its regulatory regime.

Further recommendations have been made to improve the competitiveness of the Canadian transportation industry. These recommendations, from the privatization of airports to the elimination of subsidies, will have long term impacts on the competitiveness of Canadian supply chains.

Electronic Commerce: Electronic commerce, as defined by the Ontario Ministry of Economic Development and Trade, is "...the term used to define the creation, movement, use and display of business information in electronic (or digital) form by and between enterprises." Electronic commerce can take many forms. Examples include, electronic data interchange (EDI), which is used to exchange business documents, the use of fax machines, and database enquiries. Technological advancements have occurred at a very rapid pace in our society and those firms which have been able to effectively manipulate these technologies have had a competitive advantage.

These technologies enable firms to meet the demands of their customers more quickly and reliably through the improvement of their service capabilities, including reduced order-cycle times and greater accuracy of information in order-processing. Costs may be reduced through the integration of planning processes, facilitated by these technologies, for the production and distribution of goods. This results in reduced inventory carrying costs and more efficient production processes and the constraints of time and distance may be minimized considerably.

If Canadian industries are to remain competitive, they will have to embrace new technologies without concern over the potential obsolescence of these items. The initial cost of implementing electronic commerce technologies may be quite high and part of the reason for the slow adoption of their use. Firms which do not have the human capital to use the various technologies or lack the financial resources to employ individuals with these skills, may also be hesitant to invest in these new technologies.

Customer Driven Business Practices

The business environment in which Canadian industries now operate has precipitated changes in the way organizations conduct themselves. Firms are adopting customer-driven business practices as a means of remaining competitive in a global business environment.

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Variance in the cost and quality of products has diminished between firms, and products are being differentiated according to who can meet the needs of the consumers in terms of service, flexibility, and reliability (Chow and Heaver, 1993). Consumer satisfaction, although always an important consideration, has become an even more critical factor in the success of many organizations.

Through the employment of customer-driven business practices, firms seek to optimize customer satisfaction in order to meet their own goal of profits. Firms can meet these demands by ensuring the ideal selection of distribution channels and the movement of goods through them in the most efficient and reliable manner. Supply chain management will be the main instrument in ensuring that customer requirements are satisfied.

Arthur Andersen (1994) describes the change in supply chain operations as moving from a push philosophy to a pull philosophy driven by customer demand. Technological advancements have allowed for the instantaneous flow of information which has reduced and potentially eliminated the need to forecast customer needs throughout the supply chain and prepare for the production and distribution of goods based on these forecasts. The supply chain activities are "pulled" along by an initial order from the consumer. This triggers a response from the manufacturers, shippers, and carriers in a system where activities of the organizations involved in the supply chain may be operating with respect to real demand rather than perceived or anticipated demand.[3]

Logistics is a "process" which crosses many functional operations. Byrne and Markham (1991) of A.T. Kearney write, "The goal of the logistics process is to weave together and coordinate all activities involved in acquiring, converting, and distributing goods from raw material source to final consumer in order to accomplish the customer service objectives. This process includes the physical activities of moving and storing goods, providing information to support these operations, and managing the overall process."[4]

There has been a re-definition of the links between producers, distributors and retailers in the supply chain in response to a mutual recognition that integration of their activities will result in superior customer responsiveness and satisfaction. Over time there has been a shift in logistics ideology from traffic and materials management, to materials physical distribution, to pipeline management, to integrated logistics, and recently to supply chain management. The current issues and trends in supply chain management, including: re-engineering; applied technologies; out-sourcing; strategic alliances and partnerships; carrier, supplier and distribution facility rationalization; carrier mode; performance measures and distribution channels are reviewed in the following section.

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[3] Compagno (Manufacturing Systems, June 1992) discusses many of these issues.

[4] Byrne and Markham, pg.30

Re-engineering: To remain competitive, firms are re-engineering their operations to conform with customer-driven business practices. Re-engineering is a "buzzword" which we hear often today. In relation to supply chain management, re-engineering usually refers to the shift from a functional approach to supply chain activities to a process approach. Each functional operation of an organization may be included in the logistics process. In discussing how to compete in the global marketplace Christopher (1993) writes, "There has to be nothing less than a shift from a functional focus to a process focus. Such a radical change entails a re-grouping within the organization so that the key tasks become the management of cross-functional work flows."[5] This technique ensures that customer orders will be able to be filled and that inventory holding costs will be reduced.

Christopher (1993) cites Hewlett-Packard as an example of a company that has restructured its organization around "market-facing processes", rather than functions. They have implemented a system where an order management system links order entry, order management and factor order/shipment processing. This allows orders to be tracked throughout the system at any time, and delivers a higher level of customer service. Order cycle times are reduced as a result of this change in business practices and customer inquiries as to the status of their order are easily answered.

Applied Technologies: Advances in technology have supplied firms with tools through which they can reduce order-cycle times, improve order fill rates, and lower their logistics costs. Technologies included under the umbrella term "electronic commerce" include EDI (electronic data interchange), bar codes, electronic mail, electronic information systems, card based technologies, electronic payments, EDI to fax, optical character recognition, imaging, electronic forms, CD-ROM, and optical disks.[6]

Just-in-time, Quick Response, and Efficient Consumer Response are examples of management practices which have been adopted by industry for the distribution of their products that rely on the use of electronic commerce technologies. There is less need to forecast what future demand for products will be as the supply chain is being managed with respect to current demand. Electronic communication linkages allow for information on consumer demand to be passed on to manufacturers via new electronic channels almost immediately. Communication linkages developed between the supply chain participants can result in reduced order cycle times and improved consumer satisfaction.

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[5] Christopher, pg.261

[6] The CECC has included these items in their survey of firms about the use of electronic commerce.

The use of electronic commerce technologies allows for less handling of paper throughout the supply chain and relevant information only needs to be recorded into the system once. In firms that do not employ modern technology there may often be a duplication of effort, especially in administrative tasks. The accuracy of information is increased due to fewer chances for an error to occur, and administrative costs will be reduced.

The Canadian Electronic Commerce Committee (CECC) (1994) has conducted an extensive survey of businesses in Canada concerning the use of electronic commerce technologies. They identify a number of dominant themes throughout Canadian industry. For example, the CECC found that small businesses lag larger businesses in the use of electronic commerce. Another dominant theme inferred from their survey results is that organizations need to understand that the full value of using electronic commerce can best be realized by integrating these applications into their long-term business strategies. For example, they found that only 22% of respondents had done a detailed cost-benefit analysis before implementing any electronic commerce technologies.

The two greatest obstacles, identified by the CECC, to the adoption of electronic commerce technologies are a lack of financial resources and a lack of personnel to implement and manage the systems. Of the respondents who were using electronic commerce technologies 78% of respondents indicated a lack of personnel as their largest impediment. The funding required for new applications was also an issue with 68% of respondents expressing concern. A number of respondents also indicated some concern over the lack of knowledge of new applications or potential benefits.

The U.S. Customs Service has successfully integrated electronic commerce technologies into its operations. They process 94% of all their customs declarations electronically and collect 60% of duties electronically. One of the most impressive benefits has been that their accuracy rate has improved dramatically; error rates have fallen from 17% to 1.7%. Also, they save $500 million in processing costs each year. Another example of a company using electronic commerce technologies is Harley Davidson who through use of just-in-time inventory control and total quality management practices reduced manufacturing cycle times for motorcycle frames from 72 days to 2 days.[7] Common responses by companies as to why they use electronic commerce technologies include; to meet customer requirements, to improve customer service, to gain a competitive advantage, increased accuracy, reduced transaction time, reduced paper, ease of access to information, and cost savings.

Out-sourcing: Out-sourcing, also a growing trend in logistics, is when a firm contracts out some or all of its supply chain management activities. The benefits of doing this for the

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[7] Information Infrastructure technology and Applications Task Group, National Coordination Office for High Performance Computing and Communications, 1994, pg.8

firm is that it can focus on core strength activities which are central to its operation. Non-core activities, such as logistics, may be more efficiently performed by third party sources who are specialists in those activities. A firm may be able to cut down its costs in terms of inventories, labour, and capital and improve service by using a third party.

A survey prepared by KPMG (1993) of 100 Canadian shippers revealed that about 98% of the companies were using either contract/common carriers and/or freight brokers to provide a full range of transportation and inventory management services for the distribution of their products to their customers. The survey also revealed that 66% of respondents were using import/export services and 51% were using third-party warehousing. Third-party sources used to perform total logistics management was used by only 2%.

Use of Third-Party Services

Source: KPMG, 1993
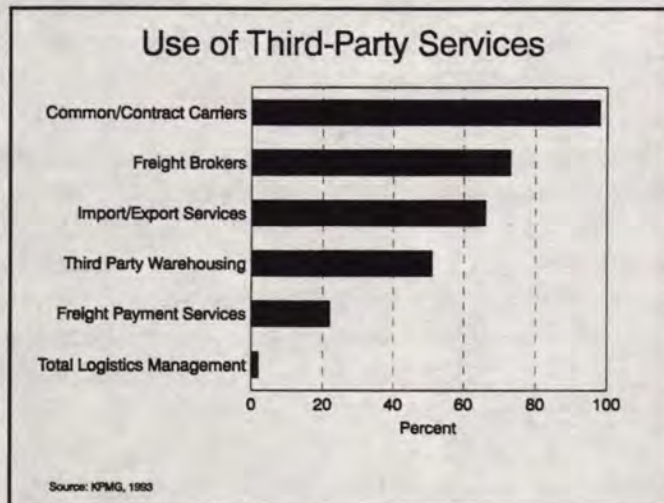
Strategic Alliances and Partnerships: Shippers, carriers and logistics providers are forming alliances to create systems which operate more efficiently in terms of costs and especially, service. These unions have been facilitated by the use of electronic commerce which allows each part of the system to have information concerning the other's activities. A more competitive business and regulatory environment has fostered a more cooperative atmosphere between the organizations involved in the delivery of products through the supply chain so that optimum customer service may be achieved. According to the Bay Consulting Group alliances are formed between distribution channel participants to "...improve the quality of services provided, to obtain better prices, broaden product mix, or to achieve improved market access."[8] They also note that there has been a trend toward north-south alliances between Canadian and U.S. firms.

Henriksson, Chow and Heaver (1994) cite the Burroughs Corporation as an example of a firm which has successfully formed a partnership with a carrier. They gave the carrier full responsibility for all inbound transportation, which included selection of transportation mode and the receiving and processing of freight. The computer systems are linked together and purportedly the partnership has been successful in reducing transit times and freight costs, as well as leading to "sharp" increases in inventory turnover rates.

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[8] Bay Consulting Group, pg.2

A second example Henriksson, Chow and Heaver present is that of Motorola, which has witnessed improved carrier performance by forming partnerships with a small group of transportation suppliers. Supplier education programs may be the main reason for the success of Motorola's programs, where involvement of the transportation suppliers in Motorola's activities has been helpful in improving communication between the organizations. Strategic alliances and partnerships are not always successful though, and part of the reason we do not hear of them, as Henriksson, Chow and Heaver note, is that often the unsuccessful ventures are filed away in a drawer.

Carrier, Supplier and Distribution Facility Rationalization: There has been a trend towards reducing the number of carriers a supplier uses to transport its materials. According to Chow and Heaver (1993), carriers and logistics suppliers' alliances with clients involves commitments with fewer firms. A couple of reasons for the reductions in the number of respective relationships include the greater ability to influence the carrier and the likelihood of forming stronger partnerships. They cite the Burroughs Corporation as a firm which has reduced its inbound carriers into its Flemington plant from 120 to less than 15.

Chow and Heaver also note that there has been a rationalization of distribution facilities. They indicate that firms have been "substituting" transportation and communication technologies in lieu of warehouse distribution centres in their networks. The Bay Consulting Group (1994) supports this finding, and attributes it to a variety of reasons including more direct sales on the part of manufacturers, the use of third-party warehousing, and the trend toward more warehouse format stores.

The number of suppliers that retailers deal with may be rationalized as well. One major reason for this may be that, as participants in the distribution channels form alliances, it becomes easier to deal with fewer suppliers who respond to orders quickly, are flexible and reliable.

Carrier Mode: Shippers' decisions of which carrier mode to utilize in the movement of their products is now based on different variables than in the past. Cost is still an important factor, but even more so is the need for quick and reliable transportation of their products. A shipper may elect to use a high cost mode of transportation that delivers more quickly to ensure customer satisfaction. But, the higher cost does not necessarily translate into lower profits. If a shipper is able to move a greater volume of goods due to increased speed, although it may cost more per unit to ship, profits may increase as a result of the higher number of units transported. The need to fill customer demands quickly may be, for example, a large part of the reason trucks have gained considerable market share in the movement of value added products.

Performance Measures: In order to measure how well the logistics strategies of firms meet customer requirements, and to maintain good relations, organizations must evaluate

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their performance on a regular basis in terms of how quickly and reliably items move through the supply chain. Cost is still a consideration but the most important measure is the length of order cycle time or efficient customer response. Order cycle time is a measure of the amount of time it takes from the placement of an order by a customer until the time the product is received by that customer. Other interesting measures are on-time delivery evaluations, order accuracy and completeness measures.

Distribution Channels: Distribution channels influence the costs involved in delivering a product through supply chains and the level of service received by the customer. More fundamentally, business agreements are necessary to select partners to produce and distribute products through supply chains before any product is sold. These distribution agreements constitute the distribution channels for products.

Access to distribution channels affect the basic ability of a firm to sell its products in some markets. For example, distribution of Canadian goods into the "new" Mexican market is limited for some products due to our late entry into those markets or because we lack a sufficient volume of business to enter into distribution agreements with Mexican nationals. In these cases, Canadian enterprises have found it more effective to distribute their goods through U.S. firms operating in Mexico.

The Bay Consulting Group (1994) has identified a number of trends related to distribution channels, with special consideration given to the role of the wholesaler or distributor. Alternate channel forms, including direct sales by manufacturers and the use of third party warehousing, are being used more and more. There may be a rationalization of small independent wholesalers as suppliers and customers have raised expectations about the value-added services they expect to receive from their wholesalers and distributors. The traditional wholesale-distributors are faced with competition from warehouse format stores who store their products on-site or in their own warehouse facility. The adoption of electronic commerce technologies has been slow by wholesalers and distributors.

Supply chain management is a dynamic process which has evolved over time to meet the demands of the market which it serves. As the business environment changes, those firms which can effectively respond to the forces impacting upon it and take advantage of new technologies will be in a position to gain market share and be the most profitable.

Overview of Canadian Performance in Supply Chain Management:

The current performance of Canadian industries in supply chain management is varied although it is generally felt that improvements are being made. Unfortunately, it is also a consensus that we are lagging behind the United States in our logistics performance. Byrne and Inglis (1993) note several key findings regarding logistics performance, service and
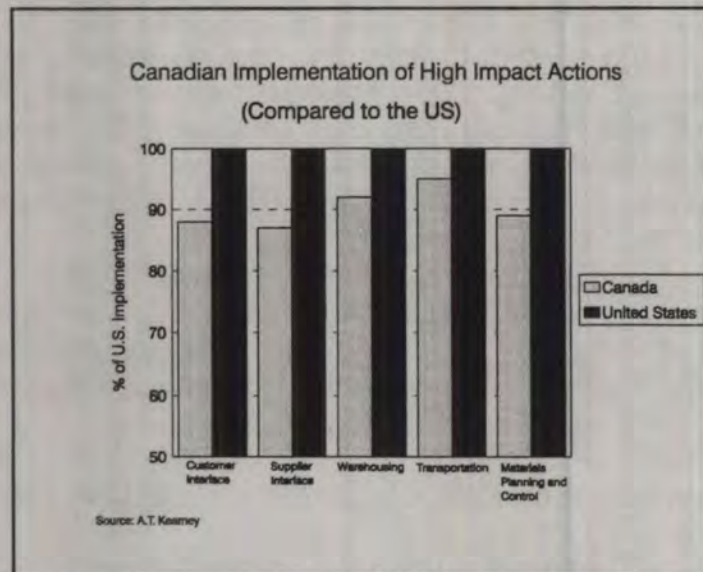
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productivity that were observed from A.T. Kearney's studies of these issues in the U.S. and Canada. Their first and most important conclusion is that overall a significant gap does exist between the logistics performance of Canadian companies and U.S. companies. Byrne and Inglis write, "The performance gap exists because Canadian companies have failed to adopt high impact logistics strategies and tactics, namely logistics-oriented improvement programs . . . Key areas of attention are cycle time reduction, error elimination, inventory reduction, and effective asset use."[9] The U.S. is better at what they call "high attention" items such as, fill rate, order completeness, on-time performance, and cycle time.

Canada lags behind the U.S. in terms of the implementation of formal improvement programs. Canadian firms are just beginning to implement formal improvement plans, while in the U.S. many firms are already beginning to reap the benefits of programs in place. According to Byrne and Inglis, Canada is lagging behind the U.S. in terms of the implementation of "high impact" actions at the customer and supplier interfaces, warehousing, transportation, and materials planning and control.

The number of canadian respondents with action in place to convert from manual to computerized order processing was 67%, while in the U.S. the figure was 75%. And the percentage of respondents in the U.S. replying that they had action in place to implement a number of electronic programs, such as on-line confirmation of stock availability and centralized order entry to improve productivity, was consistently higher in the U.S. than in Canada. Although Canada is lagging behind the U.S. in logistics performance, there have

been some improvements in service and productivity. It is expected that future improvements in Canada will be generated in the areas of information and materials management rather than in the traditional areas of transportation and warehousing.

According to a survey sent to the CEO/president/owner level of Canadian suppliers and retailers across the country, prepared by Deloitte & Touche (1994), over 85% of respondents are upgrading their computer systems and more than 70% are re-engineering merchandise flow and paper work


Canadian Implementation of High Impact Actions
(Compared to the US)

Source: A.T. Kearney

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[9] Byrne, pg.41

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processes. Quick response replenishment practices are being adopted by 70% or more of suppliers and retailers. Suppliers and retailers are also entering into strategic partnerships, out-sourcing to improve distribution centre productivity, and investing in product handling equipment.

Deloitte & Touche also found the respondents' opinions on how to improve existing supply chains varied. The method receiving the highest percentage response was decreasing stock levels through shorter replenishment cycles with about 83% of retailers and 65% of suppliers expressing interest. Other methods receiving considerable support were; reducing the number of similar product lines carried, more frequent deliveries to stores, more reserve stock at distribution centres to improve retail-in-stock positions, and more direct shipment to stores.

How companies are improving and streamlining their supply chains
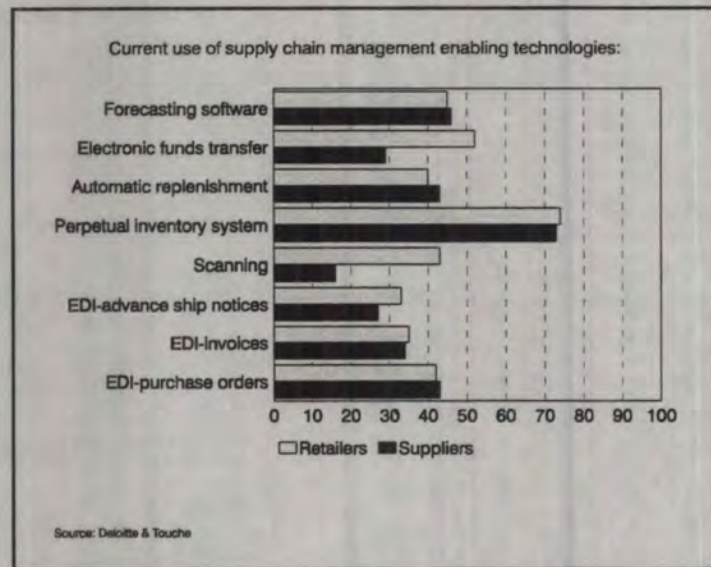
Source: Deloitte & Touche, 1994
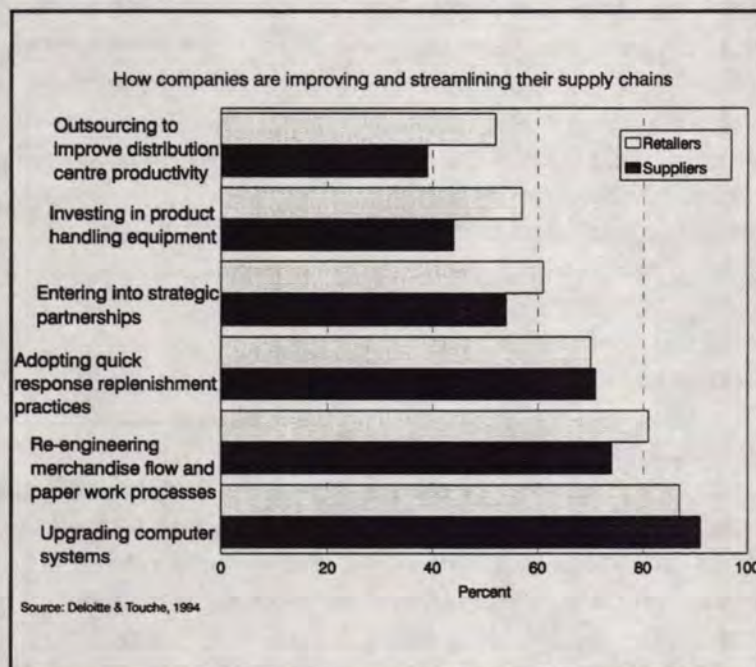
The retailers identified four items as being the most significant advantages from re-engineering the supply chain. These advantages are; to remain competitive, better in-stock positions, better customer service, and shortened re-order cycles. The suppliers identified three items which seemed to be more important; better customer service, remaining competitive, and better in-stock positions.

Deloitte & Touche found that respondents were currently using supply chain management enabling technologies to differing degrees. The most widely used technology is a perpetual inventory system. Other more commonly used techniques by retailers and suppliers are electronic funds transfer, forecasting software, EDI-purchase orders and EDI-invoices, scanning and automatic replenishment. Many respondents indicated they were planning to install or upgrade these technologies within three years. The most interest was shown for installing or upgrading scanning technologies by suppliers at 63%. Retailers were most interested in installing or upgrading technologies for EDI-purchase orders at 49%. EDI-invoices, EDI-advance ship notices, scanning and automatic replenishment technologies were closely behind, between 44% and 48%.

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The survey responses also indicated that there is a growing awareness of the value of forming strategic partnerships. Retailers (41%) and suppliers (58%) indicated that they were planning to form new partnerships arrangements over the next 12 months. Suppliers were most concerned about the impact new partnerships would have on existing relationships, while retailers were most concerned about the confidentiality of information.

Current use of supply chain management enabling technologies:

Forecasting software
Electronic funds transfer
Automatic replenishment
Perpetual inventory system
Scanning
EDI-advance ship notices
EDI-invoices
EDI-purchase orders

0 10 20 30 40 50 60 70 80 90 100

☐ Retailers ■ Suppliers

Source: Deloitte & Touche

Canadian industries are gaining an awareness of the importance of supply chain management and improvements are being made. However there is still much work to be done. A survey performed by KPMG (1993) indicated that 58% of all of their respondents did not have a formal logistics strategy in place and that while 60% of respondents were measuring on-time deliveries, customer complaints, and fill rates, less than one half tracked invoice accuracy and stockouts and only one third tracked order cycle time. The future success of many organizations will depend on how well they are able to meet customer requirements.

Conclusion:

This paper has examined some ways that Canadian industry is adjusting to customer driven business practices. Business is facing more open competition from the external forces of deregulation, free trade and electronic commerce. To remain competitive, firms are adopting new supply chain management techniques, such as forming strategic alliances, outsourcing, supplier and distributor rationalization, and opening new distribution channels. The future of Canadian industrial success is linked to their proficiency in supply chain management. The government has an opportunity to play an active role in fostering the proper environment to encourage future successes. There are opportunities to build infrastructure, both physical and electronic, to provide incentives, and to alter the regulatory regime, for more efficient supply chains.

BIBLIOGRAPHY

Arthur Anderson (1994), <u>Why and How Canadian Companies are Developing Logistics Strategies</u>, presented at the 27th Annual CALM Conference, Toronto.

A.T. Kearney, Inc. (1991), <u>Achieving Customer Satisfaction Breakthroughs</u>.

Bay Consulting Group (1994)," Structural Change in Canada's Wholesale Industries", <u>Industry Canada</u> .

Bowland, J.M. and F.R. Denham (1992), "Canadian Shippers Needs Assessment", <u>KPMG Management Consultants.</u>

Byrne, P.M. and P. F. Inglis (1993), "Canadian Logistics Performance Improving", <u>Transportation and Distribution</u>, August, 41-49.

Byrne, P.M. (1992), "Improve the Customer Service Cycle", <u>Transportation & Distribution</u>, June, 66-67.

Canadian Business Telecommunications Alliance (1994), "The Availability and Cost of Telecommunications Services in Canada and the United States", <u>Industry Canada</u> (unpublished).

The Change Corp. (1994), "Doing Business on the Electronic Highway", <u>Canadian Electronic Commerce Committee</u>

Christopher, M. (1993) "Logistics and Competitive Strategy", <u>European Management Journal</u>, Vol.11, No.2, 258-261.

Chow, G. and T. Heaver (1993) "Logistics Systems in an age of Technological, Political and Market Change: Implications for Spatial Development", <u>Regional Development Dialogue</u>, Vol.14, No.2, Summer.

Denham, R., "Competitiveness, Logistics and Business Process Re-engineering", <u>Materials Management and Distribution</u>, 10-12.

Delaine, V.D. (1994), Fourth Annual State of Logistics Report, <u>Cass Logistics Inc.</u>

Economic Analysis Branch (1994), "Trucking Price Indices 1981-1992", <u>Transport Canada.</u>

Economic Research Branch (1994), "A Profile of Canadian Trade and Modal Shares", Transport Canada (Internal Study).

Eckler, H.J., R.B. Lennox and M.E.Lynch (1993), "Canadian Logistics Benchmarks", KPMG Management Consultants.

Emmelhainz, M. A. (1990) Electronic Data Interchange, A Total Management Guide, New York, Van Nostrand Renhold.

Emmelhainz, M. A. (1988) "Strategic Issues of EDI Implementation," Journal of Business Logistics, Vol.9, No.2, 55-70.

Ernst & Young (1992),"Responding to Cross Border Shopping, A study of the competitiveness of distribution channels in Canada", The Public Policy Forum.

Henriksson, L.E., G. Chow and T.D. Heaver (1994) "Trends in Logistics: Implications for Carriers, Researchers and Policy Makers", Canadian Transportation Research Forum.

Houlden B. (1994), "Supply chains improving..but the journey has just begun", The Retail Advisor 94-4, Deloitte & Touche

Industry, Science and Technology Canada and Communications Canada (1990), Technologies in Services.

Inglis, P. and T. Summers (1991), "The Customer is No.1", A.T.Kearney Management Consultants.

Johnson A., B. Allen and M. Crum (1992), "The State of EDI Usage in the Motor Carrier Industry", Journal of Business Logistics, Vol.13, No.2, 43-68.

Jones A. (1994), "The Economic Cost of Logistics, Canada and the United States Compared", Industry Canada (unpublished)

Jones A. (1994), "The Distribution and Storage Sector: The Supply and Demand of Transportation Services", Industry Canada (unpublished)

Moody, F. (1990), "Silent Partners", Canadian Transportation ,February, 22-25.

National Transportation Agency of Canada. (1994), Annual Review of the National Transportation Agency of Canada 1993.

Porter, M. and Monitor Company (1991), "Canada at the Crossroads-The Reality of a New Competitive Environment", <u>Harvard Business School and Monitor Company</u>.

Tulipan G. (1994), "Trucking Price Indices 19981-1992", TP10785E, Economic Analysis, <u>Transport Canada</u> (Internal Study)

Westler, R, (1994) "EDI in Transportation", <u>Canadian Transportation Research Forum</u>.

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