THE ECONOMICS
OF THE SERVICE SECTOR
IN CANADA

Telecommunications in Canada

An Analysis of Outlook and Trends

Steven Globerman with Deborah Carter

THE FRASER INSTITUTE

Telecommunications in Canada

THE ECONOMICS OF THE SERVICE SECTOR IN CANADA

Series Editors:
Herbert G. Grubel
Michael A. Walker

Telecommunications in Canada

An Analysis of Outlook and Trends

Steven Globerman
with
Deborah Carter

THE FRASER INSTITUTE

This study is part of a general programme of research into the services sector made possible by a contribution from the Department of Regional Industrial Expansion, Government of Canada.

Canadian Cataloguing in Publication Data

Globerman, Steven.

Telecommunications in Canada: an analysis of outlook and trends

(The Economics of the service sector in Canada, ISSN 0835-4227)

Includes bibliographical references.

ISBN 0-88975-095-5

1. Telecommunication - Economic aspects - Canada. I. Fraser Institute (Vancouver, B.C.). II. Title. III. Series.

HE7814.G46 1988 384.041'0971 C88-091029-1

Printed in Singapore.

CONTENTS

Figures and Tables

Figures

Tables

PREFACE AND SUMMARY

This book synthesizes and assesses available data and studies regarding the Canadian telecommunications industry. The study seeks to provide an overview of the main economic characteristics of the industry with a focus on several hypotheses relevant to service sector industrial activity.

This book is divided into six chapters. Chapter 1 provides a detailed description of the telecommunication industry in Canada. Chapter 2 outlines the industrial organization characteristics of the telecommunication carriers. Chapter 3 is an empirical and theoretical discussion of output, input and productivity growth for the industry. Chapter 4 addresses the issue of "bimodalism" within the context of employment characteristics of telecommunication workers. Chapter 5 considers the factors that influence the overall demand for telecommunications' services. Finally, Chapter 6 outlines the major public policy issues surrounding the telecommunication industry and relates these issues to the characteristics of the industry as outlined in Chapters 1 - 5.

As noted above, this book was prepared in order to provide an overview of the Canadian telecommunications industry. As the research progressed it became apparent that available data sources and industry studies did not have common boundaries for defining the "telecommunications industry." The softening of industry boundaries due to regulatory changes, and rapid internal/external technological change complicated the task of studying the environment in which telecommunication functions take place. Ideally, the economic role of the telecommunications industry should be viewed within the context of the broader information market. However, we continue the historical practice of segmenting telecommunications from computer and office automation.

For the purposes of this book, the participants in the telecommunications industry include: the terrestrial carriers, interconnect companies, cross border and satellite resellers, cellular radio carriers, radio common carriers and satellite carriers.

The operating environment of the telecommunications industry has undergone substantial structural change in recent years. In sum, the participants operate in a "mixed" market environment, where some participants (e.g. interconnect companies) are essentially unregulated, while others, such as the common carriers, remain regulated. The

regulatory environment is fragmented both across carriers and across services.

The market structures of the individual components of the telecommunication industry are diverse and complex, with the exception that the level of foreign ownership in the industry is low. The telephone carrier segment of the industry is highly concentrated with the two largest carriers, B.C. Telephone and Bell Canada accounting for 68 percent of total revenue and 64 percent of total employment in 1985. These figures somewhat understate the prominence of Bell Canada, due to significant ownership positions by Bell in Maritime Telephone and Telegraph, New Brunswick Telephone Company and Newfoundland Telephone Company. Applying Bell's ownership shares to Bell Canada's own revenue and employment totals we estimate Bell Canada directly or indirectly accounted for 57 percent of total revenue and 51 percent of total employment in 1985. Hence, the performance characteristics of the terrestrial sector will largely reflect the economic and technological performance of Bell Canada.

The emergence and growth of the interconnect industry in Canada reflects two regulatory decisions by the Canadian Radio-Television and Telecommunications Commission (CRTC), that allowed consumer control of access to the public switched telephone network. In four years since CRTC decision 82-14, the interconnect industry has grown to over 100 firms employing approximately 3,300 individuals. The interconnect segment of the telecommunications market is also highly concentrated with the top four interconnectors controlling 56.5 percent of total revenue in 1985. Initially this sector experienced rapid growth; however increased competition from the telephone companies has slowed the rate of growth of revenues from 39 percent in 1983 to 13 percent in 1985.

The reselling industry, both terrestrial cross-border and satellite, is an infant industry with one firm operating in each segment.

The Canadian cellular radio industry is a structured duopoly established by the Department of Communications in 1983. Cantel is the only national cellular licensee that competes with the cellular divisions of local telephone companies. Cantel's mandate as the nationally licensed cellular company is to provide cellular telephone service in 23 centres across Canada.

In Canada, both domestic and international satellite communications are monopolized. However, recent regulatory and federal government decisions have paved the way for an increasingly competitive operating environment. The domestic satellite carrier, Telesat Canada, has evolved from a "carrier's carrier" that faced restrictions on its customer base,

provision of services and markets served, to an independent competitive player in the telecommunications industry. Teleglobe, the international satellite carrier, historically a non-regulated Crown corporation, was recently privatized with the possibility of becoming subject to regulation.

The mix of ownership (public and private) and extensive regulation (both with respect to prices and with respect to companies that are allowed to provide specific services) has become increasingly complex and diverse in recent years. The combination of publicly and privately owned companies operating in the same industry suggests that an economic efficiency-equity tradeoff is made both within sectors of the industry as well as for the industry as a whole. The structure and behaviour of the industry reflects important policy conflicts between efficiency and perceived equity, and the result is a more costly structural option for the final consumer in terms of pricing and availability of services.

The analyses contained in Chapters 3 - 5 are limited by a paucity of data which prevents a complete description of productivity growth, "bimodalism" and demand considerations for the newer sectors of the telecommunications industry. Specifically, our discussion in these areas is restricted to the terrestrial common carriers. The lack of data for the growing competitive segment of the industry is a cause for concern, especially in view of the major public policy concerns outlined in Chapter 6. With this limitation in mind, a summary of recent economic analysis of the industry is presented.

The empirical evidence, regarding the measurement of output in the telecommunications industry, indicates that local and long-distance service constitute the overwhelming portion of output, as measured by deflated revenue. Available studies of real output in the sector exclude output of private systems, cellular radio systems and the interconnect industry. With respect to input growth, we note that both the terrestrial and non-terrestrial carriers enjoyed substantial increases in total factor productivity over the period 1972-1981. However, this productivity performance of the terrestrial and non-terrestrial carriers is atypical of the broad economy. To illustrate, the average annual productivity gain for five companies, representing over 80 percent of the telecommunications industry, was 4.4 percent during the period 1972 to 1981. During the same period, the productivity of the Canadian economy as a whole declined by an average of .5 percent per year.

The productivity performance of the telecommunications industry reflects a number of factors; exploitation of economies of scale and scope, as well as technological change. The conventional view of service industries as being subject to inexorable unit cost increases is not applicable

to the telecommunications industry. However, the sources of productivity gain in the industry have not been identified precisely. In particular, despite the large number of studies examining production conditions in the telecommunications industry, the extent of and evidence regarding aggregate scale economies is inconclusive. Furthermore, estimates of product specific economies of scale and economies of scope are both limited and contradictory.

The magnitude of economies of scale and scope in the industry is inextricably tied to the issue of technological change, since the latter has been suggested to influence both the magnitude and nature of production economies, as well as the rates of introduction of new services and service pricing. The major recent development in the industry is the emergence of digital telecommunication techniques. This "digitization" of the network has allowed the industry to enjoy some of the benefits of the massive cost reductions that have characterized the production of computer components. Additionally, digitization has facilitated the introduction of a host of new services and modifications to existing networks. To our knowledge, there is no study of the rate at which digital technology has been integrated into the telecommunications industry.

The current empirical estimates of technological cost savings inadequately reflect technological advances in the industry. First, the estimates do not allow for differing rates of technological change among activities. Second, the models do not incorporate the effects of external technological change. Furthermore, the two studies cited explicitly in the report reach opposite conclusions regarding the causality between introducing new technologies and the degree of economies of scale.

Notwithstanding biases and omissions in extant real output measures, it is clear that the telecommunications industry represents an important component of the social infrastructure for all areas of economic activity. This is evidenced by the fact that telephone systems alone accounted for 3.1 percent of constant dollar Gross Domestic Product in 1985, and that the share of telephone systems' contribution has been increasing over the period 1977-1985.

To the extent that telecommunications services increase efficiency in other sectors of the economy, and to the extent that suppliers of telecommunications services do not capture all of the potential efficiency gains in the form of higher prices, the sector could have an important indirect effect on both the magnitude and nature of real economic output in Canada. Unfortunately, we are unaware of any studies that have looked at this issue in a comprehensive way. Based on admissible speculations that the industry is serving as a vehicle for the transmission of digital communications and that

diffusion of new technology may be fostered by increased competition, we conclude it is likely that the activities of the telecommunications carriers have important potential "spillover" benefits for the Canadian economy.

Overall employment in the telecommunications sector was approximately 125,000 in 1984, with the telephone companies accounting for approximately 84 percent, the interconnect companies 2.4 percent, contract employees 5.6 percent and "other" 8 percent. A comparison of 1971 and 1981 Census data for the telephone companies support several inferences. First, a faster relative growth in demand for telecommunications services will increase educational requirements in the work-force, all other things constant and second, there has been an increase in the average educational attainment of the telecommunications work-force over the period 1971-1981.

The employment of labour in the industry reflects the influence of three interrelated factors: (1) the growth in real output; (2) the substitution of material and capital for labour; (3) increases in productivity. The studies surveyed indicate that the demand for factors of production is price inelastic and that both labour and capital and labour and materials are substitutes in telecommunications services production. Finally, technological change was found to be labour saving, capital using and material neutral.

These findings when combined with the discussion of productivity change and employment determinants, allow us to conclude that the industry has enjoyed significant rates of productivity growth that are directly and indirectly linked to labour saving technological change. Increased productivity potentially affects not only the overall demand for labour but also the mix of occupations. The latter is relevant to the issue of "bimodalism"—the employment implications of a declining manufacturing sector, where the wage structure of the "high tech" industries become "bipolar," i.e. larger proportions of high- and low-income earners. Using broadly defined occupational categories for telephone workers from published Statistics Canada data, we found that the occupational rankings changed over the period 1978-1985 and that the data offered no support for the bimodalism hypothesis.

In concluding our discussion of employment in the telecommunications industry, we suggest that the overall growth of this sector will open up employment opportunities requiring above-average education levels. Furthermore, technological change will encourage a shift in demand away from relatively unskilled occupations towards relatively skilled occupations. Therefore, it appears that the telecommunications sector represents a source of new employment that contradicts the popular stereotype of employment trends in the service sector.

Focusing on the factors that influence the overall demand for telecommunications' services, we note that specification of the demand function involves considerations beyond the usual variables of price and income. They include: the interdependence of preferences across subscribers; the willingness to pay for the option to make or receive calls, although this option may never be realized; attributes of telephone calls such as time and duration; and a distinction between the demand for access to the system and the demand for use of the system once access has been secured.

Empirical testing of the demand for telephone services indicates that demand is both price and income inelastic. Modelling the external benefits to individual subscribers from having access to a greater number of potential connections is achieved by specifying a "market size" variable measuring potential toll connections. The market size coefficient implies that growth in network access lines results in more than proportionate increases in long-distance calling.

A comparison of demand estimates for various service offerings of Bell Canada suggests that demand for all categories of telephone service in Canada is price and income inelastic, with demand for local service being especially price inelastic. The major variable influencing the demand for telephone service is the number of potential connections.

Households and business subscribers each account for approximately 50 percent of total revenues earned by telecommunication companies. Each also accounts for a roughly proportionate share of the two main revenue categories; local services and long distance service. Available evidence indicates that telecommunication costs for Canadian firms constitute a relatively small portion of the total cost of doing business. However, telecommunication usage in business varies across sectors with service sector organizations being the most intensive users of telecommunication services.

The changing structure of the Canadian telecommunications industry, the convergence of telecommunications and computer technology, and the desire to establish international rules for trade in service industries raises a host of political, social and economic issues for Canadian telecommunications policy-makers. In the final section of this book we address the most compelling policy issues, namely deregulation, international trade and distributional equity.

The most critical issue facing Canadian policy-makers is the extent to which telecommunications services should be subject to regulation, both with respect to prices and the provision of those services. One approach is

to allow product and service offerings to be determined completely by private sector participants, and allow prices to be set in the marketplace. Criticism of this approach seems most relevant for local subscriber services given the pronounced economies of scale in this portion of the industry. Another criticism of complete deregulation relates to potentially adverse redistributional effects of "rate rebalancing." Marginal cost pricing or Ramsey rule pricing in a deregulated market would imply higher rates for local services and lower rates for long distance services. Concern has been expressed that higher local rates will lead lower income individuals to drop off the network. In fact, there is little evidence to support this concern.

On the other hand, failure to deregulate the industry also raises policy concerns. One major concern is the loss of revenue from large business customers who may increasingly turn to lower cost alternatives to the common carrier network for their long distance services. Two potential options are cross-border bypass and cross-border reselling. Given that competition in Canada's long-distance sector is being restricted ostensibly to protect current cross-subsidies in the pricing structure, extant cross-subsidies are arguably extracting a heavy toll in the form of allocative inefficiencies.

The recently completed free-trade deal between Canada and the U.S. allows for free trade in "enhanced" telecommunications and computer services, while denying free trade in basic services such as local dialing or long distance. At the time of writing, the exact definition of "enhanced services" remains unclear, implying that the amount of increased trade will hinge on a precise service definition. Broadly defined, enhanced services are expected to include electronic mail, Telex, computer data base access and telephone transmitted electronic data. To date, there is very little trade in telecommunications services. Most trade is hardware related.

While most industry observers agree that the current pricing structure is inefficient, many argue that the interests of social equity should take precedence. The precise distributional impact of any repricing scheme is difficult to determine given the paucity of reliable quantitative estimates of price and income elasticities of demand for individual services such as access, local calling and long distance calling for different categories of subscribers. The distribution of local versus long distance calling varies across classes of customers, as does presumably the responsiveness of customers to peak/off peak pricing of metered services.

Nevertheless, it can be argued that distributional concerns are more efficiently handled by direct subsidy, rather than by subsidizing indirectly through a distorted price structure. The study concludes that much more substantial deregulation of the industry is in the social interest.

ABOUT THE AUTHORS

Steven Globerman is a Professor of Business and Public Policy at Simon Fraser University's Faculty of Business Administration. He holds a Ph.D. in economics and has served on the faculties of management schools at York University, University of California and University of British Columbia. He has also undertaken an extensive number of consulting and contract research assignments for both private and public sector organizations including Imperial Oil, Bell Canada, Consumer and Corporate Affairs Canada, the Economic Council of Canada and the Department of Communications.

Dr. Globerman's broad area of research interest is industrial organization. In particular, he has undertaken numerous studies of the relationship between an industry's organizational structure and the behaviour and performance of organizations in the industry. An aspect of this research focus is the influence of government policies towards an industry (including direct and indirect regulation) on its economic performance.

Dr. Globerman has published over fifty journal articles and fifteen monographs and books many of which deal with the impact of public policy on specific industries.

Deborah Carter received a B.A. in economics from Wilfred Laurier University in 1981 and an M.A. from the University of British Columbia in 1982. Her research has focused on the activities of the service sector for the Institute for Research on Public Policy. She is currently working for Associated Economic Consultants as an economic analyst specializing in personal injury loss, and teaching economics at Vancouver Community College.

CHAPTER 1

DESCRIPTION OF THE TELECOMMUNICATIONS INDUSTRY

INTRODUCTION

Industrialized countries have been undergoing a structural change referred to as the emergence of a post-industrial society or service economy. As a result, service sector industries are the focal point of both academic and policy analysis. The prominence of this sector in economic activity is evidenced by its contributions to gross domestic product (GDP) and employment. The most recent figures available from Statistics Canada reveal that service producing industries accounted for 64.3 percent of GDP in constant prices for the first quarter of 1986, and 73.8 percent of the estimated number of employees in Canada in August 1986. A comparison of Canadian and U.S. figures reveal that the service industries' share of GDP in current prices was 62.8 percent and 68.5 percent respectively in 1982. These figures clearly indicate that the service sector is the dominant source of economic activity in Canada.

While dominance of the service contribution is well documented at aggregate levels, there is a disturbing lack of detail available on individual industries within the service sector. The reasons for this situation need not concern us here,[1] although they are related in a fundamental way to conceptual problems in defining the nature and scope of service activities and the historical propensity for government agencies to concentrate their data collection efforts on the resource and manufacturing sectors.

The emergence of service industries as the dominant sector of developed economies has raised a host of questions. Some are basic and fundamental. What is the size and scope of service sector activities? How much international trade takes place in service industries? What has been the productivity performance of service sector industries? Others are conceptual and normative. Do occupational skill requirements differ across sectors? What has been the impact of service sector growth on income distribution? In the

following pages many of these questions will be addressed with specific reference to the telecommunications industry.

Telecommunications is the science and technology of communication by electrical or electronic means.[2] Telecommunication networks or systems perform three basic functions: reception, transmission and switching of telecommunication signals carrying information. These functional distinctions are usually made for the purpose of identifying the telecommunications production process. From the standpoint of understanding telecommunications as a service, these functions are obviously linked. Without reception, transmission would contribute no value to a subscriber; switching obviously enhances the market value of transmission capacity, and so forth. While these functions are straightforward, the environment in which these functions take place has and continues to undergo substantial technical and regulatory changes.

This study provides an overview of the telecommunications sector with respect to its primary economic characteristics and evaluates a number of hypotheses bearing upon public policy considerations. The latter include issues relating to the employment impacts of continued growth of the telecommunications sector, government policies as they affect the performance of the industry, and the potential for international trade.

THE TELECOMMUNICATIONS FUNCTION: AN OVERVIEW

Twenty years ago it would have been reasonable to assert that the information market was comprised of several distinct industries: telephone and telegraph, satellite, and computers. Technological advances combined with relaxed regulatory decisions have started to erode the conventional distinctions among product, industry and geographic location. The primary implication of this evolution is that the telecommunications industry is increasingly subject to potential (and in some cases actual) competition from other industries. "What remains unprecedented is the entry of several industries into information products and services...the telephone, telegraph, computer, software, service bureau, semiconductor, satellite, motion picture and office automation equipment companies cater to the same customers."[3] This softening of industry boundaries requires that the economic role of telecommunications firms be viewed within the context of the marketplace for information.

Telecommunication networks or systems perform three distinct processes on telecommunication signals: pick-up and final delivery, transmission, and the switching or routing of signals from one transmission link to another.[4] As pointed out in the recent federal/provincial examination of

telecommunications, the increasingly competitive environment in telecommunications has lessened the control of the carriers and regulators with respect to introduction and pricing of services.[5] In addition, the potential for large business users of telecommunications to install private microwave systems serves to further erode the market power of terrestrial carriers.[6] While regulatory restrictions on competition have helped preserve the dominant market share of established terrestrial carriers, the technological assault on the natural monopoly of telephone companies is paving the way for increased competition and subsequently calling into question the role and extent of regulation desirable in a potentially "mixed" market structure.

With respect to pick-up and final delivery, every communications service requires a terminal device for sending and/or receiving the signals. Transmission is the carriage of telecommunication signals between terminal equipment and switching equipment or between sets of switching equipment. Transmission channels include wire, cables, coaxial tubes, optical fibres, microwave facilities, satellite systems, mobile telephone connections and radio paging systems. The primary switching function is to route electronic signals from one location to another. In the process, the electronic signals can be stored, augmented or otherwise modified. Increasingly, switching functions are being incorporated into terminal devices, thereby blurring the distinction between pick-up and delivery and switching. Switching equipment can be divided into three separate categories: network user's equipment located on the user's premises, local switching equipment to connect toll-free transmission facilities, and long-distance switching equipment.

Within the communications sector, the telecommunication system comprises all the network, equipment and services provided by electronic common carriers.[7] There are a variety of telecommunication networks in Canada. The most extensive and heavily used systems are the networks operated by the terrestrial carriers (the telephone and telex companies). With the emergence of satellite carriage, cellular radio systems, and in some instances the computer-based companies, the scope of the industry has expanded. In sum, the technologies of telecommunications are no longer unique nor entirely under the control of telephone companies.[8]

Technological advances go beyond the industry level to the product level. Products that were recognized historically as a number of separate items have developed into single pieces of hardware. To illustrate: "a TV set tied to a telephone line is a videotext; a typewriter embodying logic and memory capabilities is termed a word processor or an intelligent printer; a PBX (private branch exchange) linking data terminals is a distributed processor; a cathode ray tube with logic and memory is a work station; an

on-line printer display is termed an electronic mailer."[9] These examples highlight the extent of product and industry integration that is occurring in telecommunications.

TELECOMMUNICATION CARRIERS

To identify the specific participants in the telecommunications industry, one is forced to become more precise in defining the boundaries of the industry. This difficult task becomes an even greater challenge in the face of changing economic and technological conditions. The historical practice of segmenting telecommunications from computer and office automation companies will be continued herein.[10]

The Canadian telecommunications industry is dominated by two national systems: Telecom Canada and CNCP Telecommunications. Both these systems merge into the overseas network which is operated by Teleglobe Canada. Telecom Canada is an association of the largest telephone companies operating in each province and Telesat Canada, the domestic satellite carrier. There are approximately one hundred telephone companies operating in Canada without Telecom Canada affiliation. In addition, there are another 200 radio common carriers. These 312 traditional telecommunication carriers are currently being challenged in the provision of both equipment and services by newer entrants which include interconnect companies, cellular radio carriers, resellers, and enhanced service providers.[11] Competition is also occurring among the traditional carriers in the provision of various services.

The early evolution of telegraphy and telephony was largely competitive in both Canada and the U.S. with patent licences to the technologies involved distributed roughly on a regional basis among railroad and independent companies.[12] The railroad companies, Canadian National Railways and CP Limited, were historically granted telegraph franchises along their rail lines in support of their development of a national rail system. The CNCP Telecommunications partnership was formed in 1961 between the telecommunications departments of the two major railways. Given the separation between telegraphy and telephony, CNCP emerged to hold a de facto monopoly in the domestic telegraph market, while the member companies of the then TransCanada Telephone System (now Telecom Canada) came to hold a de facto monopoly in the inter-city voice market.

Currently, Telecom Canada[13] members operate two of the three nation-spanning microwave networks that form the backbone of Canada's telecommunications network. These companies are essentially responsible for the provision of switched voice message service in Canada. Switched

voice message service (both local and long distance) is the primary service offering of the industry, constituting almost 80 percent of the revenues of Bell Canada, the major telephone carrier in Canada.[14] CNCP Telecommunications operates the third microwave network. In addition to its traditional telegraph service, CNCP also provides voice service. However, CNCP is restricted to providing private line service, meaning that the voice traffic it carries cannot be connected to the switched telephone network operated by Telecom Canada. Both CNCP and Telecom Canada members also carry sophisticated written messages (e.g., telex), computer data, facsimile, and television broadcast signals on their networks.

While there were approximately 120 terrestrial telephone carriers operating in Canada in 1982, the Telecom Canada member companies accounted for about 95 percent of total carrier revenue. Over time, there has been a significant contraction in the number of terrestrial common carriers in Canada. As recently as 1975, there were around 850 telephone companies in Canada.[15] The recent contraction is a continuation of a trend that began in the early 1900s in both Canada and the United States. The rationalization of the industry in the 1930s was the result of aggressive mergers and acquisitions by the dominant carriers and changes in domestic legislation and regulation.

Domestic satellite service is provided by Telesat Canada, which was established by the federal government in 1969. Commercial service began in January 1973 after the launch of Telesat's first satellite. Telesat's system transmits voice, data, facsimile, television and radio signals and is interconnected to the terrestrial carriers system.

Overseas telecommunication traffic is carried through the facilities of Teleglobe Canada, a federal Crown agency established in 1950 and recently privatized and purchased by Memotec, a Canadian-owned firm headquartered in Montreal. Teleglobe's transmission facilities converge on gateway switches in Vancouver, Toronto and Montreal. Telephone, telegraph, telex, TWX and other services are connected internationally through Teleglobe's facilities. Telephone signals are the primary traffic in terms of both volume and value.

It is of interest to note the dichotomization of Canada's international telecommunication markets into continental and overseas.

> The dichotomization of Canada's international telecommunication markets and the consequent separate government approaches to their management was influenced heavily both by the country's geographic proximity to the United States and by historical relations between Canadian and American telecommunication suppliers. Indeed the integration of Canadian and U.S. networks into a single North American

> system was so far advanced by the war's end that the domestic carriers had already come to regard it as their exclusive domain. The series of interconnection and profit-sharing agreements concluded between Teleglobe and Telecom Canada through the years suggests that Teleglobe is content to leave the U.S. and Mexican markets to the other carriers. In return, the telephone companies have accepted Teleglobe's de facto monopoly in overseas service.[16]

Radio common carriers provide telecommunications service to the Canadian public in the form of radio paging (as do the telephone companies). In addition, radio common carriers enlarge the scope of the telecommunications infrastructure by providing services in remote areas not served by wireline carriers. Radio common carriers are licensed by the Department of Communications on the condition that the service is for public use and not for private commercial use. There are an estimated 200 radio common carriers in Canada. Most are medium-sized, community-oriented enterprises serving a relatively restricted geographical area.[17]

Recent regulatory decisions have facilitated the entry of a new set of participants into the telecommunications sector, interconnect companies. These companies provide competition in a previously monopolized market, that of terminal equipment. Specifically, interconnect companies are involved with marketing, installation and maintenance of various types of terminal equipment ranging from telephones, telex and PBXs to satellite earth stations.[18]

At this time, cellular mobile radio carriers provide competitive service primarily for conventional mobile-telephone service. Nonetheless, if certain regulatory changes are introduced, cellular radio systems could provide a viable alternative to the telco's local loop.[19] Even in the absence of regulatory changes, the potential for cellular mobile radio cannot be underestimated. "Cellular radio, by greatly expanding the number of subscribers that can be served by mobile telephone, could, in some instance, replace the local telco system."[20]

EVOLUTION OF TELECOMMUNICATION

As mentioned previously, industrialized countries are witnessing the emergence of the service sector as the dominant force behind economic growth. Similarly, the telecommunications industry is undergoing continued and rapid structural change. Most noticeable is the emergence of new "fringe" carriers that operate in an unregulated environment. At the same time, technological advances are blurring historical distinctions between industry, product and geographic boundaries. Therefore, it is important to document

the regulatory changes and technological innovations as they pertain to structural changes in the telecommunications industry.

Regulation

Telecommunication regulation was designed to protect consumers from overcharging by the monopoly providers of telecommunications services. Regulation was seen as the means to ensure the policy goal of universal availability of affordable telephone service. Over the years, the roles of various regulatory agencies have expanded to cover other carrier activities deemed to be in the public's interest.[21]

Canadian telecommunication common carriers are regulated by the federal regulatory agency CRTC, a provincial government public utility board, or a municipal board. Table 1 provides a list of the major telecommunication companies and their respective regulatory agencies. Two facts are worth noting. First, Teleglobe Canada is not subject to any regulation within Canada.[22] Second, while the major telcos are themselves subject to regulation, their unincorporated association, Telecom Canada, is not. As such, there is no national regulatory agency because no telco operates nationally except through Telecom Canada.

Increasing competition in the Canadian telecommunications industry and deregulation of the U.S. system have brought increasing pressure on the Canadian regulatory system. In particular, competition in the long-distance segment of the U.S. market has resulted in substantially lower long-distance rates in the United States than in Canada. This, in turn, has stimulated interest on the part of Canadian business subscribers in "bypassing" the Telecom Canada network. Several Canadian companies have emerged to facilitate such bypass activity. We shall discuss the bypass phenomenon in more detail in a later chapter.

In Canada, recent regulatory decisions have directly relaxed certain competitive restrictions (both internal and external) in the domestic telecommunications industry. One important area affected by recent regulatory decisions is interconnection. Historically, attachment and maintenance of the hardware that facilitated the pick-up and delivery of electronic signals from and to the network was the exclusive privilege of the carriers. Federal and provincial "interconnect" decisions since 1979 have allowed private ownership of telephone equipment, telex equipment and satellite earth stations. As a result, independent interconnect companies compete alongside the interconnect divisions of the telephone carriers, telex carriers and Telesat Canada. Table 2 provides an outline of the CRTC interconnect decisions, and table 3 outlines current provincial regulations regarding in-

Table 1
Major Canadian Telecommunication Carriers
and Their Regulatory Agencies

Carrier	Regulatory Agency
Newfoundland Telephone	Newfoundland Board of Commissioners of Public Utilities
Terra Nova Telecommunications	CRTC
Island Telephone	Public Utilities Commission of P.E.I.
Maritime Telegraph and Telephone	N.S. Board of Commissioners of Public Utilities
New Brunswick Telephone	N.B. Board of Commissioners of Public Utilities
Bell Canada	CRTC
Quebec-Telephone	Regie des services publics du Quebec
Telebec	Regie des services publics du Quebec
Northern Telephone	Ontario Telephone Service Commission
Thunder Bay Telecommunications	Ontario Telephone Service Commission
Manitoba Telephone System	Manitoba Public Utilities Board
Saskatchewan Telecommunications	Saskatchewan Public Utilities Review Commission
Alberta Government Telephones	Alberta Public Utilities Board
'edmonton telephones'	City of Edmonton
British Columbia Telephone	CRTC
Prince Rupert	City of Prince Rupert and B.C. Utilities Commission
B.C. Rail	Not regulated by an agency
Northwestel	CRTC
Telesat Canada	CRTC
CNCP Telecommunications	CRTC
Teleglobe Canada	Not regulated by an agency

Source: Table 1.8, Federal-Provincial Working Papers, October 1986, p.36.

Table 2

Federal Interconnect Decisions

CRTC Decision	Result
79-11 May 1979	CNCP can compete in provision of interconnected private line voice and data communications and public data telecommunications services in Bell operating territory.
81-24 November 1981	Extended CNCP interconnection of Decision 79-11 to B.C. Tel operating territory.
80-13 Interim Decision	Telephone subscribers in Bell operating territory can hook up their own terminal equipment (telephone sets, PBX) to Bell's telephone network.
81-19	Extended 80-13 to B.C. Tel subscribers.
82-14 November 1982 Final Decision	This decision set out the terms and conditions governing the attachment of subscriber provided terminal equipment to the networks of *all* federally regulated telecommunication carriers.
84-10 March 1984	Permits interconnection of cellular and conventional public and private mobile radio systems to the public switched telephone network. However, only mobile to mobile calls or calls initiated or terminated on a mobile terminal will be permitted on inter-exchange facilities between mobile systems.
85-19 August 1985	Approved application by B.C. Rail to compete with B.C. Tel in the provision of certain private line voice and data services. Allowed interconnection of private local systems and public non-voice local systems to facilities of the federally regulated common carriers. Denied CNCP application to compete with Bell Canada and B.C. Tel in the provision of long-distance telephone service (MTS, WATS). Allowed resale and sharing of telecommunication services (other than long-distance public telephone service and primary voice exchange service).
86-18 October 1986	CRTC denied CNCPs request to rescind the part of Decision 85-19 that denied CNCPs application to provide long-distance public telephone service.

Table 3

Current Provincial Interconnect Decisions

Type of Interconnection	Provincial Regulations
Customer provision of the primary telephone set*	In AGT, Quebec-Tel, Telebec, NB Tel and Island Tel territories, subscribers have the choice of renting terminal equipment from the telcos or purchasing their own. In MT&T territory, rental of the primary set is included in the basic service rate but subscribers can purchase their own equipment. In Manitoba Telephone System, Sask Tel and Newfoundland Tel, rental of the primary set is included. Attachment of residence extension sets or non-network addressing devices is permitted.
CNCP privately leased business lines with AGTs public network**	AGT refused CNCPs application to gain interconnection rights for business linesin Alberta. This decision was taken to the SupremeCourt of Canada by CNCP; a decision is still pending.

*Federal-Provincial Working Papers, pp. 59-60.

***The Financial Post Magazine*, January 1, 1985, and discussions with CRTC employee, Dave Stinson.

terconnection. The precise rules governing interconnection are quite complex since telephone common carriers are regulated by different agencies with different regulations regarding interconnect competition.

Two other important pro-competitive decisions were reached in the recent CRTC Decision 85-19, "Interchange Competition and Related Issues." First, the commission decided to allow the resale and sharing[23] of telecommunications facilities and/or services in all areas except for the provision of basic local and long-distance voice services. This decision opens up the telecommunication sector to a new set of participants—unregulated companies who can lease facilities for the purpose of providing services other than basic telephone service.[24] Leasing of facilities can be undertaken as a basis for constructing private or closed user group networks or for reselling non-switched services to third parties.

Second, the CRTC permitted the interconnection of noncarrier-provided private local systems and public non-voice systems to the facilities of the federally regulated carriers. In practice this allows private intra-exchange networks (intra-city Tie Trunk networks) and intra-city public data networks to connect to the public communications network. Prior to this decision, cable TV companies could not interconnect, while radio paging systems, radio common carriers and cellular radio systems were allowed access to the carrier's public switched network. Overshadowing these two competitive rulings was the CRTC's refusal to allow CNCP to compete in the long-distance market for the moment. This latter decision obviously represents a major regulatory obstacle to competition and (in its consequences) probably overshadows the moves taken to liberalize competition; however, the CRTC did not reject the principle of inter-exchange competition.

Technology and Telecommunications

> No longer is a telephone simply an instrument for voice communications, but rather an information terminal...Communication networks originally designed to provide simple voice grade connections are rapidly evolving into systems that permit users to transmit information in a variety of electronic forms, volumes and speeds.

This quote by AT&T chairman Charles Brown aptly summarizes the current technological advances in telecommunications. Technological change is both internal and external to the telecommunications industry. Within the industry itself, major developments include digitization, new transmission systems and electronic switching facilities. The merging of computer companies, cable companies and common carriers is making it increasingly difficult to distinguish the telecommunications portion of the information market. Recent structural changes can be viewed from the perspective of emerging and new technologies.

Digital Transmission

Historically, the telephone has functioned using analog transmission. Sound waves are converted into electrical signals at the transmitter and reconverted to sound waves at the receiver. While analog systems were capable of carrying voice and non-voice messages (telex, telegrams, data), non-voice messages (particularly data) could not be transmitted quickly. Digital transmission converts voice into a computer code of on-off pulses and transforms these back into voice by means of a circuit called CODEC (COder/DECoder). In addition to being a much faster means of transmis-

sion, digital systems are capable of handling voice, graphics, video telex, facsimile and computer data. As a consequence, the historical distinction between voice, data and image communications is becoming obsolete. In fact, digital technology and the ensuing applications will ultimately make the telephone indistinguishable from the computer.

This development raises serious concern when one considers the fact that the telephone industry is regulated, while the computer industry is a competitive marketplace. Within the telecommunications industry, digitization combined with the terminal interconnect decisions now makes it impossible for telephone companies to determine the type of information being transmitted over the public switched network.

> The result of these technological developments is that the distinction between the use of the carriers' transmission facilities for voice data and image is eroding. The provision of transport services will eventually evolve to that of band, with customers determining the application. Application based tariffs for basic carriage will not be supportable in the marketplace and new tariffs will, of necessity, be transparent to applications.[25]

Transmission Systems

Two major developments in transmission facilities are providing alternatives to the telephone system. Satellite transponders can be used in place of microwave transmission, and fibre optics are being developed that can transmit digital signals in competition with copper wire and coaxial cable. Fibre optics are cheaper, faster, capable of carrying voice, data and video signals, and are "virtually impossible to wiretap." A field test by Bell Canada in Toronto determined "a single fibre optic line could handle all the services currently being carried into the home by phone and cable TV systems and more."[26] These new transmission systems, such as satellite and fibre optics, are making it technically possible for non-telcos to provide telecommunications in direct competition with the telephone companies.

Hardware

Private branch exchanges (PBX) and local area networks (LAN) are two advances in electronic switching equipment that allow the user to develop an internal telephone network that is a substitute for the public switched telephone network. "Computer controlled PBX's...now have the capability of tying private line facilities and public switched services together into powerful networks. The PBX performs the switching function that was previously performed by toll switching in the public network."[27] Local area networks (LAN) are an alternative data transmission network that is

capable of carrying more traffic at higher speeds than the PBX. The newer LANs are also capable of voice transmission.

These two electronic switching devices pose a serious threat to the telephone companies' market share of both local and long-distance revenues. The ability of companies to establish their own private networks and bypass the telephone companies' facilities is become a technological reality. Currently, bypass is only economically feasible for large users of telecommunications.[28]

External Technological Change

Traditionally, computer service and cable companies have been seen as providing services distinct from the telephone common carriers. This is primarily due to the historical focus of the telcos on two-way voice communications as opposed to data communications or broadcast signals. However, the changing nature of technology is making this distinction increasingly tenuous. Many observers already argue for the abandonment of any distinction between telephony and computer services. For example, Oka argues that with the advances in on-line data processing in recent years, it has been getting more and more difficult to draw a borderline between communications and data processing. He notes that the Japanese regard the term "telecommunications" as referring collectively to data transmission through telecommunication circuits and to data processing by computers in the course of transmission, and both activities are called data communications.[29]

Some observers suggest distinguishing between telecommunications and data processing on the basis of whether the output data constitute a programmed response to input data.[30] Where input data are transformed in some direct or indirect way to produce output data, some would argue a boundary can be drawn between data processing and data communications. This distinction, in turn, converges to a distinction between "basic" and "enhanced" telecommunications services. The latter involve the addition of commercial value to the basic transmission function.

However, a number of industry participants, including AT&T and IBM, argue that this conceptual approach is flawed. The flaw rests in the tenuous presumption that the only "value added" in data communications is associated with transforming the digital information in some non-trivial way. However, economic value can be added to information in other ways. For example, information can be stored for some period of time and then forwarded to a location in an essentially unchanged form. The telephone companies are engaged in message store-and-forward activities. Presumably, this "inventory" function enhances the value of the basic information to the

individual paying for the service. Ancillary services can also be attached to the basic transmission function. An example in this regard is billing algorithms in private branch exchange (PBX) switching machines that itemize costs associated with sending messages by caller, by time of call, and so forth. Both the telephone companies and computer services companies are capable of providing the appropriate terminal equipment.

The absence of a clear borderline between data processing and telecommunications raises one immediate problem with respect to government sources of data on the industry. Government data sources continue to treat telecommunications and data processing as distinct activities. For example, major publications dealing with telephone carriers on the one hand and data processing organizations on the other hand fail to acknowledge the interaction and overlap between the two sectors. This treatment makes it more difficult to identify the magnitude of activity in the relevant sector as well as the nature and extent of competition in specific service categories.

The service sector project imposes a division of labour in terms of analysis; that is, telecommunications and computer services constitute separate studies. We have acknowledged that any separation between the two sectors will inevitably involve some degree of arbitrary judgement; however, one distinction that may be reasonably robust, at least at the present time, is based on the criterion that transmission of message traffic is the primary service being demanded of telecommunications carriers rather than transformation of the traffic. In this context, transformations of messages undertaken by telephone companies (e.g., analog to digital) are "invisible" to the user of telephone services. Conversely, transformations of messages undertaken by computer services companies (e.g., converting basic data to formal accounting statements) are not only "visible" to the customer but are required to be "visible."

OVERVIEW OF SERVICES

The telecommunications industry provides a range of services that continues to expand with technological advances and relaxed regulatory decisions. Classification of services for discussion purposes could follow numerous schemes: by carrier type, by service type, basic versus enhanced, competitive versus monopolized, or domestic versus international. The picture is further complicated by the overlap among the carriers and the services they provide. Furthermore, one only needs to glance at an annual report of any carrier to appreciate the number of services each company offers.[31]

This report will follow the classification of services used in the recent "Federal Provincial Examination of Telecommunications Pricing and the Universal Availability of Affordable Telephone Service" (see figure 1). In this examination, they divide services into two broad categories, voice telephony and non-voice services.

Voice Telephony

The primary service offered by the telecommunications industry is the transmission of voice messages. In 1980 it was reported that only 10 percent of communications was in the form of data, the remaining 90 percent was voice communication.[32] Voice telephony is provided by public switched telephone services and leased circuits or private lines.

Public Switched Telephone Services

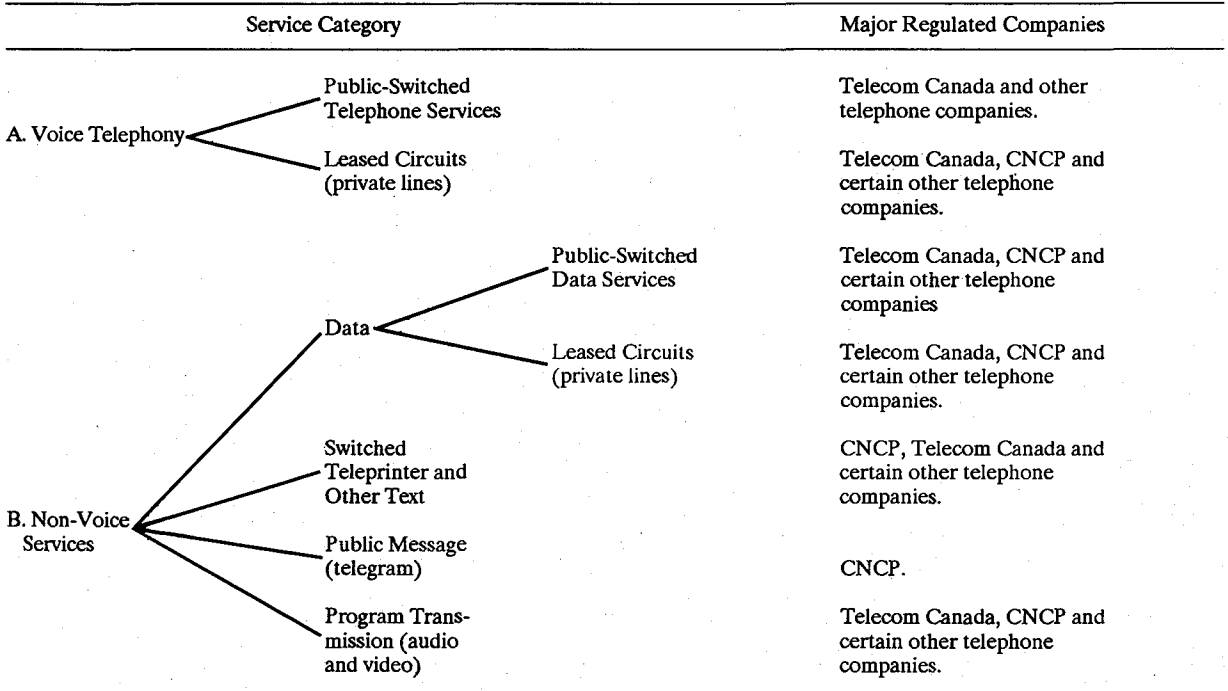
These services are generally provided under monopoly conditions and represent the major area of service provision for Canadian telephone companies. Public switched telephone services can be further subdivided into local (exchange) services and long-distance (inter-exchange) services. Table 4 reports data on local and long-distance calls handled by the terrestrial common carriers. From this table, it is clear that local conversations constitute the overwhelming majority of all telephone calls. It is interesting to note that the growth rate of long-distance calls has outstripped the growth rate of local calls.[33] Completed telephone calls can be considered one major output of the telecommunications industry.

A second measure of output produced by telecommunications companies is access to the public telephone network. Access may be thought of as option demand, i.e., the capacity to send messages to or receive messages from other telephone subscribers. In a broad sense, access can be thought of as the provision of capacity to enter the telecommunications network. This capacity can be crudely measured by the number of subscriber terminals attached to the public switched telephone network. It is important to recall that the recent interconnect decisions allow for subscriber-owned equipment, so the figures in table 5 will also reflect interconnection of privately-owned equipment in the years 1980 and 1984.

Table 5 reports the number of attachments, primarily through standard telephone sets, to the telephone network for selected years. Several trends are apparent from the data in table 5. One is the remarkable growth in the number of individual telephone lines, especially in the residential sector. The 454 percent growth in the number of individual residence lines over the period 1950 to 1984 partly reflects a substitution away from multi-party

FIGURE 1

Overview of Telecommunication Services



Source: Federal-Provincial Working Papers, p. 25.

Table 4
Local and Long-Distance Calls
(in Millions)

Year	Local Calls	%	Long-Distance Calls	%	Total
1945	3,145.5	98	64.8	2	3,210.3
1950	4,894.7	98	117.9	2	5,012.6
1955	6,808.4	98	153.1	2	6,961.5
1960	9,364.6	98	215.3	2	9,579.9
1965	12,138.2	98	301.6	2	12,439.8
1970	15,436.8	97	458.4	3	15,895.2
1975	20,340.6	96	853.5	4	21,194.1
1980	31,204.8	95	1,640.9	5	32,845.7

Source: Statistics Canada, *Telephone Statistics*, various issues.

Table 5
Number of Telephone and PBX Exchange Lines
(in thousands)

	Individual Lines		Multiparty Lines		PBX & Extension			
Year	Business	Residence	Business	Residence	Business	Residence	Pay Phones	Total
1935	160.4	284.5	23.0	494.4	178.7	44.4	23.5	1,209
1940	184.9	347.6	30.0	596.0	222.9	51.9	28.7	1,462
1950	313.0	464.3	77.2	1423.6	467.1	127.7	44.3	2,917
1970	786.3	4222.4	139.3	1380.8	1942.6	1381.0	74.8	13,165
1980	1428.4	7235.1	31.6	1103.1	3446.0	3227.0	115.1	16,531
1984	1733.6	8095.6	26.9	967.6	859.5*	-*	144.0	16,480

Source: Statistics Canada, *Telephone Statistics*, various issues.

* In 1984, extension phone lines are not reported.

residential lines. However, the bulk of this growth represents new access capacity for households. A second relevant trend is the growth in PBX lines. These are the lines that terminate in an intra-office switchboard and may be taken as representative of a relative decentralization of the telephone switching function away from the central offices of the telephone companies, at least for business subscribers.

Several other characteristics of terrestrial telephone access might be noted. In the household sector, access is virtually universal. In 1985, 98.2 percent of Canadian households had access to at least one telephone.[34] Universal access to telephone service represents a major public policy goal in the telecommunications sector. By any practical standard, it has been achieved. A second characteristic is the relative equality in access across different regions of the country. Table 6 reports total access lines per 100 population in the 10 provinces and the Yukon and Northwest Territories and the percentage of households with telephone service. Given substantial differences in income levels, industrial structures and population densities, the similarity in access is noteworthy. One suggested hypothesis is that public policy has encouraged an extensive and complex pattern of cross subsidies through pricing and inter-company revenue settlements to ensure comparable levels of basic telephone service across regions.

Leased Circuits

In most regions in Canada, private lines for voice, data and programme transmission are available from the telcos, CNCP and B.C. Rail in British Columbia. The private line services essentially provide unmetered communication capacity between two dedicated locations for a given bulk rate. Private lines may be leased on an individual line or bulk basis; offerings include foreign exchange lines, off premises extensions and tie trunks. Comprehensive data on the provision of these "off network" services by terrestrial carriers are not publicly available.

As a result of changes to the Telecom Canada Connecting Agreement,[35] Telesat Canada provides satellite-based, private line services directly to business customers. Overseas leased circuits are available by interconnection to Teleglobe facilities at its gateway switches in Vancouver, Toronto and Montreal. To our knowledge, there are no measures of physical output in the satellite sector comparable to those in the terrestrial carrier sector, e.g., total completed calls.

Newer Voice Service Offerings

Canada's cellular radio system was established as a duopoly by the Department of Communications in December 1983. Cantel was chosen to com-

Table 6
Telephone Access by Region

Region	(1) Total Access Lines Per 100 Population (1984)	(2) Percentage of Households With Telephone Service (1985)
Newfoundland	32.8	94.4
P.E.I.	40.0	95.2
Nova Scotia	42.3	96.7
New Brunswick	43.5	94.9
Quebec	46.6	98.6
Ontario	48.1	99.0
Manitoba	49.3	97.2
Saskatchewan	49.1	97.5
Alberta	45.4	98.0
British Columbia	48.0	97.7
Yukon	47.5	n.a.
Northwest Territories	38.5	n.a.
Canada	46.8	98.2

Sources: Column 1: Author's calculations from data in Statistics Canada, *Telephone Statistics*, Ottawa:Supply and Services Canada, 1985, table 4.
Column 2: *Federal-Provincial Examination of Telecommunications Pricing and the Universal Availability of Affordable Telephone Service*, Ottawa: Minister of Supply and Services Canada, 1986.

pete with the cellular division of the local telephone company in each market as the only national cellular licensee.

Several other minor telecommunications services will be mentioned briefly. They relate to the "resale" of common carrier capacity. In Canada, at least one company, Cam-Net Inc., provides transborder resale services. This Vancouver-based company leases circuits from B.C. Telephone which terminate in a switch located in Washington state. By dialing a specific long-distance number, Cam-Net subscribers are connected to the switch. They then dial the U.S. numbers they wish to contact. Their calls are, in turn, carried on one of the U.S. resale carrier's facilities. The implication is that a substantial portion of the subscriber's call to the U.S. is carried on the facilities of a U.S.-based carrier. Given that long-distance rates are lower in the United States than in Canada, Cam-Net is effectively acting as an arbitrageur of price differences between the Canadian and American markets. However, a recent study determined that (given the existing rate structure) there are very limited cost savings associated with this type of bypass activity. Specifically, the long-distance charges on the Vancouver to Washington portion of the call typically outweigh the cost savings on the intra-U.S. portion of the call.[36]

In December 1986, Canadian Satellite Communications Inc. (CANCOM) announced it was launching a new service, a satellite-based data distribution network. The new service, CANCOM Satlink, moves CANCOM out of the role of a Canadian broadcaster into that of a telecommunications reseller. CANCOMs Satlink is a one-way link where users send data to CANCOMs uplink that sends signals to the orbiting Telesat satellite which are then picked up either by customer-owned earth station antennas or CANCOM dish sites. Telephone lines are then used to send the data from CANCOMs earth stations to the customers' premises.[37]

There is little information on the extent of resellers' activities. As more companies take advantage of relaxed regulatory rulings, the need for comprehensive data collection in these newer areas of telecommunications will increase. All that we can establish so far is that Cam-Net is the only transborder reseller, while CANCOM is the only satellite reseller.

Non-Voice Services

Switched Teleprinter and Other Text

CNCP competes with Telecom Canada in the provision of switched teleprinter services. CNCPs service is known as telex, while Telecom Canada provides teletypewriter exchange (TWX). CNCP and others provide facsimile communication service which allows for the transmission

of text or graphics over their networks. Teleglobe provides the link for overseas telex and facsimile services. New electronic mail, message and text services are being introduced by CNCP, Telecom Canada and Teleglobe Canada.

Telegram Service

Telegram or public message service is provided on a monopoly basis by CNCP. New technologies are replacing this public message service and, as a result, customer demand has declined dramatically in recent years. In 1980, telegram service accounted for 8.1 percent or $19,295,000 of CNCPs operating revenue. In 1985, telegram service was estimated to account for 4.2 percent or $15,750,000 of operating revenues.

Programme Transmission

Terrestrial common carrier and satellite facilities are used on a local, regional or national basis for radio, television and cable television transmission. The majority of Telesat's transponder capacity is rented by Canadian broadcasters, including the CBC and CANCOM.

OVERVIEW OF EMPLOYMENT TRENDS

Published statistics on employment in the communications industry are confined to telephone companies, telegraph and cable broadcasters, and the post office. This relatively narrow definition, combined with the presence of new entrants in recent years, makes it a difficult task to collect data on a historical basis. Employment by the telecommunications carrier industry in Canada, including the telephone companies, CNCP Telecommunications, Telesat Canada, Teleglobe Canada, the radio common carriers, the cellular industry, the interconnect industry and contract construction labour was estimated at 110,000 in 1975, 130,000 in 1982, and 123,000 in 1984.[38]

The bulk of employment, as might be expected, is concentrated in the telephone carrier sector of the industry. For example, terrestrial carriers (Telecom Canada) accounted for 75 percent of the estimated number of employees in 1975 and 1982. The most recent figures available from Statistics Canada estimate the number of telco employees at 102,600 in August 1986.[39] This represents 46.4 percent of all communication workers, 1.5 percent of all service producing industry employees, and 1.1 percent of the estimated Canadian labour force.

The next largest single employer is CNCP, which had an estimated 6,027 employees in 1982 and 5,038 employees in 1985. The third largest employer is the interconnect industry whose estimated number of

Table 7
Employment by Major Carriers

Year	Telephone Company	Teleglobe	CNCP	Telesat
1930	26,575	n.a.	n.a.	n.a.
1940	18,696	n.a.	n.a.	n.a.
1950	45,396	321	9,757	n.a.
1960	59,564	398	10,279	n.a.
1970	68,334	722	7,678	n.a.
1975	82,866	1,052	7,162	n.a.
1980	107,960	1,312	6,055	407
1985	101,696	1,177	5,038	573

Sources: Statistics Canada, *Telephone Statistics*; Statistics Canada, *Telegraph and Telex Statistics*; Teleglobe Canada, *Annual Report*; Telesat Canada, *Annual Report*.

employees is 3,600. A significant change which has had an impact on employment is the tendency of major users to manage their own facilities. Combined with the internal integration of voice and data services, large business users employ technical and management experts in the telecommunications field to plan, operate and maintain the wide range of voice and data services offered. It is estimated that total employment by users of telecommunications services across Canada is approximately 5,000.[40]

The major telecommunications service providers have been reducing their employment levels in recent years, as reported in table 7. This decrease has been partially mitigated by growth in employment in the newer sectors of the industry, in particular the interconnect and cellular radio sectors. However, these remain minor employers in the context of the overall industry. The continued growth in the output of telecommunications services combined with the recent decline in employment suggests that productivity growth rates may have accelerated in the industry. More will be said on this point in a later chapter, along with a discussion of the likely impacts of technological change on human capital requirements in the industry.

OVERVIEW OF REGIONAL DISTRIBUTION OF ACTIVITY

As might be expected, the major portion of the industry's activity is centred in Ontario and Quebec, specifically in Bell Canada's operating territories. This can be seen in a number of different statistics. One summary statistic

that illustrates the concentration of economic activity is the total number of exchange lines (table 8). This table shows that in 1984 around 60 percent of total exchange lines in Canada were located in either Quebec or Ontario.

The distribution of working lines parallels the distribution of completed calls. However, a revenue measure of activity would give a slightly less concentrated distribution of activity. Specifically, the revenue settlement used by Telecom Canada accords revenues to carriers whose facilities are used as "throughways" for calls originating and terminating in other provinces. As a result, in 1985, Bell Canada's revenues were 54 percent of the revenues earned by all terrestrial common carriers in Canada. As noted earlier, there are few significant differences in telephone access conditions by province. Nor are there major differences in telephone penetration rates by urban/rural split as illustrated in table 9.

Data on the regional distribution of other aspects of telecommunication services are not readily available. However, it can be inferred that they are less evenly distributed (on a per capita basis) than basic telephone service. For example, cellular radio service was not available (as of December 1986) in Calgary, Halifax, Regina, St. John, Saskatoon, St. Johns, Sudbury, Thunder Bay and Winnipeg. Interconnectors are virtually non-existent in the Atlantic provinces. In the case of cellular radio, the geographic pattern of service reflects the licensing activities of the Department of Communications. In the case of interconnection, the pattern reflects the fact that a number of provinces outside CRTC jurisdiction are very slow to grant interconnection privileges for individual residential and business subscribers.

TRADE IN TELECOMMUNICATIONS

For the first time in history, there is a movement to develop international rules for trade in services. Unlike goods trade, services trade does not come under the guise of the General Agreement on Tariffs and Trade (GATT). The previous round of multilateral trade negotiations (known as the Tokyo Round, 1973-79) established five new codes. Services were explicitly dealt with in only one of these, the Government Procurement Code. Under this code, procurement contracts (including incidental services) in excess of $195,000 must observe national treatment and cannot discriminate between local and foreign suppliers. Furthermore, the code covers services incidental to a product where the value of the service does not exceed the value of the product. Service contracts per se are not covered in the Government Procurement Code nor in the larger set of GATT rules. It was expected that the September 1986 meeting in Uruguay would result in a decision on

Table 8
Working Exchange Lines Connected to Central Offices, 1984

Province	Total Exchange Lines
Newfoundland	174,018
Prince Edward Island	499,885
Nova Scotia	3,275,303
New Brunswick	2,941,018
Quebec	28,180,191
Ontario	40,440,586
Manitoba	4,355,626
Saskatchewan	4,487,689
Alberta	14,143,938
British Columbia	13,768,036
Yukon	58,890
Northwest Territories	107,268
TOTAL	112,432,443

Source: Statistics Canada, *Telephone Statistics*, 1985, table 10.

Table 9
Telephone Penetration Rates by Urban/Rural Splits
Canada and Regions, 1983
(Percentage Households With Telephone Service)

	Canada	B.C.	Prairies	Ontario/ Quebec	Atlantic Provinces
Urban	98.0	97.5	98.1	98.2	96.0
Rural	96.1	95.6	96.9	97.3	92.1

Source: *Federal-Provincial Examination of Telecommunication Pricing and the Universal Availability of Affordable Telephone Service, Working Papers*, Ottawa: Minister of Supply and Services Canada, 1986, p.207.

whether or not to include services in GATT. A consensus could not be reached. Currently, discussions of the service sector and the development of rules for trade continue outside the GATT jurisdiction.

Multilateral and/or bilateral trade negotiations with respect to services will face the same legal obstacles in Canada as negotiations in goods trade. That is,

> the federal government...conscientiously follows a policy of not ratifying treaties in the international trade area that impinge upon provincial jurisdiction without the concurrence of the province. As a result, the ability of Canada to participate in international arrangements which would benefit Canada depends upon obtaining cooperation among the provinces. No formal mechanisms exist for securing this cooperation. Because of the difficulty in getting agreement, Canada has been forced to negotiate for inclusion of "federal state clauses"...these clauses provide that if a contracting state has two or more territorial units which have their own rules in respect of treaty subject matter, it may at the time of signature ratification...declare that the convention shall extend to all its territorial units or only to one or more of them.[41]

In addition, the Canadian Constitution provides the provinces with exclusive jurisdiction over "property and civil" rights. Because of this, many of the regulatory policies which constitute barriers to services trade are not federally controlled. These last two points are particularly important when discussing international trade in telecommunications services.

A comparison of the Canadian and U.S. telecommunications service industry reveals that the value of Canadian exports is less than one percent of the value of U.S. exports. In fact, U.S. export sales of all information-based services was estimated at $30 billion in 1982[42] (excluding intra-company transmission to foreign affiliates), while Canadian export sales were estimated at $237 million in 1983.[43] While these figures give a rough idea of the size of the two markets, they must be interpreted with caution for several reasons. First, it is well known that statistics on the service sector as a whole suffer from accounting and definitional difficulties. Telecommunication statistics are even less reliable as the changing regulatory environment complicates the picture by expanding the industry. Second, it is difficult to dichotomize the activities of the telecommunications industry from those of the data processing/computer industry. Finally, any discussion of trade in telecommunications without considering the equipment market is incomplete given that the demand for equipment is derived from the demand for services.[44]

Table 10 provides recent figures for trade in business and communication services. A word of caution—these figures are based on Statistics Canada's definition of the communication industry which includes telephone, telegraph, telex, data transmission, courier and postal transactions. It is apparent that trade in telecommunication services is a relatively small proportion of total business service trade. The largest proportion of communications trade is conducted with countries other than the U.S. or the E.E.C. Finally, it is interesting to note that while trade in business services has been in a deficit position for 1983 and 1984, communications trade has enjoyed a surplus position.

To complete the trade discussion, figures are provided for trade in telecommunications equipment. In 1982, Canadian exports and imports of telecommunication equipment amounted to $475 million Canadian and $164 million Canadian, respectively. Of these totals, $185 million of exports and $82 million of imports were traded with the U.S. In 1984, the total production of telecommunications equipment in Canada was estimated at $2.3 billion Canadian.[45] The world market in telecommunications equipment and services was estimated to be in excess of $200 billion in 1983 and it is expected to reach $400 billion by 1990.[46] Of the $200 billion, the U.S. accounts for $20 billion, while Canada accounts for approximately $2 billion.

In closing, it is important to note that there are no statistics available that provide Canadian/U.S. comparisons of the proportions of services trade. This is due to the lack of a consistent definition of the telecommunications industry. Until there is international agreement on services definitions and accounting practices, it will remain impossible to accurately portray international trade in services.

Table 10

Trade in Business and Communication Services by Area, 1983-1984

(in millions of dollars)

	Total		U.S.		EEC		Other	
	1983	1984	1983	1984	1983	1984	1983	1984
EXPORTS (X)								
Business Services*	3979	4486	2162	2493	471	544	1346	1450
Communication Services	238	304	91	109	43	68	104	127
IMPORTS (M)								
Business Services	5978	6667	4270	4883	905	888	805	895
Communication Services	194	262	25	43	73	88	96	131
BALANCE (X-M)								
Business Services	-1999	-2181	-2108	-2390	-434	-344	543	555
Communication Services	44	42	66	66	-30	-20	8	-4

Source: Statistics Canada, "Canada's International Trade in Services 1969-1984," Catalogue 67-510, Ottawa, Supply and Services Canada, 1985, tables 6 and 7.

*Business Services include: consulting and professional fees, transportation related services, management and administrative services, research and development royalties/patents/trademarks, films/broadcasting, advertising/promotion services, financial services, insurance, other financial computer services, equipment rental, franchises and similar rights, communications, refining and processing services, tooling and other automotive charges.

NOTES

1. An overview of the problems associated with defining and measuring output in the service industries can be found in Victor Fuchs, ed., *Production and Productivity in the Service Industries*, New York: Columbia University Press, 1967.
2. See Government of Canada, Restrictive Trade Practices Commission, *Telecommunications in Canada, Part I: Interconnection*, Ottawa: Consumer and Corporate Affairs, 1981, p. 21.
3. H. Janisch and M. Irwin, "Information Technology and Public Policy: Regulatory Implications for Canada," *Osgoode Hall Law Journal*, Vol. 20, No. 3, 1982, p. 618.
4. For a detailed description, see Canada, RTPC, Telecommunications in *Canada Part III, The Impact of Vertical Integration on the Equipment Industry*, Ottawa, 1983, p. 21, 35.
5. See p. 50 of the report *Federal-Provincial Examination of Telecommunications Pricing and the Universal Availability of Affordable Telephone Service*, Ottawa, Minister of Supply and Services Canada, October 1986. Hereafter referred to as *Federal-Provincial Report.*
6. The issue of "make versus buy" will be discussed in detail in chapter 3.
7. Common carriers in telecommunications are required by law to carry user calls, messages and other information at a reasonable cost without changing their content.
8. See p. 3 of *Federal-Provincial Report.*
9. H. Janisch and M. Irwin, op. cit., p. 619.
10. This distinction becomes increasingly tenuous when one considers recent technological advances, the subject of chapter 2 (see Interconnect Industry).
11. This report will focus only on the enhanced services provided by Telecom Canada and CNCP, although we realize the provision of enhanced services extends beyond the boundaries of our definition of the telecommunications industry to include computer and office automation companies.
12. See Dalfen Associates Consulting Inc., "A Study of the Convergence of Domestic and International Telecommunication Service," mimeo, Ottawa, March 31, 1983, pp. 4-5.

13. Detailed descriptions of the Telecom Canada carriers are provided in chapter 2.
14. Author's estimate based on Bell Canada, Response to Information Demanded by the Government of Canada, October 24, 1983, Exhibit B-82, p. 237.
15. See Statistics Canada, *Canada Year Book 1985*, Ottawa: Minister of Supply and Services Canada, 1985.
16. See Thomas Brownlee, "Teleglobe Canada: Outside the (CRTC) Regulatory Camp," *Canadian Public Administration*, Vol. 29, No. 3, Fall 1986, p. 430.
17. See Appendix I, Submission to the Ministry of Health, Province of Ontario, from the Telephone Answering Association of Canada and the Canadian Radio Common Carriers Association, December 1982.
18. Interconnection rights vary by province and type of equipment. This issue will be discussed in chapter 2.
19. See p. 259 of the *Federal-Provincial Report*, October 1986.
20. Government of Canada, RTPC, Telecommunications in Canada, Part III, The Impact of Vertical Integration on the Equipment Industry, op. cit., p. 50.
21. For a detailed breakdown of activities by agency, see Federal-Provincial Working Papers, October 1986, table 1.9, pp. 37-51.
22. This apparent oversight is discussed in detail in chapter 2 (see Radio Common Carriers).
23. Standard definitions describe resale as an activity wherein an entrepreneur subscribes to the communication services of a common carrier and then re-offers communication services to the public, with or without adding value for profit. Sharing may be defined as a non-profit arrangement in which two or more users collectively use communications services obtained from an underlying carrier or reseller in order to reduce their individual costs.
24. The distinction between basic and enhanced telephone service is vague. Hence, allowable boundaries for resale and sharing activities remain unclear.
25. See B.C. Telephone, Memorandum of Evidence, April 1984, Appendix 3, pp. 5-6.

26. See Andrew Weiner, "What Telecommunications Means to You," *The Financial Post Magazine*, January 1, 1985, pp. 38-58.
27. See B.C. Telephone, Memorandum of Evidence, April 1984, Appendix 3, p. 1.
28. See chapter 6 for a discussion of bypass.
29. See Toshisada Oka, "Data Network Developments and Policies in Japan," *Policy Implications of Data Network Developments in the OECD Area*, Paris, OECD, 1980, pp. 44-76.
30. This formula was proposed a decade ago (in 1976) by the Federal Communications Commission and subsequently abandoned.
31. Teleglobe Canada's 36th Annual Report, 1985, lists the following 10 services: telephone, telex, telegraph, transit traffic, data transmission, facsimile, private satellite business services, broadcast services, maritime telecommunications and teleconferencing.
32. See Northern Telecom, Annual Report, 1980.
33. A later chapter will evaluate the determinants of local and long-distance calling.
34. See p. v, *Federal-Provincial Report*.
35. This will be discussed in detail in chapter 2 (see Radio Common Carriers).
36. See D.A. Ford and Associates Ltd., *Study of Employment in the Communications Industry*, report submitted to the Communication Division, Ontario Ministry of Transportation and Communications, March 1986, p. 2. It should be noted that in 1985 B.C. Tel received permission to restructure its rates, increasing its rates significantly on Vancouver to Seattle calls while lowering rates on calls from Vancouver to other U.S. cities.
37. See Lawrence Surtees, "Cancom Launches Network to Rival Telesat Canada," *The Globe and Mail*, December 11, 1986, p. B8.
38. See D.A. Ford and Associates Ltd., *Study of Employment in the Communications Industry*, op. cit., p. 2.
39. Recall that Statistics Canada's definition of communication industries is narrower than our definition. It does not account for radio common carriers, the cellular radio industry, the interconnect industry or contract construction labour.

40. See D.A. Ford and Associates Ltd., *Study of Employment in the Communications Industry*, op. cit., p. 2.

41. See R.C.C. Cummings, "Harmonization of Law in Canada: An Overview," in Ronald C.C. Cummings, ed., *Perspectives on the Harmonization of Law in Canada*, Vol. 55, Royal Commission on the Economic Union and Development Prospects for Canada, University of Toronto Press, 1985, p. 18.

42. See Helen Helena Stalson, *U.S. Service Exports and Foreign Barriers: An Agenda for Negotiations*, Washington: National Planning Association, 1986, Appendix B, p. 73. A recent study concluded that from 1970 to 1981 international telephone calls originating in the United States increased by a factor of 11.3 and telex messages 8.89 times. Telegraph messages declined from 10,232,000 to 6,308,000. In the same years, U.S. international trade grew in nominal terms by a factor of 6, the U.S. multinationals abroad by a factor of 3. In real terms, the latter growth factors were 3 and 1.5, respectively. The author concludes, therefore, that international business is using more and more international telecommunications. See Christiano Antonelli, "Multinational Firms, International Trade and International Telecommunications," *Information Economics and Policy*, Vol. I, 1984, pp.333-343.

43. See Peter Cowhey and Jonathan Aronson, "Trade in Communications and Data Processing," in Robert Stern, ed., *Trade and Investment Services: Canada/U.S. Perspectives*, Toronto: Ontario Economic Council, 1985, pp. 266-267.

44. This does not hold where the equipment market is unregulated as innovations in equipment can create a service demand.

45. See Report to Chairman, "Current Issues in U.S. Participation in Multilateral Trading System," September 23, 1985, p. 50.

46. See Cowhey and Aronson, op. cit., p. 267.

CHAPTER 2

INDUSTRIAL ORGANIZATION CHARACTERISTICS OF THE TELECOMMUNICATIONS CARRIERS

TELEPHONE CARRIERS

The major segment of the telecommunications industry is comprised of common carriers. A distinction is conventionally drawn between terrestrial carriers (telcos) and satellite carriers based on differences in the technology employed. Specifically, the former rely upon land-based transmission systems such as microwave relay, coaxial cable and fibre optic cable. The latter transmit messages from earth-based terminals to space-based transponders and back to earth-based stations.

In 1982 there were approximately 120 terrestrial telephone carriers operating in Canada, accounting for 95 percent of total carrier revenue. The major conventional carriers, along with recent data on their sales revenue, profit and number of employees, are listed in table 11. These data show that the structure of the telephone carrier sector is highly concentrated. Bell Canada and B.C. Telephone account for approximately 68 percent of total revenue earned in the sector and almost 64 percent of total employment. These percentages approximate the share of originating telephone messages handled by these two companies. The companies listed in table 11, in turn, account for over 90 percent of the revenue earned and approximately 90 percent of total employment in Canada's telephone industry.

The prominence of Bell Canada in the Canadian telephone industry is understated in table 11 owing to the fact that Bell Canada has significant ownership positions in a number of other major telcos. On December 31, 1984, Bell held 31.4 percent of the outstanding common shares of Maritime Telephone and Telegraph. At the end of 1985, Bell Canada owned 31 percent of Bruncor, which in turn was 100 percent owner of New Brunswick Telephone Company. Bell owned 53 percent of the common shares of Newtel Enterprises Ltd., which in turn owns 100 percent of the common

Table 11

Leading Canadian Terrestrial Carriers

(1) Company	(2) 1985 Revenue (thousands)	(3) 1985 Profit or Net Income (thousands)	(4) 1985 Total Employees	(5) Geographic Area Served
Alberta Government Tel	$ 1,000,500	$ 48,200	11,477	Alberta
Bell Canada	5,829,400	652,100	50,869	Ontario, Quebec, and Eastern N.W.T.
British Columbia Tel	1,444,400	115,900	15,863	British Columbia
CNCP Telecommunications	349,124	16,584	3,906	Ontario, Quebec, B.C. (primarily)
Edmonton Telephones	206,250	814	1,870	Edmonton
Island Telephone Co.	33,325	4,423	296	Prince Edward Island
Manitoba Tel. System	340,417	15,192	4,660	Manitoba
Maritime Tel & Tel	314,741	34,009	3,686	
New Brunswick Telephone	246,263	27,505	2,474	New Brunswick
Newfoundland Telephone	138,414	20,447	1,301	Newfoundland
Northern Telephone Ltd.	28,124	4,151	290	Northeastern Ontario
Northwestel Inc.	44,534	5,985	492	N.W.T.; Yukon; Northeastern B.C.
Quebec Telephone	178,719	21,663	1,972	Region of Quebec
Saskatchewan Tel	440,052	36,984	4,458	Saskatchewan
Telebec Limitee	102,581	11,656	980	Portions of Quebec
Terra Nova Tel	38,000	3,000	391	Portions of Newfoundland
Thunder Bay Tel	23,191	5,788	231	Thunder Bay and surrounding area
	$10,758,035	$1,024,401	104,716	

Source: Ontario Government, Ministry of Transportation and Communications, "Key Characteristics of Major Canadian Telephone and Telecommunications Carriers," Toronto, mimeo, July 1986.

shares of Newfoundland Telephone Company. Bell Canada Enterprises, the holding company for Bell Canada and related investments, directly owns approximately 90 percent of Northern Telephone Limited and wholly owns Telebec Limitee.

If Bell Canada's ownership share of Maritime Telephone and Telegraph, New Brunswick Telephone Company and Newfoundland Telephone Company is applied to the revenue and employment totals for these companies and the prorated shares added to Bell Canada's own revenue and employment totals, Bell Canada directly or indirectly accounted for about 57 percent of the 1985 revenues earned by Canada's leading terrestrial carriers and approximately 51 percent of 1985 employment levels. Hence, it is obvious that the performance characteristics of the terrestrial sector of the telecommunications industry will largely reflect the economic and technological performance of Bell Canada. Bell Canada will also play a major role in shaping public policies affecting the industry. However, as table 12 suggests, the ownership and regulatory environments surrounding the sector are heterogeneous, which implies that smaller telcos may have political influence that is disproportionate to their sizes.[1]

Table 12 identifies whether a company is privately or publicly owned, the largest shareholder, and the regulatory authority with jurisdiction over the company. As can be seen, the structure of the telecommunications terrestrial carrier sector is diverse and complex. It includes companies owned by a federal Crown corporation (Canadian National) and provincial and municipal governments. The largest carrier, Bell Canada, is owned by Bell Canada Enterprises, which is the single most widely held private company in Canada. Public ownership of a number of telephone carriers can be argued to have a specific influence on public policy decisions affecting this sector. Specifically, it might be suggested that public ownership leads to an emphasis on goals related to income redistribution rather than economic efficiency.[2]

The regulatory environment surrounding the industry is also fragmented. The federal regulator, the Canadian Radio-Television and Telecommunications Commission (CRTC), has jurisdiction over the two largest carriers, Bell Canada and British Columbia Telephone, as well as CNCP Telecommunications, Telesat and two small carriers owned by Canadian National. The CRTC is clearly the dominant regulatory force in the Canadian telecommunications industry in terms of the extent of the market over which it exerts regulatory influence. However, unique problems are created by the fact that the majority of carriers (in terms of number) are regulated by other government agencies at the provincial or municipal level.[3]

Table 12

Ownership and Regulation of Terrestrial Carriers

(1) Company	(2) Ownership Public or Private	(3) Major Shareholder	(4) Regulator
Alberta Government Tel	Public	Alberta Government	Alberta Government Utilities Board
Bell Canada	Private	Bell Canada Enterprises	CRTC
British Columbia Telephone	Private	GTE Corporation	CRTC
CNCP Telecommunications	Private/Public	50% by Canadian Pacific 50% by Canadian National	CRTC
'edmonton telephones'	Public	City of Edmonton	City of Edmonton
Island Telephone Company	Private	Maritime Tel & Tel	P.E.I. Utilities Commission
Manitoba Telephone System	Public	Manitoba Government	Manitoba Public Utilities Board
Maritime Tel & Tel	Private	Bell Canada	Nova Scotia Public Utilities Board
New Brunswick Telephone	Private	Bruncor	New Brunswick Public Utilities Board
Newfoundland Telephone	Private	Newtel Enterprises	Newfoundland Public Utilities Board
Northern Telephone Ltd.	Private	Bell Canada Enterprises	Ontario Telephone Service Commission
Northwestel Inc.	Public	Canadian National	CRTC
Quebec Telephone	Private	Anglo-Canadian Telephone	Regie des services publics du Quebec
Saskatchewan Tel	Public	Saskatchewan Government	Saskatchewan Public Utilities Review Commission
Telebec Limitee	Private	Bell Canada Enterprises	Regie des services publics du Quebec
Terra Nova Tel	Public	Canadian National	CRTC
Thunder Bay Tel	Public	Thunder Bay City Council	Ontario Telephone Service Commission

Source: Ontario Government, Ministry of Transportation and Communications, *ibid.*

Finally, we should note that the level of foreign ownership in this segment of the telecommunications industry is relatively low. The major foreign shareholder is the GTE Corporation which, through its Anglo-Canadian subsidiary, owns approximately 50 percent of the outstanding shares of British Columbia Telephone Company and about 51 percent of Quebec Telephone.

To some extent, the balkanization of regulatory authority is mitigated by the association of the major carriers (both terrestrial and satellite) within Telecom Canada. The latter is a voluntary association of carriers which has responsibility for managing trans-national telecommunications facilities, including the compatibility of equipment and data protocols and the sharing of revenues from inter-provincial traffic. Of the carriers listed in tables 11 and 12, the following are Telecom Canada members: Alberta Government Telephones, Bell Canada, British Columbia Telephone, Island Telephone Company, Manitoba Telephone System, Maritime Telephone and Telegraph, New Brunswick Telephone Company, Newfoundland Telephone Company, Saskatchewan Telecommunications, and Telesat Canada. Two notable non-members of Telecom Canada are Teleglobe Canada and CNCP Telecommunications.

The activities of Telecom Canada have largely ensured that the public has access to the same quality of telephone service in all parts of Canada through the Telecom Canada network, while the CRTC has ensured that inter-provincial rates are similar between the fully interconnected federal and provincial telephone companies. However, there are no comparable institutional mechanisms to assure equality of rates and interface specifications within provincial boundaries, nor should the cohesiveness of the Telecom Canada membership be overstated. The association is a voluntary one, and any individual member can veto a proposed change in Telecom Canada policies. In some cases, this has resulted in stalemated negotiations, for example the CRTC decision ordering Bell Canada and B.C. Telephone to renegotiate national accounting procedures with co-members of the then TransCanada Telephone System (the forerunner of Telecom Canada). Several prairie telcos refused to co-operate without the approval of their provincial regulator.[4]

TELEX CARRIERS

Telex was introduced by CNCP in 1956 (overseas service) and in 1957 (domestic service). Bell Canada introduced TWX to compete with CNCPs telex in Ontario and Quebec in 1962. Subsequently, other members of the

Table 13
CNCP Operating Revenues
(in thousands)

	1980		1982		Forecast 1984		1985[1]	
	$ (in thousands)	%	$ (in thousands)	%	$ (in thousands)	%	$ (in thousands)	%
Telex	108,136	45.4	144,160	47.7	157,800	45.5	159,372	42.8
Telepost	1,165	.5	1,458	.4	2,000	.5	2,884	.7
Leased services	88,461	37.2	112,885	37.4	144,703	41.7	166,397	44.7
Public telegram	19,295	8.1	19,442	6.4	16,583	4.8	15,750	4.2
Broadband	6,414	2.6	6,679	2.2	7,012	2.0	7,240	1.9
Info services	1,418	.6	3,187	1.0	5,368	1.5	6,674	1.8
Telenet	9,069	3.8	10,672	3.5	11,582	3.3	12,001	3.2
Miscellaneous	3,918	1.6	3,720	1.2	1,952	.5	1,935	.5
Total	237,876		302,203		347,000		372,253	

Source: CNCP correspondence to author.

[1] W/O rate increase.

then TransCanada Telephone System offered similar services. Teleglobe provides international telex services.

Table 13 provides recent data on CNCPs operating revenue by service. It is clear that telex is the major source of revenue, accounting for 48 percent in 1982, 46 percent in 1984, and 43 percent in 1985. While telex has been losing ground, leased services have been gaining—from 37 percent in 1982 to 45 percent in 1985.

INTERCONNECT INDUSTRY

Canada's interconnect industry was born out of deregulation at the federal level in 1980, specifically, CRTC Interim Decision 80-13 and CRTC Final Decision 82-14. The combined effect of these regulatory decisions was to place control of the public switched telephone network access in the hands of the consumer. In the industry, this is known as level I and III interconnection. It permits private ownership of single line terminals, key telephone systems (KTS) and private branch exchange (PBX) equipment. Intercon-

nection rights vary by province and type of equipment. The most liberal interconnection rights are found in Ontario, Quebec, British Columbia, Alberta and Prince Edward Island.

In the four years since Decision 82-14, the interconnect industry has grown to over 100 firms employing more than 3,300 individuals.[5] Table 14 provides recent data on revenues and market shares of the top interconnect companies in Canada. These data show the extent of concentration in the interconnect industry. The top four interconnectors controlled 56.5 percent of total revenue in 1985, an increase from 50.5 percent in 1984 and 44.3 percent in 1983. The industry leader, Bell Communication Systems Inc. (BCSI), a subsidiary of Bell Canada, accounted for 16.4 percent of revenues in 1985, 13.1 percent in 1984, and 13.4 percent in 1983.

Table 15 illustrates interconnect penetration into two markets previously monopolized by the telephone companies; private branch exchange (PBX) and key telephone systems (KTS). In 1980, interconnectors accounted for 0.18 percent of the total installed PBX systems. By 1983, interconnect penetration had increased to 16.6 percent. With respect to KTS, interconnectors accounted for 2.3 percent of the market in 1981 and 6.1 percent in 1983. Comparing growth rates from 1981-83 for the two markets, we observe a growth rate of 0.5 percent telco versus 388 percent interconnect in PBX, and 15 percent telco versus 219 percent interconnect in KTS.

To further illustrate the successful market penetration of the interconnect companies, table 16 provides churn ratios[6] for telephones in Canada. In 1982, the four provinces in which interconnection was allowed experienced negative churn ratios. While the churn ratio will pick up mobility effects, the absolute values of the ratios indicate telephone-installed bases are being replaced by subscriber-owned equipment from interconnect companies. Revenue figures indicate that the overall growth of the interconnect industry is slowing. The $351 million in revenue in 1985 represented 13 percent growth, compared to 18 percent in 1984, and 39 percent in 1983. Experts attribute a large portion of this slowdown to increased competition from the telephone companies.

Observation of the top four interconnect companies in Canada reveals an even split between foreign and domestic ownership.[7] BCSI and TTS are Canadian owned, while CTG and Rolm are foreign controlled (see table 17 for details). BCSI is the only arm's length telco-backed interconnect with a substantial market share. There are four telephone manufacturer-owned interconnects in Canada—Ericsson Inc., ITT Canada, Rolm Canada and Siemens Electric Ltd. B.C. Telephone and Alberta Government Telephones operate interconnect divisions[8] known as Business Telecommunication

Table 14

Canadian Interconnect Market Revenue/Shares

Company	1983 Revenue (millions $C)	1983 Mkt. Share %	1984 Revenue (millions $C)	1984 Mkt. Share %	1985 Revenue (millions $C)	1985 Mkt. Share %
BCSI	38.1	13.4	40.6	13.1	57.7	16.4
CTG	34.4	12.1	45.2	14.6	50.0	14.2
Rolm	23.0	8.01	27.1	8.7	37.5	10.7
TTS	19.7	6.9	27.0	8.7	31.1	8.8
Aatel	1.9	.7	2.5	.8	3.5	1.0
EIT	5.9	2.1	7.1	2.3	11.0	3.1
Modular	1.6	.6	3.1	1.0	3.1	.8
Santel	6.0	2.1	12.5	4.0	10.0	2.8
Datel	8.6	3.0	9.2	2.9	11.9	3.4
All Others	144.8	50.9	135.1	43.6	135.7	38.6
TOTAL	284.0		309.4		351.5	
Number of Firms	121[1]		122[2]		115[3]	

Source: *The Telecom Market Letter*, Vol. 6, No. 15/16, December 16, 1985, p. 2.

[1] NBI, p. 34.

[2] Market Monitor, March 15, 1985.

[3] Estimate by NBI.

Table 15
Interconnect Share of PBX System Installations

	1980	1981	1982	1983
P.E.I.	0	0	0	.9
Ontario	.34	7.1	14.7	24.5
Quebec	.34	5.9	12.6	21.8
Alberta	0	0	3.6	7.8
B.C.	0	2.5	10.5	18.8
Canada	.18	3.8	9.3	16.6

Source: NBI Exhibits 2-8, 2-9, 2-10, 2-11.

KTS Installed Base by Telco/Interconnect in Canada

	Telco	Interconnect	Total
1980		208	
1981	233,007	5,520	238,597
1982		10,375	
1983	268,771	17,599	286,370

Source: Northern Business Information Ltd., *Canadian Interconnect Market,* 1984, June 1984, Exhibits 2-13, 2-14, 2-15.

Equipment (BTE) and AGT Communications. CTG bills itself as the only independent interconnect, i.e., neither horizontally nor vertically integrated.

RESELLERS

Cross Border Resellers

The reselling industry in Canada has developed as a result of relaxed regulatory decisions by the CRTC, in particular, the 1980 "interconnect" decision that allowed subscriber-owned equipment to be attached to the public telephone network and the 1985 decision that denied B.C. Telephone the right to block "certain calls" to the U.S. It was this 1985 decision that gave formal approval of Cam-Net's alternative long-distance service. Cam-Net of Vancouver is currently the only cross border reseller in Canada. Cam-Net leases lines from B.C. Telephone from Vancouver to their switch

Table 16
Churn Ratios

Province	1980	1981	1982
Newfoundland	4.9	7.8	24.2
P.E.I.	4.5	5.8	5.3
Nova Scotia	4.8	5.4	7.6
New Brunswick	4.6	6.4	8.2
Quebec	6.2	26.1	-9.5
Ontario	7.4	28.4	-14.7
Manitoba	7.3	6.7	10.2
Saskatchewan	5.4	5.7	7.0
Alberta	2.6	2.6	-6.0
British Columbia	5.6	7.2	-44.2
N.W.T.	31.5	6.1	20.7
National Average	5.6	9.3	-24.4

Source: Northern Business Information Ltd., *Canadian Interconnect Market*, June 1984, Exhibit 2-18.

Table 17
Corporate Ownership of Top Four Interconnects

Company	Foreign Ownership	Shareholders
BCSI	No	Bell Canada Enterprises 100%
CTG Telecommunications[1]	Yes	Interconnect Corp. of British West Indies - 14% Dutch Canadian Investment Ltd. - 6.8% Rancor Corporation - 5.6%
Rolm Canada Inc.	Yes	Wholly owned subsidiary of Rolm Corporation of California
TTS	No	Partnership of Canadian Pacific Ltd. and Canadian National

Source: Northern Business Information Ltd., *Canadian Interconnect Market*, 1984, June 1984.

[1] *Financial Times of Canada*, May 13, 1985, proposed sale of CTG to British Telecommunications PLC.

located in Seattle. This enables Cam-Net subscribers to take advantage of lower U.S. long-distance rates as their calls will be completed on U.S. leased lines. Savings are advertised to be between 30 percent and 70 percent of Canadian long-distance rates.

Cam-Net was established as a private company in June 1984. In December 1985, Cam-Net Inc. purchased all existing shares of Cam-Net Communications Inc., merging Cam-Net into a public company. Prior to 1986, there existed two other cross border resellers located in Vancouver, Long-Net and Long Distance Access Corporation. Both companies subsequently have ceased to operate.

This is truly an infant industry with only one operational firm, and as such there is little information available. "In reviewing the financial statements, we would like to point out that these do not reflect the business environment, conditions or revenues of the company."[9] What is known is that Cam-Net has a work-force of 12, is not subject to CRTC regulation and has recently expanded its discount long-distance service to 70 countries.

Satellite Resellers

The Canadian Satellite Communication Inc. (CANCOM) is Telesat's second largest customer. CANCOM leases transponders on Telesat's satellite Anik D1 to provide radio voice services to the underserved regions of Canada. The existence of excess subcarrier capacity in these transponders and the CRTC decision to allow resale and sharing of satellite services has seen CANCOM develop into a satellite reseller. This places CANCOM in competition with Telesat Canada for certain services just as Cam-Net is competing with B.C. Telephone.

CANCOM is the first licenced network broadcaster that has entered the telecommunications business. Being a broadcaster, CANCOM is regulated under the Broadcasting Act in contrast to the common carriers which are regulated under the Railway Act. CANCOM is 49 percent owned by Western International Communications of Vancouver. Allarcom Ltd. of Edmonton and Selkirk Communications Ltd. of Toronto each have a 6 percent ownership share, and Telemedia Inc. of Montreal has a 5 percent share.

CELLULAR RADIO INDUSTRY

Canada's cellular radio system was established as a structured duopoly by the Department of Communications (DOC) in December 1983. Cantel was selected by the DOC to compete against the cellular division of the local

Table 18
Corporate Ownership of Cantel
(Equity Shares)

	1986	1983
Rogers Communications Inc.	37	-
Telemedia Enterprises	12	30
First City Financial	12	30
Rogers Telecommunications Ltd.	12	20
Ameritech (U.S.)	20	-
Cantel service centre owners and Cantel management	7	20

Source: Cantel Information, "Cantel Background," November 1986, p. 3.

telephone company in each market as the only national cellular licensee. Several measures were taken by the DOC to ensure this market structure. First, Cantel's licence was awarded on December 14, 1983, while wireline cellular mobile service was delayed until December 1, 1985. Second, interconnection of Cantel's system to the public switched telephone network through the telephone companies is a prerequisite to the launch of cellular service in each of the 23 census metropolitan areas. Cantel's mandate as the nationally licensed cellular company is to provide cellular telephone service in all 23 centres.

Cantel was founded in April 1983 by Rogers Telecommunications Ltd. of Toronto, First City Financial Corporation of Vancouver, and Telemedia Enterprises Inc. of Montreal. In 1985, Pan Canadian Communications Ltd., a subsidiary of Ameritech Mobile Communications of Chicago (the company that first introduced cellular service in the U.S. in 1980), purchased an interest in Cantel. In 1986, Rogers Communications Inc. of Toronto acquired the controlling interest in Cantel. Table 18 details the corporate ownership of Cantel in 1983 and 1986.

Cantel's financial statements are not made public so little is known about their relative market share. As of November 1986, Cantel claims to have 25,000 subscribers, 22,000 of these in Quebec and Ontario. "This figure gives the company the largest subscriber base of any cellular service company in Canada as well as the majority share of the national cellular market."[10] Only the operators of the cellular networks, Cantel and the cellular divisions of the telephone companies, can sell cellular subscriptions.

The cellular industry is regulated by both the federal government Department of Communications and the CRTC. The CRTC oversees the rates that the cellular operators must pay the telephone companies for the costs of services and facilities required for interconnection to the public switched telephone standards and certification procedures as well as ensuring fair competition between Cantel and the wireline cellular operators. To achieve this, the DOC allocated one half of the 800 megahertz spectrum to Cantel and gave Cantel the right to expand its cellular network to all provinces in Canada.

RADIO COMMON CARRIERS

Radio common carriers (RCC) provide "conventional"[11] wireless mobile communications using radio frequencies. Very little information is available on the industrial organization characteristics of this industry except to say that there are relatively few large-scale operations. Most are medium-sized, community-oriented enterprises that serve a relatively restricted geographical area. This need not concern us in view of the fact that cellular systems are capable of carrying larger numbers of users on available channels; the sound quality is superior and there is no difficulty in obtaining a clear frequency to use the system. Furthermore, it is expected that the source of growth in mobile communications will be the cellular radio systems at the expense of the RCC.

The Department of Communications is responsible for licensing radio common carriers and ensures that anyone licensed intends to provide service to the public. As such, private systems and provincial government agencies cannot provide commercial communication services. On the other hand, telephone companies have traditionally held licences for their mobile services.[12]

SATELLITE CARRIERS

In Canada, both domestic and international satellite communications are monopolized. Telesat Canada is the domestic satellite communications operator, and Teleglobe provides international telecommunications to Canada. Table 19 provides recent data on operating revenues, profits and number of employees. Telesat's profitability is dependent on the Telecom Settlement as established in the 1976 Connecting Agreement (more will be said on this later). Teleglobe has been described as "the government's most profitable Crown Corporation." In 1985, Teleglobe's net income was recorded at $54 million, up 15.4 percent over 1984. In 1986, Teleglobe was privatized through its sale to the publicly owned company Memotec.

Table 19
Canadian Satellite Carriers
(in thousands)

		Revenues (operating)	Profit or Net Income	Telecom Settlement	Employees
Telesat					
	1985	101,233	10,742	19,397	573
	1984	109,170	16,898	18,820	520
	1983				513
	1982				482
	1981				430
Teleglobe					
	1985	240,456	53,229		1,177
	1984	201,431	41,176		1,356
	1983	173,815	54,603		1,391
	1982	170,162	47,073		1,361

Source: Telesat Canada and Teleglobe Canada annual reports, various years.

Telesat's work-force has been steadily increasing to reflect its expanded role as a service retailer.

To provide a complete picture of Telesat's operating environment, it is necessary to outline the establishment of Telesat Canada. Policymakers have a distinct perspective of satellite technology as a specialized medium that should fit into the existing terrestrial systems. It was not seen as a competitive alternative, nor as a potentially broad-based source of telecommunications services. As a result, when Telesat Canada introduced the world's first domestic satellite service on January 1, 1973, Telesat was restricted to two classes of customers: television broadcasters and Trans-Canada Telephone System (TCTS) carriers (now Telecom Canada). The 1976 Connecting Agreement between Telesat and Canadian common carriers made Telesat the tenth member of TCTS but restricted Telesat's business to that of wholesaler in return for the telephone companies guaranteeing Telesat a minimum rate of return on common equity.[13] Telesat was permitted to sell satellite capacity for broadcast, voice, data and images only to TCTS members, who in turn sold the services to the end user. This arrangement restricted Telesat's role to that of a "carrier's carrier."

The Telesat Canada Act of 1969 defined the satellite communications system to include earth stations as well as satellites. Telesat was granted a monopoly in the ownership of both uplink (provider) and downlink (receiver) earth stations. As a result of recent federal government and regulatory decisions, Telesat's operating environment has become increasingly competitive. In particular, changes in earth station ownership restrictions liberalized earth station licensing policy, resulting in Telesat Canada losing its monopoly position in the ownership of uplink and downlink earth stations.

In 1981, Telesat was permitted to market directly to one class of end user, broadcasters. In May 1986, the CRTC approved amendments to the Connecting Agreement allowing Telesat to develop and market voice, data, and image telecommunication services independent of the terrestrial carriers. Furthermore, Telesat's customer base is no longer restricted to broadcasters and Telecom common carriers. After December 31, 1987, transfer payments to Telesat from the other Telecom Canada members will cease. These amendments, coupled with CRTC Decision 85-19 (Inter-exchange Competition and Related Issues), will allow Telesat Canada to offer interconnected private line services throughout Canada.

In summary, Telesat Canada has evolved from a "carrier's carrier" that faced restrictions on its customer base, provision of services, and markets served to an independent competitive player in the telecommunications in-

Table 20

Ownership and Regulation of Canadian Satellite Carriers

Company	Ownership	Shareholder	Regulator
Telesat	Semi-public	Canadian Development Investment Corp.- 50% Bell Canada - 25% Telecom members - 16% CNCP - 9%	CRTC
Teleglobe	Public	(formerly) Crown corporation	International Agencies - Int'l Telec. Union - Pacific Telec. Council - North Atlantic Consultative Process - Inter-American Telec. Conference

Source: Annual reports.

dustry. It remains to be seen what market share Telesat will be able to secure in its new environment. Two recent developments indicate Telesat is aggressive in exploiting its new role. In March 1986, Telesat began marketing a new low-cost, two-way earth station terminal called VSAT (Very Small Aperture Terminal) aimed at businesses considering a private communications network.[14] In September 1986, Telesat signed a $1.2 million agreement with Gandalf Technology Inc. to transmit voice/data via satellite across the Canada-U.S. border.[15]

Teleglobe, established as a Crown corporation in 1950,[16] provides Canadians with a full range of international telecommunications services. On August 1, 1985, the federal government announced its intention to privatize Teleglobe. As noted, it was subsequently purchased by Memotec.[17]

International carriers cannot act unilaterally and, as such, Teleglobe is a signatory to Intelesat[18] and Inmarsat[19] Operating Agreements as a major user and part owner. Various regulatory and consultative bodies oversee the operation of international telecommunications. The primary agency is the International Telecommunications Union (ITU) whose regulations govern telecommunications in almost every country (for a complete listing of agencies, see table 20). The Minister of Communications exercises Canada's right of vote in the ITU. Currently, the 1988 World Administration Telegraph and Telephone Conference (WATTC)[20] is in the process of developing a new international regulatory framework. Proposals include

the regulation of private international networks set up by businesses.[21] Teleglobe Canada provides the links (to Intelesat satellites or submarine cables) that allow Canadian businesses to establish international communications systems.

Teleglobe is in a unique regulatory position given that it has never been subject to regulation by the CRTC or its predecessor (CTC). Teleglobe's "domestically unregulated" position is a result of the Interpretation Act, which precludes the application of statutes either to the Crown or its agents unless they are specifically named in the statutes. Since Teleglobe is not named in either the Transportation Act or the Railway Act (the sources of CRTC regulatory power), neither act applies. However, it is felt that Teleglobe as a private company would be subject to CRTC regulation.[22]

NOTES

1. This suggestion is elaborated on in other parts of the study.
2. This point is discussed further in chapter 6 when issues facing the industry are addressed.
3. The reader is referred to chapter 6 for a more detailed discussion.
4. See CNCP, Telecommunications: Monopoly in Demise, prepared for the Telecommunications Policy Review, Department of Communications, May 1984, pp. 36-37.
5. In 1983 there were 121 firms and 3,318 employees. See Northern Business Information, "Canadian Interconnect Market," mimeo, June 1984, p. 34.
6. "Churn is the amount of new equipment which must be delivered to increase the installed base by a single unit after accounting for disconnections....The higher the churn, the faster the rate at which the installed base is being replaced." Northern Business Information, p. 32.
7. This section on ownership and integration draws exclusively on Northern Business Information, pp. 39-43.
8. The CRTC decision on structural separation, March 20, 1986, invoked a costing approach for Bell Canada and B.C. Telephone (to prevent cross subsidization of their multiline and data terminal equipment operations by the monopoly telephone services) rather than requiring these companies to spin off their interconnect companies. See CRTC Annual Report, 1985, p. 33.
9. Cam-Net Annual Report, 1985, p. 3.
10. See Cantel Inc., "Corporate Background," *Cantel Information*, November 1986, p. 6.
11. In contrast to the new cellular radio service currently being introduced in Canada.
12. See submission by the Radio Common Carriers Association in response to Notice No. DGTN-001-84 in *The Canadian Gazette*, May 1984.
13. TCTS guaranteed Telesat a rate of return on Telesat's entire capital base equal to a weighted average of Bell Canada and B.C. Telephones returns.
14. See the B.C. Telephone newsletter, *Competitive Edge*, March 1986.

15. See Cable Communications, September 1986, p. 10.
16. Prior to 1974, Teleglobe was the Canadian Overseas Telecommunications Corporation.
17. Included in the guidelines and assumptions governing the bidding was a restriction on foreign ownership of 20 percent.
18. International Telecommunications Satellite Organization of 110 countries.
19. International Maritime Satellite Organization with 45 member states.
20. WATTC is an ITU body whose rules and regulations are bound as an international treaty to ITU signatories.
21. Canada's position on this proposal is discussed by Lawrence Surtees, "Telecommunications Changes Opposed," *The Globe and Mail*, December 12, 1986, p. B6.
22. For a good discussion of Teleglobe's unique position in the Canadian regulatory framework, see Brownlee Thomas, op. cit.

CHAPTER 3

OUTPUT, INPUT AND PRODUCTIVITY GROWTH OF THE INDUSTRY

MEASURING THE OUTPUT CONTRIBUTION OF THE INDUSTRY

As noted in chapter 1, the telecommunications industry provides a large number of products and services with diverse characteristics. Ideally, to construct output measures one requires the prices and physical volumes of each product. Kiss (1983) points out the difficulty of such a task with reference to Bell Canada, "...working with 30 to 40 thousand prices and volumes."[1] This serves to illustrate the enormity of the task involved in extending the analysis from the firm level to the industry level. In addition to the sheer size of the task, it must be noted that data are lacking for the newer entrants into the industry, the interconnect companies, cellular radio systems and privately-owned systems. Given these data limitations and the fact that available output indexes for the industry as a whole do not account for changes in the price of output or the mix of services, it is not possible to report a time series of real output for the telecommunications industry let alone the terrestrial carriers. Finally, recent technological advances, such as digitization, make it virtually impossible to distinguish between voice, data and video traffic.

The best available output measures are constant dollar revenues of the various service offerings of the terrestrial carriers. However, there are problems associated with using prices as weights. First, output aggregates will be distorted if cross subsidization occurs either within a service category or between broad service categories. In this regard, data limitations prevent the identification of cross subsidies within service categories. Second, given flat monthly rates for local service, constant dollar revenues will not account for changes in usage.

To obtain total volume output of a firm, the volumes of all products or services being produced are aggregated by applying a chosen index num-

ber. Similarly, output prices of the firm's service offerings are aggregated using an index consistent with the output volume index.

As pointed out by Kiss (1983), ideally one would like both Tornquist volume and price indices. However, for the Bell productivity study, only Paasche price indices and Laspeyres volume indices were available. It has been shown by Diewert (1976) that a Tornquist index is "superlative or exact" while Laspeyres and Paasche indices are not. The advantage of exact indices is important for measuring productivity and is discussed further in the appendix to this chapter. Output measurement is expected to improve as the telecommunications industry moves toward marginal cost pricing, hence, eliminating the upward bias in output volume indexes. In addition, the construction of hedonic cost functions for telecommunications will allow researchers to account for quality changes in services.

Turning now to the empirical results of output growth, we refer to three studies: Kiss and Lefebvre (1984), Kiss (1983), and Denny, Fuss and Waverman (1981). The Kiss and Lefebvre study constructed real output indexes for Alberta Government Telephones and Bell Canada. The Kiss and Denny, Fuss and Waverman studies focused only on Bell Canada. The Kiss and Lefebvre (1984) and the Kiss (1983) studies measure output using revenue series deflated by an index of output prices. Denny, Fuss and Waverman (1981) use both constant dollar revenues and the number of calls. In all three studies, the individual output series are, in turn, aggregated using shares of total revenue.

The Kiss and Lefebvre study estimates that over the period 1969-81, total real output in Alberta Government Telephones (AGT) grew at an annual rate of 14.2 percent, while over the same period total real output in Bell Canada grew at an 8.2 percent annual rate.[2] These output series were composed of three components: local services, long-distance services, and other. In this regard, the share of total revenue for local services was 33 percent in AGT and 57 percent in Bell Canada in 1968. By 1981, AGTs local revenue share dropped to 30 percent and Bell's to 48 percent. Correspondingly, the long-distance revenue share in AGT increased from 62 percent in 1968 to 66 percent in 1981; while in Bell, the long-distance revenue share went up from 37 percent in 1968 to 42 percent in 1981.[3] The revenue share of other services was 5 percent in 1968 and 4 percent in 1981 in both firms.

The Kiss (1983) study estimates that over the period 1952-80 the average annual growth rate of real output for Bell Canada was 8.74 percent.[4] These output series included local services, monopoly toll services and other services. Dividing the sample period into three sub-periods, 1952-59, 1960-75, and 1976-80 revealed very high growth rates for local

service from 1952-59 and very low growth rates from 1976-80. Monopoly toll service showed no trend, but rather "drastic" year-to-year fluctuations in growth rates. However, Kiss does report slow output growth between 1957-61 and fast output growth between 1972-75. Finally he notes that local volumes grew more slowly than toll, and message toll has grown more slowly than other.

Denny, Fuss and Waverman report output growth for Bell Canada over the period 1952-76.[5] The output of Bell Canada is divided into six categories: constant dollar local-service revenue (Local), toll message revenue within Bell Canada (Bell Toll), toll message revenue within Canada and outside Bell Canada territory (Trans Toll), toll message revenue on calls to the U.S. and overseas (U.S. Toll), other nonmessage toll including WATS and private line service (Other Toll), and miscellaneous (Misc.). Table 21 reproduces the study's findings with respect to growth of real outputs. Summarizing these results, over the period 1971-76 the largest output growth occurred in Trans Toll (15.6 percent) and the smallest growth in local service (7.31 percent). Among the message toll outputs, growth rates varied according to region: 8.58 percent for Bell toll, 14.03 percent for U.S. Toll, and 15.6 percent for Trans Toll. Output growth for WATS, private line, and specialized data transmission was 12.78 percent over the same period (1971-76).

As mentioned earlier, Denny, Fuss and Waverman also use alternative output measures for local service output and toll message output. For both types of output, the number of calls replace constant dollar measures. The results indicate that these alternative measures understate output growth for both local and toll message services. In 1976, the constant dollar local service indicator is 51 percent larger than the number of local calls indicator, and the constant dollar toll revenue indicator is 64 percent larger than the number of toll calls indicator. Thus, choice of an output indicator can substantially influence the measured rate of total factor productivity growth.

From these three studies we note that local and long distance constitute the overwhelming portion of output for terrestrial carriers as measured by deflated revenue. In the case of Bell Canada, despite the rapid growth of long-distance service, aggregate output growth is only marginally above the slower growth rate for local service outputs. As we shall discuss in chapter 6, the current regulatory structure discourages the use of long-distance services and encourages local service use. However, two recent developments may also affect consumers' and businesses' choice between local and long-distance calls. First, in federal Finance Minister Michael Wilson's tax reform, the federal sales tax was extended to telecommunication services effective January 1, 1988. "The sales tax will be extended to telecom-

Table 21

Average Annual Percentage Rates of Growth of Real Outputs,

Bell Canada, 1952-1976

	Local	Bell Toll	Trans Toll	U.S. Toll	Other Toll	Misc
1952-57	9.23	8.23	22.60	14.98	30.47	7.85
1958-62	7.34	7.68	12.43	6.58	16.72	7.62
1963-66	6.83	7.85	12.06	16.54	19.96	1.42
1967-70	7.03	9.29	12.25	11.78	14.97	6.82
1971-76	7.31	8.58	15.60	14.03	12.78	-7.22

Source: M. Denny, M. Fuss and L. Waverman, "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries, with an Application to Canadian Telecommunications," in T. Cowing and R. Stevenson (eds.), *Productivity Measurement in Regulated Industries* (NY: Academic Press, Inc.), 1981, table 2, p.184.

munication services, such as telephone and telex services, at a rate of 10 percent. Service charges for local residential telephone lines will be exempt from this tax."[6]

Second, in the spring of 1987 the CRTC approved reductions of 18 to 29 percent in the rates for full price long-distance intra-Bell calls. Bell's application for reduced "Trans Canada" long haul and short haul rates between 7 and 12 percent is still pending at present. B.C. Tel has also been awarded similar long-distance rate reductions.

Available studies of real output in the sector exclude output of private systems, cellular radio systems and the interconnect industry. Indeed, with respect to the output of privately owned systems, it is even unclear who owns the systems and what output is being carried on them. Consequently, there are no figures regarding either the volume or the value of traffic under private systems. As part of a recent federal/provincial examination of the industry undertaken in 1986, the terrestrial carriers identified other telecommunications systems that were currently being used to bypass the common carriers facilities. The companies operating their own systems are identified in table 22. In some cases, the systems identified are operated by other common carriers (outside of Telecom Canada) such as CNCP and B.C. Rail. However, in many cases, they are microwave facilities operated by hydro companies or railway lines. As a practical matter, it is impossible to identify the nature of the traffic being carried on these private systems. And as a technical matter, digitization of telecommunications systems is making distinctions between voice and data traffic increasingly irrelevant.

Cellular radio systems introduced in Canada earlier this decade offer a second alternative to the public switched network. As any new technology, it is currently expensive and only available in selected regions. As the cost falls and availability and applications increase, there is a belief among industry experts that cellular systems could effectively compete with the local networks of the common carriers. In view of this possibility, it is clear we require a more detailed accounting of this sector's contribution to output. At present, the only public information available is the number of subscribers, as they must be licensed through the Department of Communications.

Until 1979, interconnection with the public switched network was prohibited. Since then, interconnection of subscriber-owned equipment and other systems (most notably CNCP and B.C. Rail) to the public network has been permitted in varying degrees across Canada. This sector also suffers from a paucity of publicly available data. Moreover, the service aspects of this sector are embodied in the provision of equipment, making identification of the service contribution at best a "guesstimate."

Table 22

Bypass Within Canada

Operating Territory	Companies
AGT	Two unidentified local microwave systems.
Bell Canada	1. Private microwave data/voice. Ontario Hydro, Hydro Quebec, Alcan McMaster - Chedkoke Hospital, McMaster University. 2. Point to point UHF & VHF radio dispatch systems. Consumer Gas, Time Communications, Ont. Dept. of Transportation and Communication, Ontario and Quebec Provincial Police. 3. Various systems. Videotron and Ciba-Geigy (private data), Toronto-Wellesley Hospital and Sudbury Hydro (cables connecting buildings), "private stockbroker channel" in Toronto, Rogers Cable (traffic light control), Imperial Oil (private satellite network).
B.C. Telephone	B.C. Hydro, B.C. Rail (private microwave systems), Can-Net, Cantel (potential bypass).
Manitoba	CNCP & Telesat (in selected locations). Private microwave systems (unidentified).
Maritime Telegraph & Telephone	N.S. Power Corp., N.S. Dept. of Lands & Forests, CNR, & Telephone CNCP.
N.B. Tel	Several private microwave systems (unidentified).
Newfoundland Telephone	None.
NorthwesTel	B.C. Tel & S.E.D. (satellite earth station utilization), B.C. Rail.
Quebec Telephone	CNCP, Hydro Quebec, Customer owned earth stations.
Saskatchewan Telephone	CNCP, Private microwave & satellite systems.
Telebec Ltd.	Hydro Quebec, CNCP.
Terra Nova Telecommunications	RCMP, Newfoundland & Labrador Hydro, Newfoundland Light & Power, Provincial Dept. of Forestry (all have private microwave systems).

Source: Federal-Provincial Working Papers, pp. 264-267.

INPUT GROWTH IN TELECOMMUNICATIONS

This section will focus on productivity of the inputs used in the telecommunications industry. Our analysis is restricted to the terrestrial and satellite carriers due to the paucity of published data for the newer industries in the telecommunications sector.

Table 23 reports the labour share of total cost for telephone companies based on Statistics Canada data. Table 24 reports labour, material, and capital shares for Canada's three largest carriers, Bell Canada, B.C. Telephone and Alberta Government Telephones, based on a study conducted by Olley and Le for the Department of Communications.[7] A comparison of the two data sets reveals that, over time, labours' share of total cost is increasing for the three largest carriers (0.30 in 1972 versus 0.35 in 1981) and decreasing for all telephone companies (0.41 in 1972 versus 0.38 in 1981). In addition, there is a convergence of the labour shares for the two samples over the period 1972-81.

The Olley and Le study for the DOC provides a more detailed analysis of factor productivity, although their sample is restricted to three carriers. Based on their results in table 25, it is observed that real output increased 137 percent, while the inputs—labour, material and capital—increased 48 percent, 67 percent, and 62 percent, respectively. These estimates suggest a significant increase in labour productivity, i.e., output per unit of labour input, over the period 1972 to 1981. As well, we note that labour is being used relatively less, implying a substitution of material and capital for labour in the production process. This substitution is partially reflected in the price indexes of the inputs. Over the period estimated, the price indexes for labour, capital and materials rose 120 percent, 89 percent, and 86 percent respectively, while the output price index rose by an estimated 47 percent.[8] Finally, we note that the increase in total real inputs of 59 percent compared to the 137 percent increase in real output is evidence of a substantial increase in total factor productivity over the period 1972-81.

Real output and input volume indexes were also calculated for the major non-terrestrial carriers, Telesat and Teleglobe. We merely report here that the index of real output increased 187 percent, while the input volume increased 27 percent over the period 1972-81. Hence, the non-terrestrial carriers enjoyed a dramatic increase in total factor productivity over the period.

A study by Denny, Fuss and Waverman (1981)[9] provides a more detailed examination of input and output growth for Bell Canada during the period 1952-76. The historical nature of the study illustrates the effect of labour saving technological advances, in particular, direct distance dialing

Table 23
Labours' Share of Total Cost for Telephone Companies
1972-1985

Year	Labours' Share of Total Cost
1972	.41
1973	.48
1974	.41
1975	.41
1976	.41
1977	.40
1978	.39
1979	.39
1980	.38
1981	.38
1982	.38
1983	.37
1984	.36
1985	.35

Source: Statistics Canada, *Telephone Statistics*, various issues.

Table 24
Input Shares of Total Costs for Canada's Three*
Largest Terrestrial Carriers

Year	Labour	Material	Capital
1972	.30	.15	.55
1973	.30	.15	.55
1974	.32	.15	.53
1975	.32	.15	.53
1976	.33	.15	.52
1977	.33	.16	.51
1978	.32	.16	.52
1979	.33	.16	.51
1980	.34	.17	.49
1981	.35	.17	.48

Source: R.E. Olley & C.D. Le, "Total Factor Productivity of Canadian Telecommunications Carriers," Project Report to the Department of Communications and to members of the Canadian Telecommunications Carriers Association, mimeo, January 1984, p.67.

*Bell Canada, B.C. Tel, Alberta Government Telephones.

Table 25

Output and Input Volume Indexes

(1980 = 100)

Year	Total Output	Inputs			
		Labour	Material	Capital	Total
1972	46.14	71.40	62.71	64.62	66.37
1973	51.32	75.55	66.40	68.09	70.08
1974	57.90	79.43	69.79	71.89	73.85
1975	64.73	79.27	69.80	76.99	76.54
1976	70.05	81.09	76.11	82.60	81.05
1977	75.35	85.21	84.28	88.20	86.58
1978	82.89	92.07	91.48	92.19	92.04
1979	90.21	96.04	94.45	95.72	95.62
1980	100.00	100.00	100.00	100.00	100.00
1981	109.44	105.90	104.94	104.99	105.29

Source: R.E. Olley & C.D. Le, *op. cit.,* p.68.

Table 26

Average Annual Percentage Growth Rates of Real Inputs: Labour, Capital and Materials

	Labour	Capital	Materials
1952-1957	5.05	11.74	9.71
1958-1962	-2.00	10.02	6.04
1963-1966	2.37	6.69	4.50
1967-1970	.13	5.71	4.72
1971-1976	2.53	4.40	4.33

Source: M. Denny, M. Fuss and L. Waverman, "Total Factor Productivity in Canadian Telecommunications," in T. Cowing and R. Stevenson (eds.), *Productivity Measurement in Regulated Industries*, (NY: Academic Press, Inc.), 1981, p.185.

and the introduction of electronic switching equipment. Table 26 reports annual growth rates of three inputs—labour, capital and materials—for five time periods 1952-57, 1958-62, 1963-66, 1976-70 and 1971-76.

Focusing on labour input growth, the study reveals rapid growth from 1952-57, modest growth during 1963-66 and 1971-76, essentially zero growth from 1967-70 and negative growth from 1958-62. The negative labour growth is attributable to the introduction of direct distance dialing. As reported by the authors, there is no adequate explanation for the zero growth from 1967-70. They argue that stagnation is in part due to the continued diffusion of labour saving technologies, changes in relative input prices and properties of the production function during this period.

The authors find substantial productivity growth in Bell Canada over the period 1952-76. Specifically, aggregate real inputs grew at an average annual rate of 8.5 percent from 1952-57, then declined to an average rate of less than 5 percent from 1958-76. Aggregate real output showed no associated decline in growth indicating "impressive productivity growth" for Bell Canada.

The productivity performance of the terrestrial and non-terrestrial carriers is atypical of the broad economy. By way of illustration, the average annual productivity gain for the five participating companies, which represent over 80 percent of the telecommunications industry, was 4.4 percent during the period 1972 to 1981. During the same period, the productivity of the Canadian economy as a whole declined by an average of 0.5 percent per year.

TOTAL FACTOR PRODUCTIVITY MEASUREMENT—EMPIRICAL RESULTS IN THE TELECOMMUNICATIONS INDUSTRY

The productivity performance of the telecommunications industry reflects a number of factors, including the exploitation of extant economies of scale and scope as well as technological change. The conventional view of the service industries is that they are subject to inexorable increasing cost pressures, both because of the absence of scale economies and a lack of technological change. This stereotype is inappropriate when applied to the telecommunications industry.

In recent years, there has been a veritable explosion of studies examining production conditions in the telecommunications industry. These studies use econometric cost functions as the means of estimating scale economies. In the appendix to this chapter, there is a discussion of the rationale for using cost functions. Table 27 summarizes the estimates of aggregate scale

Table 27

Bell Canada Studies: Estimates of Aggregate Scale Economies

			Scale Economy Coefficient
Single Aggregate Output			
1.	Smith and Corbo (1979)	translog cost function 1952-1976	1.22
2.	Denny, Fuss and Everson (1979)	translog cost function 1952-1976	1.58
3.	Denny - Fuss (1980)	two-stage translog cost function 1952-1972	1.46
4.	Kiss, Karabadjian & Lefebvre (1981, 1983)	generalized translog cost function 1952-1978	1.75
5.	Kiss and Lefebvre (1984)	translog cost function 1956-1981	1.73
Disaggregated Outputs			
1.	Smith and Corbo (1979)	2 outputs translog cost function 1952-1976	1.20
2.	Breslaw and Smith (1980)	2 outputs translog cost function 1952-1978	1.29
3.	Kiss, Karabadjian & Lefebvre (1981, 1983)	2 outputs generalized translog cost function 1952-1978	1.62
4.	Fuss and Waverman (1977)	3 outputs translog cost function 1952-1975	1.02
5.	Denny, Fuss & Everson (1979)	3 outputs translog cost function 1952-1976	1.46
6.	Breslaw and Smith (1981)	3 outputs translog cost function 1959-197	1.60
7.	Fuss and Waverman (1980)	3 outputs hybrid translog cost function 1952-1977	.94
8.	Kiss, Karabadjian & Lefebvre (1981)	3 outputs generalized translog cost function 1952-1978	1.43
9.	Fuss and Waverman (1980)	3 outputs translog cost function 1952-1977	1.43

*The scale elasticity reported here is for the single firm model.

Sources: M.A. Fuss, "Recent Results in the Analysis of Production Conditions," in Courville, de Fontenay and Dobell (eds.) *Economic Analysis of Telecommunications*, (Amsterdam:North Holland), 1983, tables 1 and 4.
F. Kiss, et. al., "Economies of Scale and Scope in Bell Canada," in Courville, de Fontenay and Dobell (eds.), *Economic Analysis of Telecommunications*, (Amsterdam:North Holland), 1983, table 7.
Kiss and Lefebvre, "Econometric Models of Telecommunications Firms," *Revue Economique*, Vol. 38, No. 2, March 1987, table 6, pp.356-357.

economies based on Bell Canada studies. Table 27 distinguishes between single aggregate output estimates and disaggregated output estimates of scale economies.

The data in table 27 indicate that the estimates of aggregate economies of scale based on a single aggregate output average around 1.6 and based on disaggregated outputs average around 1.4. Disaggregated output models are the preferred approach given that one cannot justify the use of a single output volume index and that the cost tests for a multiproduct natural monopoly are tests of cost subadditivity. Subadditivity is said to exist when the following expression is negative:

$$SUB = \frac{C(\text{Bell Canada}) - C(\text{Firm A}) - C(\text{Firm B})}{C(\text{Bell Canada})} < 0$$

i.e., when the cost of a single supplier such as Bell Canada is lower than the total cost of two or more independent suppliers, given that all suppliers use the same technology to produce the same output.

Based on the disaggregated output studies, one would be tempted to conclude substantial economies of scale exist in telecommunications production. However, a study by Fuss and Waverman (see table 27) using a hybrid translog cost function could not reject the hypothesis of constant returns to scale. Two conclusions are drawn by Fuss based on the substantially different results of the Fuss and Waverman study. First, "we still do not know the extent of aggregate scale economies in telecommunications despite the enormous amount of research effort devoted to that topic" and second, there is "the danger of accepting for policy purposes...the evidence generated by the ordinary translog cost function estimates—that telecommunications production is subject to substantial increasing returns to scale in the aggregate."[10]

Estimates of product specific economies of scale can aid policymakers in deciding whether competition in the provision of particular services is desirable. Product specific economies of scale imply that the unit cost of producing a specific product or service declines with increased production holding all other outputs fixed. The only known econometric evidence is a study by Fuss and Waverman (1980).[11] They found that Bell Canada's production of private line services was subject to increasing returns to scale, which would be exhausted should Bell become a monopoly supplier of this service. Based on their findings, they conclude that competition should be encouraged in the provision of private line services.

Economies of scope in the production of two outputs, X_1 and X_2, would exist if the production of the two outputs by an individual firm resulted in

lower costs than the separate production of X_1 and X_2 by individual firms, i.e., if $C(X_1,X_2) < C_1(X_1, 0) + C_2(0, X_2)$. Economies of scope in telecommunications may arise due to the sharing of common capital, labour or maintenance costs.

Statistical evidence on the magnitude of economies of scope in Bell Canada suffers from the inability to test for global economies of scope. The necessary and sufficient conditions for a global test of economies of scope requires the computation of stand alone costs using product specific cost data.[12] This demanding data requirement makes a global test of economies of scope difficult. Two studies that tested for global economies of scope provide contradictory evidence. Fuss and Waverman[13] found no evidence of global economies of scope, while Kiss, Karabadjian and Lefebvre[14] report positive economies of scope.

Local economies of scope can be tested for by calculating the value of the second order derivative of the cost function.[15] These local cost complementarities can explain changes in marginal costs and may contribute to economies of scope when marginal costs of outputs X_1 and X_2 fall when the output of X_3 is increased. In this case, joint production would realize cost savings above the independent production of the three outputs. The empirical evidence on local cost complementarities once again is contradictory. Fuss and Waverman, in contrast to the other "disaggregated output" studies, found no cost complementarities between local and the two categories of toll services. Those studies that found cost complementarity between local and the two categories of toll output did not always find statistically significant results.[16]

In contrast to the econometric studies, the anecdotal evidence in the literature suggests that there are significant cost complementarities between inter-exchange transmission and local exchange services.[17] These complementarities are suggested to derive primarily from the common technology shared by innovations designed for the local network and those designed for message-toll services. In particular, digital technology is increasingly common to transmission media, such as fibre optic lines and local switching machines. Hence, there are complementarities in co-ordinating capital investment and research and development in transmission and local switching.

On the other hand, there is no such strong "conventional wisdom" regarding cost complementarities between competitive and monopoly (message-toll) long-distance services or between basic and enhanced services. Nevertheless, cost complementarities between basic and enhanced services are suggested to be increasing in importance with the spread of microprocessing technology. In particular, a switch can not only direct

electronic signals but can also process the information carried by the signals. At the same time, terminals that were used for communication can now also process data. As a result, the common carrier network is increasingly capable of providing enhanced services such as store and forward messaging and data processing that have hitherto been the domain of specialized suppliers.

The issue of economies of scale and scope in the telecommunications industry is inextricably tied to the issue of technological change, since the latter has been suggested to influence both the magnitude and nature of production economies as well as the rate of introduction of new services and service pricing. It is obviously impossible in this limited study to detail in any adequate way the nature of technological change in the telecommunications industry. Hence, comments will be restricted to a summary of the major recent development in the industry, the emergence of digital telecommunications techniques.

Switching, transmission and subscriber equipment have historically been based on analog technology, whereby messages are "coded" and "decoded" on the basis of their sound wave characteristics. In digital telecommunications, messages are coded as binary bits as in the architecture of computers. The architecture and functioning of telecommunications equipment is increasingly coming to resemble the architecture of computers. The digitization of the telecommunications network has allowed the industry to enjoy some of the benefits of the massive cost reductions that have characterized the production of computer components. This is manifested in the declining cost of telecommunications hardware. For example, it has been reported that satellite earth terminal costs have fallen by a factor of 400 in the last 20 years, while fibre optic cable prices have fallen more than 80 percent since 1975.[18] Furthermore, a modern digital network requires less equipment than an analog network, in particular because the need for multiplexing and demultiplexing equipment is dispensed with.

Digitization has also facilitated the introduction of a host of new services and modifications to existing services. In particular, digitization of the public telephone network is making data transmission more widespread and cheaper as well as encouraging the growth of textual and image communications. It is enhancing the quality of both data and voice communications which, in turn, is encouraging the growth of enhanced services such as the use of touch telephones to record messages to be stored or forwarded to their users, e.g., voice mailboxes.[19] The ultimate direction being taken by common carriers in North America and Western Europe is the development of the Integrated Services Digital Network. This network will allow computers and telephones to be linked over existing cables and permit

simultaneous transmission of computer data, voice conversations and video pictures.

To our knowledge, there is no study of the rate at which digital technology has been integrated into the telecommunications industry; however, fragmentary data suggest that the bulk of the industry's capacity is still analog in architecture. Bell Canada (the largest common carrier in Canada) had only 3 percent of telephones in its exchange service areas connected to digital electronic central office switching machines in 1981.[20] Other observers of the telecommunications industry suggest that there has been a relatively slow rate of adoption of new services such as teleconferencing, electronic mail and advanced methods of document storage and retrieval, notwithstanding that these services can provide cost savings.[21]

Before presenting the empirical estimates of technological cost savings, it is important to note that the current measures inadequately reflect the technological advances in the telecommunications industry. First, they do not allow the rates of technological change to differ among activities. In fact, all rates are assumed to equal the rate of technological change in switching technology. This is particularly troublesome given the introduction of digital technology. Second, the models fail to incorporate the effects of external technological change into the telecommunications industry. This could be a serious shortcoming given the increasing technological integration of the computer and telecommunications industries.

Table 28 reports average annual estimates of total factor productivity gains due to technological cost savings. The data reveal that technological change contributes to an estimated 0.6 percent to 1.3 percent annual total factor productivity gain. Based on these studies, Kiss and Lefebvre[22] conclude that new technologies improved firm level total factor productivity by approximately one percent per year and led to even greater productivity improvements in the long run as their cost saving potential was enhanced by increasing volumes of telecommunications services.

On the other hand, in a 1984 study by Kiss and Lefebvre,[23] the opposite conclusion is reached; i.e., that the major reason for introducing new technologies may be to raise the degree of economies of scale. This conclusion is based on a study of two common carriers: Alberta Government Telephones (AGT) and Bell Canada. Over the period 1969-81 for AGT and 1956-81 for Bell Canada, the most significant determinant of productivity performance was economies of scale. For AGT, 86 to 89 percent of the productivity gain over the period is due to growth achieved in the presence of economies of scale, while the pure technology effect is only 7 to 11 percent. For Bell Canada, 86 to 91 percent of the estimated productivity gain was generated by the scale effect. The technology effect accounts for 20 to

Table 28
Average Annual Estimates of Total Factors Productivity Gains Due to Technological Cost Savings

	$\dot{B}$ [1.]
Single Output Models	
Denny, Fuss and Everson (1979)	.68
Kiss, Karabadjian and Lefebvre (1981, 1983)	.83
Kiss and Lefebvre (1984)	.75*
Two Output Models	
Kiss, Karabadjian and Lefebvre (1981, 1983)	1.3
Kiss and Lefebvre (1984)	.63
Three Output Models	
Denny, Fuss and Everson (1979)	.57 -.80
Kiss, Karabajian and Lefebvre (1981, 1983)	.94

*The estimate is for the single firm model.

1. $\dot{B} = -\epsilon_{ct} \dot{T}$

where

ϵ_{ct} = cost elasticity with respect to technological change

$\dot{T}$ = proportionate change in the technology variable.

Source: Kiss and Lefebvre, "Econometric model of telecommunications firms," *Revue Economique*, Vol. 38, No. 2, March 1987, table 6, pp. 356-357.

22 percent of the productivity gain. Hence, the residual sources of productivity growth total around 3 percent in the case of AGT and 11 percent in the case of Bell Canada.

Empirical work continues to suffer from the usual problem of identifying the separate influences of returns to scale and technology. Furthermore, as pointed out by Kiss and Lefebvre, "While the...econometric models have been highly successful in estimating the presence and approximate degree of overall economies of scale, they fall significantly short of expectations concerning their ability to quantify the two components of overall economies of scale: output specific economies of scale and economies of

Table 29
Shares of Gross Domestic Product in Constant (1971) Prices, for Selected Years and Industries

	1977	1979	1981	1983	1985
Telephone Systems	2.6	2.7	3.0	3.1	3.1
Communications	3.7	3.9	4.1	4.3	4.2
Service Producing Industries	61.5	61.8	62.9	64.7	64.3
Goods Producing Industries	38.5	38.2	37.1	35.3	35.7

Source: Calculations based on Statistics Canada, *Gross Domestic Product by Industry*, various years.

Table 30
Growth in GDP for Selected Years (%)

	1977-1979	1979-1981	1981-1983	1983-1985
Telephone Systems	13.9	15.1	1.5	10.0
Communications	12.3	10.8	1.4	7.9
Service Producing Industries	7.8	6.0	1.1	8.7
Goods Producing Industries	6.7	1.0	-0.6	10.8
Gross Domestic Product	7.4	4.1	-1.7	9.5

Source: Calculations based on Statistics Canada, *Gross Domestic Product by Industry*.

scope."[24] In light of this mixed evidence and the potential for common carriers to compete on criteria besides simply price, the case for any one carrier (including Bell Canada) to enjoy a natural monopoly status is not persuasive.

STUDIES OF OUTPUT CONTRIBUTION

Notwithstanding biases and omissions in extant real output measures, it is clear that the telecommunications industry represents an important component of the social infrastructure for all areas of economic activity. It is also clear by (albeit imperfect) revenue-based measures of output that the telecommunications industry is of substantial size. Telephone systems alone accounted for 3.1 percent of gross domestic product (in constant 1971 prices) in 1985. This share has increased fairly consistently over the period 1977-85 (see table 29). This increase reflects the fact that growth in GDP

by the telephone systems has outstripped growth in Canadian GDP in all years 1977-85, including the recessionary period 1981-83, as shown in table 30.

In dollar values, telephone systems contributed $4.1 billion to a gross domestic product of $130.3 billion in 1985. This compares to contributions of $5.5 billion by communications, $83.7 billion by service producing industries, and $46.5 billion by goods producing industries. Table 31 reports dollar contributions for these sectors for selected years 1977-1985.

Unfortunately, there are no published figures for U.S. telephone systems' gross domestic product. In order to provide a comparison of the Canadian and U.S. telephone and telegraph industries, operating revenues were compiled for the years 1977-83. Table 32 reports these figures. All U.S. figures were converted into Canadian dollar equivalents using the average noon spot rates as published in the *Bank of Canada Review*, February 1986. The data in table 32 reveal that both the Canadian telephone industry and the telegraph industry operating revenues are constant percentages of the respective U.S. industries. Specifically, the Canadian telephone industry operating revenues average 8.7 percent of the U.S. revenues over the period 1977-83, while the Canadian telegraph industry averages 30.3 percent of U.S. telegraph operating revenues over the same period. The larger relative size of the Canadian telegraph industry may partially be explained by definitional differences between the two countries. It is unclear whether the operating revenues of the U.S. satellite carriers are included in U.S. telegraph revenue figures. Finally, the stability of the ratio of carrier revenue in Canada to carrier revenue in the U.S. suggests similar growth rates for the Canadian and U.S. industries over the period 1977-85.

The apparent similarity could be explained by the fact that the U.S. data do not reflect the more extensive deregulation of the U.S. industry. For example, the U.S. data do not include statistics for numerous specialized common carriers, including resellers. Since most common carriers in the U.S. are unregulated now, it is difficult to form an accurate picture of overall economic activity in the U.S. sector. Much of the entry and growth of specialized carriers took place in the 1980s.

The available evidence is relatively clear, however, that U.S. rates, especially for long-distance services, are lower than Canadian rates for comparable services.[25] In particular, overall telecommunications costs to businesses in Canada are significantly higher than those in the United States where the services are based on a "market basket" comprising local, toll and WATS components. Except for low mileage bands, costs of message toll service are also much higher in Canada. For example, a three-minute call (customer-dialed, business day) over a distance of 1,500 miles

Table 31

Estimates of Gross Domestic Product in Constant (1971) Prices, for Selected Years and Industries

(in millions of dollars)

	1977	1979	1981	1983	1985
Telephone Systems	2,780.1	3,168.3	3,646.5	3,699.8	4,070.5
Communications	4,006.6	4,498.7	4,987.9	5,059.6	5,461.5
Service Producing Industries	66,680.5	71,873.5	76,183.9	77,014.0	83,722.9
Goods Producing Industries	41.649.1	44,422.4	44,869.3	41,969.8	46,536.1
Gross Domestic Product	108,330.6	116,295.9	121,053.2	118,983.8	130,259.0

Source: Statistics Canada, *Gross Domestic Product by Industry*, various issues.

Table 32

A Comparison of Canadian and U.S. Operating Revenues for Telephone Carriers and Telegraph Carriers

Selected Years ($C millions)

	Telephone Carriers			Telegraph Carriers		
	Canadian[1]	U.S.[2]	(1)-(2)	Canadian[3]	U.S.[4]	(3)-(4)
1977	3,853.8	43,322.0	.089	302.1	1,011.9	.299
1978	4,472.3	52,343.0	.085	348.3	1,176.1	.296
1979	5,151.4	59,283.0	.087	411.7	1,320.6	.312
1980	5,848.3	66,329.0	.088	439.2	1,439.9	.305
1981	6,987.1	79,735.0	.088	492.9	1,626.9	.303
1982	7,864.8	91,013.0	.086	536.3	1,748.7	.307
1983	8,533.4	96,243.0	.089	n.a.	1,827.3	

[1] Source: Statistics Canada, *Telephone Statistics*. Data cover the principal telephone systems (15 in 1977, 14 in all other years) that account for 98% of telephone activity in Canada.

[2] Source: Federal Communications Commission. Data cover principal domestic telephone carriers reporting to the FCC. These carriers account for over 90% of the annual gross operating revenues of the telephone industry in the U.S. including Hawaii, Puerto Rico and Alaska.

[3] Source: Statistics Canada, Telecommunications Statistics. Data cover the principal telegraph and satellite carriers, notably CNCP Telecommunications, Teleglobe Canada and Telesat Canada.

[4] Source: Federal Communications Commission. Data are compiled from monthly reports of telegraph carriers having annual operating revenues in excess of $250,000.

in Canada would be more than double a similar call over AT&T lines. At the same time, local rates in Canada are lower than in the U.S. However, since long distance is substantially more price elastic than local calling, the overall impact of the price structure is to restrain the growth of telecommunications output in Canada relative to the U.S.

INDIRECT OUTPUT EFFECTS

To the extent that telecommunications services increase efficiency in other sectors of the economy, and to the extent that suppliers of telecommunications services do not "capture" all of the potential efficiency gains in the form of higher prices, the sector could have an important indirect effect on both the magnitude and nature of overall real economic output in Canada. Unfortunately, we are unaware of any studies that have looked at this issue in a comprehensive way; however, several speculations seem admissible.

One is that the industry is increasingly serving as a vehicle for the transmission of digital communications. To this extent, it is an important instrument for the diffusion of computer-based technologies. Movements toward deregulating the non-voice segment of the industry can be seen, therefore, as a spur toward faster adoption of such technologies. A second speculation is that the industry is an important contributor to the level of R&D performance in the country. Bell-Northern is the largest private R&D lab in Canada, and personnel from Bell-Northern have left the company to start other companies. One notable example in this regard is Mitel. Bell Canada has argued that comprehensive deregulation of the industry would lead to a reduction in the amount of basic research carried out by its Bell-Northern subsidiary, a suggestion that is consistent with the experience of Bell Labs, AT&Ts research arm in the United States. However, the broader issue is whether both the rate of innovation as well as the rate of diffusion of new technology would be affected by structural changes to the industry.

A substantial amount of both theoretical and empirical work has been done concerning this issue. The debate in the theoretical literature centres on the results of Schumpeter and Arrow. Schumpeter argues that monopolistic market structures give greater incentives for innovation, while Arrow has shown competition provides the greater incentive to innovate. Given that the telecommunications industry is regulated, the question becomes: is a regulated monopoly more innovative than an unregulated industry? At least one major U.S. study concludes that innovation has not suffered due to competitive entry into portions of the U.S. telecommunications market.[26]

Nevertheless, the broader evidence suggests that large research organizations such as Bell Labs and Bell-Northern Research play unique roles in the

innovation process, particularly through their basic research activities.[27] It is too early to conclude anything about the relationship between competitive entry and innovation based on the post-AT&T divestiture experience. While there is some preliminary evidence that Bell Labs is doing relatively less basic research, the overall impacts of any such cutbacks may not be evident for years, if ever.

Proponents of deregulation argue that, notwithstanding any adverse impacts on innovation, increased competition in the industry would lead to a faster rate of diffusion of new technology developed both inside and outside of Canada with overall net economic gains for the Canadian economy. The experience with deregulation of the interconnect segment of the industry strongly supports this assertion.[28]

In summary, it is likely that the activities (particularly the investment activities) of the telecommunications carriers have important potential spillover benefits for the Canadian economy, i.e., benefits related to externalities from telecommunications innovation and the infrastructure role played by the telephone system that are not fully captured in the prices of telephone services. These benefits are more likely to be fully disseminated among users of telecommunications services in an environment where telecommunications services are provided on a competitive basis.

Appendix 1

Total Factor Productivity Measurement: A Theoretical Background in Regulated Industries

Productivity is considered to be the efficient transformation of inputs into outputs within the production process. In the literature, there are two well-known approaches to measuring productivity: the use of index numbers and the econometric estimation of production or cost functions. Briefly stated, the indexing approach measures productivity growth as the residual growth that is not accounted for by input growth. Estimation of production or cost functions allows productivity growth to be decomposed into a scale effect and a technology effect. The two approaches are not mutually exclusive but, rather, interrelated. "The indexing approach requires econometric hypothesis testing and the econometric approach uses index numbers."[29]

There exist two classes of indexes, Divisia indexes[30] and exact or superlative index numbers. The following discussion of these two approaches is drawn from Diewert.[31] Both types of index numbers can be applied to firms that produce multiple outputs, a necessary condition for their application to the telecommunications industry. The advantage of using exact index numbers is that they are better suited to discrete data and, unlike Divisia index numbers, will produce unique estimates of total factor productivity. The major shortcoming of exact index numbers is that they require the firm's variable cost function to be of the translog functional form. Given it is an unlikely characteristic over the relevant range of input prices, output quantities, and capital stock, the use of index numbers to measure total factor productivity will yield "approximation errors." This is also a shortcoming of Divisia index numbers and the econometric approach.

While bearing in mind its shortcomings, it has been suggested that "one of the most defensible methods of aggregation for use in productivity analysis is Divisia aggregation."[32] However, the use of Divisia aggregation when applied to the telecommunications industry raises several concerns. The Divisia index approach assumes the underlying production exhibits constant returns to scale, marginal cost pricing and no rate of return regulation—three conditions that are not characteristic of production in the telecommunications industry. Furthermore, the measurement of total factor

productivity using index numbers cannot separate the effects of economies of scale and technical change.

In measuring total factor productivity, we are interested in both movements along and shifts in the production function. The econometric approach, combined with duality theory, allows the use of cost functions to estimate productivity gains due to both scale effects and technical change.[33] The advantages of using cost functions rather than production functions are, first, that output prices are treated as exogenous, conforming to the institutional rate of return regulation in the telecommunications industry; and second, by applying Shephard's lemma, input share equations can be derived and estimated with the cost function, increasing the degrees of freedom and hence the efficiency of the estimates.

To estimate a cost function, a functional form must be specified. The use of Cobb-Douglas, Constant Elasticity of Substitution (CES) or Leontief functional forms is unsatisfactory as these "simple" functional forms impose a priori restrictions on the technology of the firm. For example, the Cobb-Douglas function imposes a unitary elasticity of substitution between capital and labour. A more troublesome restriction is that the capital to labour ratio must remain constant as scale expands. Telecommunications technology is such that the capital intensity of production increases as the scale increases. For these reasons, studies that have estimated the scale elasticity using a Cobb-Douglas function were not reviewed. Flexible functional firms, such as Transcendental Logarithmic (translog) and quadratic and generalized Leontief are preferred as they do not impose serious restrictions on the firm's technology.[34] The empirical results based on estimates of translog cost functions were reviewed in chapter 3.

The use of cost functions to estimate changes in total factor productivity is based on the pioneering work of Solow and others, who showed that the rate of productivity growth could be identified with the rate of Hicks-neutral technical change. However, the underlying assumptions of constant returns to scale and perfect competition (made in these early studies) were obviously inappropriate for estimating total factor productivity in a regulated industry.

The application of duality theory allowed researchers to estimate cost functions that could incorporate the institutional characteristics of the telecommunications industry. Four modifications to early models used in measuring productivity growth of an industry exist in recent work. First, the assumptions of constant returns to scale and competitive equilibrium have been relaxed, allowing the extension of traditional models to regulated industries. Second, the assumption of Hicks-neutral technological change has been relaxed to allow for factor-specific biases in patterns of technological

change. Third, the Averch-Johnson effect has been incorporated by amending the cost function to account for the rate of return constraint on the earned return to capital. Finally, the existence of non-marginal cost pricing has been accounted for through modifications to the cost function model.

The most recent econometric approach in this area involves the use of dynamic or variable cost functions. This approach allows a distinction to be drawn between short-run and long-run effects. By estimating short-run demand equations for variable inputs, and long-run demand equations for quasi-fixed and variable inputs, one can distinguish between short-run changes in factor utilization and long-run changes in economies of scale. To date, the use of dynamic cost functions has not provided statistically consistent results.

NOTES

1. F. Kiss, "Productivity Gains in Bell Canada," in L. Courville, A. de-Fontenay, R. Dobell (eds.), *Economic Analysis of Telecommunications Theory and Applications* (Amsterdam: North Holland), 1983, p. 96.
2. See Ferenc Kiss and Bernard Lefebvre, "Comparative Analysis and Econometric Forecasting of Factor Inputs and Productivity: Some Empirical Results in Canadian Telecommunications," paper presented at the Fourth International Symposium on Forecasting, London, England, July 8-11, 1984.
3. Ibid., p. 3.
4. See F. Kiss, op. cit., p. 98.
5. See M. Denny, M. Fuss and L. Waverman, "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries With an Application to Canadian Telecommunications," in T. Cowing and R. Stevenson (eds.), *Productivity Measurement in Regulated Industries* (NY: Academic Press, Inc.), 1981, pp. 179-218.
6. See Department of Finance, Canada, The White Paper Tax Reform 1987, The Honourable Michael H. Wilson, Minister of Finance, June 18, 1987, p. 58.
7. R.E. Olley and C.D. Le, "Total Factor Productivity of Canadian Telecommunications Carriers," project report to the Department of Communications and to members of the Canadian Telecommunications Carriers Association, mimeo, January 1984.
8. Ibid., p. 83.
9. Denny, Fuss and Waverman, op. cit.
10. See Melvyn Fuss, "Recent Results in the Analysis of Production Conditions," in L. Courville, A. deFontenay and R. Dobell (eds.), *Economic Analysis of Telecommunications* (Amsterdam: North Holland Press), 1983.
11. See Melvyn Fuss and Leonard Waverman, *The Regulation of Telecommunications in Canada,* Draft of the Final Report to the Economic Council of Canada Regulation Reference (June 1980) Final Draft, (February 1981).
12. In the case of 3 outputs, X_1, X_2, X_3, global economies of scale exist if:

$$\sum_{j=1}^{3} C_j(X_j) - C(X_1, X_2, X_3) > 0$$

13. See Fuss and Waverman, 1980, op. cit.

14. See F. Kiss, S. Karabadjian and B.J. Lefebvre, "Economies of Scale and Scope in Bell Canada: Some Econometric Evidence," presented at the Telecommunications in Canada Conference at l'Ecole des Hautes Etudes Commerciales, March 1981.

15. Again in the case of 3 outputs:

$$\frac{\partial^2 C}{\partial X_i \partial X_j} < 0 \quad i, j = 1, 2, 3 \quad i \neq j$$

16. For a complete description of empirical evidence on local cost complementarities, the reader is referred to F. Kiss and B. Lefebvre, "Econometric Models of Telecommunications Firms: A Survey," *Revue Economique*, Vol. 38, No. 2, March 1987, pp. 307-372.

17. See Almarin Phillips, "The Impossibility of Competition in Telecommunications: Public Policy Gone Awry," in Michael Crew (ed.), *Regulatory Reform and Public Utilities* (Lexington: D.C. Heath), 1982, pp. 7-33.

18. See CNCP, "Telecommunications: Monopoly in Demise," prepared for Department of Communications' Telecommunications Policy Review, mimeo, May 1984.

19. For a fairly comprehensive overview of the impact of technological change on the way in which telecommunications services are produced and the nature of new services, see the papers in Tom Forester (ed.), *The Information Technology Revolution* (Cambridge: MIT Press), 1985.

20. See Ferenc Kiss and Bernard J. Lefebvre, "Comparative Analysis and Econometric Forecasting of Factor Inputs and Productivity: Some Empirical Results in Canadian Telecommunications," paper prepared for presentation at The Fourth International Symposium on Forecasting, London, England, July 8-11, 1984, p. 8.

21. See Michael Tyler, "Telecommunications and Productivity: The Need and the Opportunity," in Mitchell L. Moss (ed.), *Telecommunications and Productivity* (Reading, Mass: Addison-Wesley Publishing Co.), 1981, pp. 2-51.

22. See Kiss and Lefebvre, op. cit., 1987.

23. See Kiss and Lefebvre, op. cit., 1984.
24. See Kiss and Lefebvre, op. cit., 1987, p. 360.
25. See D.A. Ford and Associates Ltd., "The Impact of International Competition on the Canadian Telecommunications Industry and Its Users," Ottawa, mimeo, August 1986.
26. See John R. Meyer, et al., *The Economics of Competition in the Telecommunications Industry* (Cambridge, Mass: Oelgeschlager, Gunn and Hain Publishers, Inc.), 1980.
27. For an assessment of the different roles of large and small firms in the innovation process, see Steven Globerman, "Markets, Hierarchies and Innovation," *Journal of Economic Issues*, Vol. XIV, No. 4, December 1980, pp. 977-998.
28. Ibid.
29. F. Kiss, op. cit., p. 108.
30. The Divisia index for aggregate output is defined as:

$$\dot{Q} = \frac{\sum_j P_j Q_j \dot{Q}_j}{R}$$

P_j - price of output j
Q_j - quantity of output j
$\dot{Q}_j$ - rate of proportional growth of output j
$R = \sum_j P_j Q_j$ - total revenue

Similarly, the Divisia index for aggregate input is defined as:

$$\dot{F} = \frac{\sum_i W_i X_i \dot{X}_i}{C}$$

W_i - price of input i
X_i - quantity of input i
$\dot{X}_i$ - rate of proportional growth of input i
$C = \sum_i W_i X_i$ - total cost

Hence, total factor productivity is defined as:

$$TFP = \dot{Q} - \dot{F}$$

The discrete approximation of TFP is:

$$\Delta TFP = \Delta \log Q - \Delta \log F$$

$\Delta \log Q$: Törnqvist volumes index
$\Delta \log F$: Törnqvist price index

31. See. E. Diewert, "The Theory of Total Factor Productivity Measurement in Regulated Industries," in T. Cowing and R. Stevenson (eds.), *Productivity Measurement in Regulated Industries* (NY: Academic Press, Inc.), 1981.

32. Using this approach, total factor productivity is defined as:

$$TFP = -\dot{B} + (1 - \Sigma_{CQ})\dot{Q}$$

where

$-\dot{B} = \Sigma_{CQ}(\dot{Q} - \dot{F})$ technology effect

$\Sigma_{CQ}\dot{Q}$ scale effect

$\Sigma_{CQ} = \partial \log C / \partial \log Q$ cost elasticity with respect to output

$\dot{Q} = \dfrac{\Sigma_j P_j Q_j \dot{Q}_j}{R}$ Divisia output index

33. See T. Fisher, "Economies of Scale and Technological Change in The U.S. Bell Telephone Systems: 1947-1978," unpublished M.A. Thesis, Vancouver: University of British Columbia, August 1982.

34. See Melvyn Fuss, "Recent Results in the Analysis of Production Conditions," in L. Courville, A deFontenay, R. Dobell (eds.) *Economic Analysis of Telecommunications* (Amsterdam: North Holland), 1983, p. 22.

CHAPTER 4

EMPLOYMENT

OVERALL EMPLOYMENT

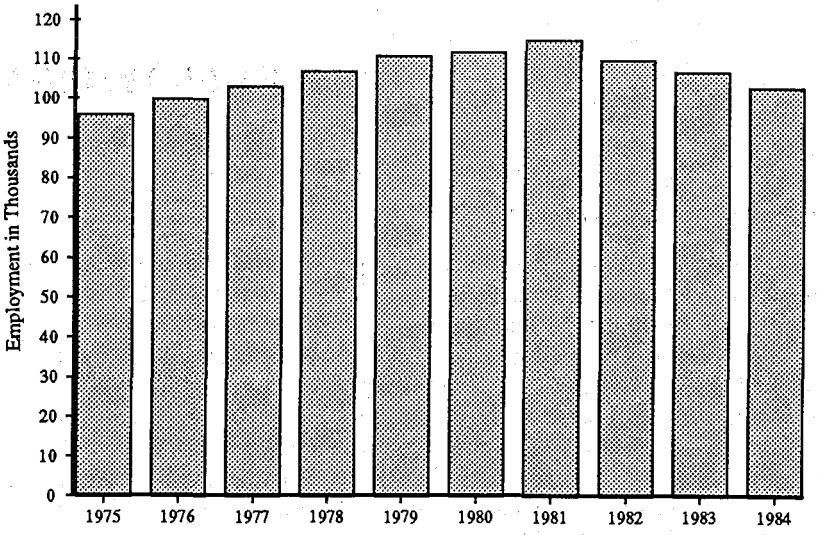
In table 7 we identified the trends in employment for the major telecommunications carriers including the terrestrial common carriers based on Statistics Canada data. Table 7 shows that employment among the major carriers increased sharply after W.W. II and continued to increase, albeit at a much slower pace, in the 1970s until 1981. Employment in 1985 was actually at a lower absolute level than in 1980. Table 7 provides a relatively reliable description of the overall trend in employment in the industry, since the 16 largest carriers in Canada account for over 99 percent of telecommunications employment.[1] As noted earlier, employment in several emerging sectors of the industry, notably the interconnect and cellular radio sectors, has been growing in recent years. However, these sectors remain relatively minor participants in the overall industry.

Figures 2, 3 and 4 provide employment data as determined by D.A. Ford and Associates in a study undertaken for the Ontario government. Figure 2 shows employment by the 16 largest carriers for the years 1975-84. Figures 3 and 4 provide information on employment levels in four sectors (telcos, interconnect, contract, and other) for Canada and Ontario 1975-84. Two observations are worth noting. First, Ontario's share of employment is stable over the ten-year period, averaging 32 percent of Canadian employment. Second, changes in Ontario employment levels mirror the Canadian trends.

In contrast to the Statistics Canada employment data of table 7, figures 2, 3 and 4 take into account the interconnect and cellular radio sectors and outside contractors serving the telecommunications industry. In order to obtain these estimates, numerous data sources were used, including: the Canadian Occupational Projection System (COPS) of Employment and Immigration Canada; annual reports of major carriers; "Financial Statistics on Canadian Telecommunication Common Carriers," an annual publication by the Department of Communication; industry surveys by Angus Teleman-

Figure 2

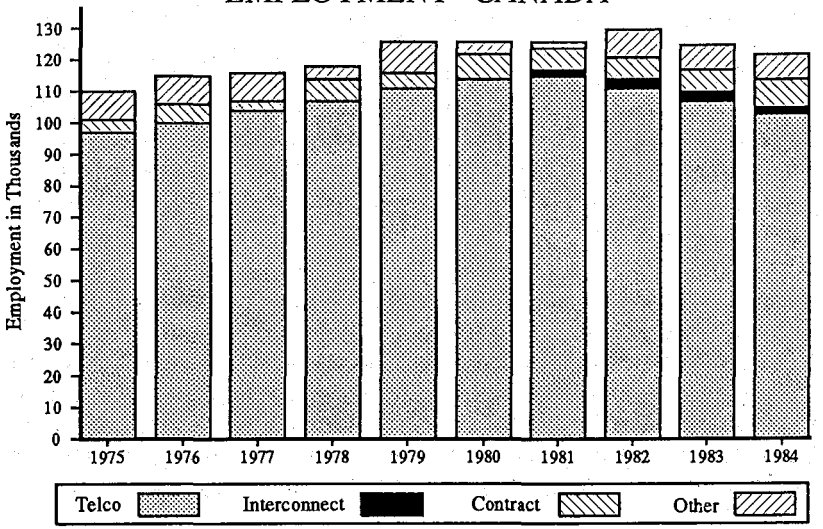
EMPLOYMENT BY 16 LARGEST CARRIERS



Source: D.A. Ford and Associates Ltd., *Study of Employment in the Communications Industry.*

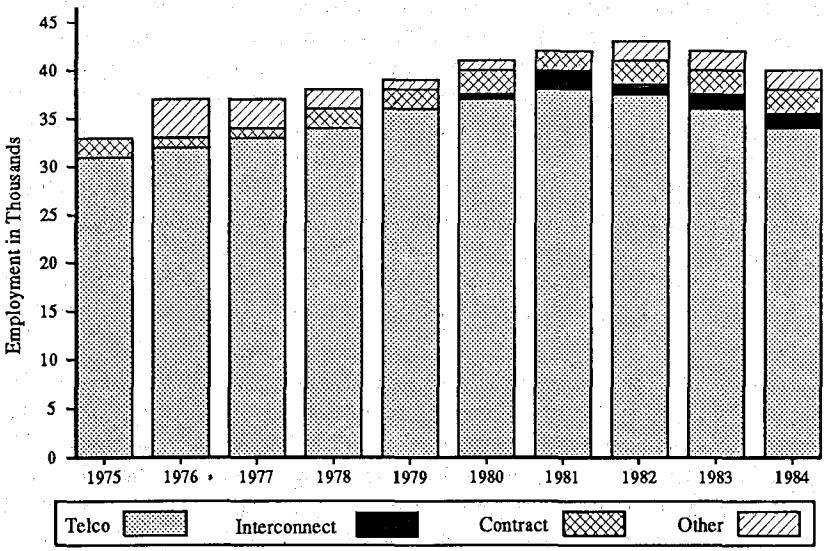
Figure 3

EMPLOYMENT—CANADA



Source: D.A. Ford and Associates Ltd., *Study of Employment in the Communications Industry.*

Figure 4
EMPLOYMENT – ONTARIO



Source: D.A. Ford and Associates Ltd., *Study of Employment in the Communications Industry.*

agement Ltd.; Statistics Canada publications; and industry sources.[2] This compilation of sources highlights the need for a comprehensive data source on the telecommunications industry. The D.A. Ford and Associates report notes that the employment figures reported by Statistics Canada are less than the figures reported in the annual reports of the major telcos. No explanation was provided for this apparent discrepancy.[3]

A relatively recent source of employment growth in the industry is the establishment of in-house telecommunication departments. Ford and Associates found that firms whose annual expenditures on telecommunications exceeded $500,000 would employ telecommunication specialists, whereas firms with annual expenditures below this level would not. Based on their sample,[4] Ford and Associates estimate this "contract" employment across Canada to be 5,000, of which 2,000 are in Ontario. This represents less than 5 percent of total estimated employment in the industry, suggesting that "contracting in" is a relatively minor source of employment in the Canadian telecommunications industry.

EMPLOYMENT CHARACTERISTICS

Detailed occupational information is not readily available for the industry. In particular, detailed employment data are lacking for the interconnect industry, resellers, cellular radio carriers and, to a lesser degree, satellite communications. Hence, our conclusions about educational and occupational characteristics of the telecommunications labour force are drawn primarily from data for the terrestrial common carriers and telegraph operators. It might be expected that this focus will underestimate the extent of "high skill" jobs and highly educated individuals in the industry, since the emerging sectors such as cellular radio are reputed to be technology intensive. However, the small absolute and relative sizes of these peripheral sectors imply that any such bias will not seriously distort the overall industry picture.

Tables 33 to 36 report proportions of the labour force by highest level of attained education for all industries and for the telephone companies. The latter are identified as 1970 Standard Industrial Classification (SIC) 544. Note that the educational classifications changed between the 1971 and 1981 census, making direct comparisons between the two years somewhat difficult. Nevertheless, several conclusions can be drawn from the census data reported in the tables. In particular, both male and female telephone employees have a proportionately higher level of education than the male and female work-force for all industries. For example, in the 1971 census, the highest proportion of male employees in all industries, 30.8 percent, had a "less than grade 9" education. This contrasts to the telephone industry where males with a "grade 12-13" education accounted for 41.6 percent of the male telephone work-force. Moreover, 41.9 percent of the female telephone work-force had a "grade 12-13" education compared to 29.1 percent for the female all industries work-force in 1971. From the 1981 census data, it is seen that the proportions of males with "some university" or "other non-university without/with degrees" (columns 6 and 7 in table 34) are greater for telephone employees than for all industry male employees (18.3 percent and 19.6 percent versus 11.7 percent and 10.4 percent). Moreover, a substantially lower proportion of male telephone employees have a "less than grade 9" education compared to the total male labour force (2.6 percent versus 15.1 percent).

In 1981, the proportion of females who obtained "grade 9-13 with certificate" is markedly higher for telephone employees than for all industry employees (33.4 percent versus 17.4 percent). Furthermore, female telephone employees with "less than grade 9" account for only 2 percent of the telephone work-force compared to 10.3 percent of the total female labour force with "less than grade 9" (see table 36). Census data therefore

Table 33

Highest Educational Levels of Total Male Labour Force, By Province, 1971 (%)

		<9	9-10	11	12-13	Some Univ.	Univ. Degree
Nfld	107,185	41.1	24.6	21.5	1.7	6.5	4.3
PEI	28,610	41.7	28.7	6.8	10.2	7.2	5.2
NS	195,485	32.6	29.6	13.4	10.8	7.0	6.6
NB	151,585	42.7	24.1	9.5	13.5	6.8	5.9
Que	1,447,370	39.2	22.1	11.9	11.2	7.2	8.4
Ont	2,151,765	27.2	23.2	9.2	24.6	7.6	8.3
Man	268,015	30.2	23.5	15.1	15.6	8.1	7.4
Sask	249,715	34.8	23.8	9.8	18.1	7.6	5.8
Alta	450,535	23.6	23.6	12.0	24.5	7.8	8.3
BC	602,325	21.5	22.9	11.0	27.5	9.3	7.7
Canada	5,665,715	30.8	23.2	11.0	19.5	7.6	7.8

Highest Educational Levels of Male Telephone Employees, By Province, 1971 (%)

		<9	9-10	11	12-13	Some Univ.	Univ. Degree
Nfld	490	15.3	16.3	45.9	2.0	15.3	5.1
PEI	105	4.7	19.0	14.2	52.3	9.5	0.0
NS	1,275	4.7	21.2	22.7	32.1	14.1	5.1
NB	1,060	10.4	10.8	12.7	47.1	9.9	8.9
Que	9,085	8.9	20.4	21.4	21.4	14.1	13.8
Ont	11,415	4.7	14.5	12.0	51.3	9.5	7.9
Man	2,110	10.9	15.5	29.3	30.7	9.2	4.7
Sask	1,520	14.1	10.8	8.8	51.9	8.8	5.3
Alta	4,455	5.9	12.0	12.0	56.2	9.6	4.0
BC	5,715	4.6	12.8	10.5	49.4	15.6	6.8
Canada	37,320	6.9	15.5	15.7	41.6	11.7	8.3

Male telephone employees accounted for 0.6% of the total Canadian labour force in 1971.

Source: Statistics Canada, 94-735, 1971 Census.

Table 34
Highest Educational Levels of Total Male Labour Force, By Province, 1981 (%)

		<9	9-13 Without Certificate	9-13 With Certificate	Trade Certificate	Some Univ. Without Degree	Some Univ. With Degree	Univ. Degree
Nfld	142,350	25.9	23.4	10.3	17.2	9.4	6.0	7.6
PEI	33,430	23.5	25.9	7.8	14.8	11.6	7.2	9.1
NS	230,360	17.4	27.9	7.6	18.6	10.5	7.0	10.8
NB	182,765	23.3	23.5	11.0	15.1	9.8	7.8	9.2
Que	1,839,845	19.9	16.6	15.1	14.8	10.5	11.9	11.0
Ont	2,585,745	13.3	25.7	11.7	13.9	11.9	10.6	12.8
Man	294,590	16.7	31.0	8.5	12.4	11.8	8.7	10.7
Sask	280,705	18.2	32.1	9.0	12.6	11.4	7.6	9.1
Alta	723,730	9.6	28.2	9.7	16.3	13.5	9.9	12.7
BC	822,645	9.1	27.4	10.8	17.0	13.9	10.2	11.5
Canada		15.1	24.1	11.8	15.0	11.7	10.4	11.7

Highest Educational Levels of Male Employees, By Province, 1981 (%)

		<9	9-13 Without Certificate	9-13 With Certificate	Trade Certificate	Some Univ. Without Degree	Some Univ. With Degree	Univ. Degree
Nfld	1,040	10.2	14.6	11.6	26.2	11.7	13.1	13.6
PEI	555	6.3	23.2	10.7	17.8	14.3	19.6	7.1
NS								
NB	1,595	2.2	14.6	18.7	15.6	13.4	22.8	12.2
Que	13,805	4.2	8.3	19.4	14.5	16.5	26.3	10.7
Ont	19,225	2.1	16.7	23.5	7.7	20.1	15.4	14.5
Man	2,770	6.0	25.1	10.5	22.9	13.7	13.5	8.3
Sask	2,595	3.5	18.9	19.3	9.6	20.1	19.1	9.7
Alta	8,120	1.4	11.4	9.6	29.1	17.8	22.4	8.2
BC	8,695	1.5	13.6	12.8	20.1	24.0	19.6	8.6
Canada		2.6	14.0	17.9	15.6	18.3	19.6	11.2

Source: Statistics Canada, 94-735, 1971 Census.

Table 35
Highest Educational Levels of Total Female Labour Force, By Province, 1971 (%)

		<9	9-10	11	12-13	Some Univ.	Univ. Degree
Nfld	40,805	20.7	25.5	36.2	1.3	12.6	3.4
PEI	14,380	20.6	32.2	9.9	18.8	14.7	3.5
NS	90,970	15.9	25.9	21.5	20.9	9.8	5.7
NB	71,945	24.7	21.1	15.8	25.0	9.3	4.3
Que	721,785	28.1	21.5	19.6	18.0	7.5	5.3
Ont	1,202,585	19.4	21.9	11.6	35.2	7.2	4.7
Man	145,900	21.5	21.8	20.9	22.7	8.3	4.6
Sask	121,360	22.2	20.6	13.5	28.4	11.6	3.7
Alta	237,745	14.8	19.9	14.6	34.4	10.5	5.6
BC	307,750	13.2	19.4	13.1	37.9	11.3	5.1
Canada	2,961,205	20.7	21.5	15.2	29.1	8.4	4.9

Highest Educational Levels of Female Telephone Employees, By Province, 1971 (%)

		<9	9-10	11	12-13	Some Univ.	Univ. Degree
Nfld	625	6.4	20.0	62.4	1.6	8.8	0.8
PEI	240	8.3	31.2	16.6	27.1	16.6	0.0
NS	1,450	3.8	25.2	36.2	27.5	5.8	1.4
NB	995	4.0	13.1	21.1	52.2	9.0	0.5
Que	10,085	8.8	21.8	36.6	22.8	7.2	2.6
Ont	12,640	4.5	23.6	19.1	53.7	6.0	2.3
Man	2,005	3.9	19.9	32.4	37.1	5.2	1.3
Sask	1,770	4.8	13.8	19.8	49.7	10.2	1.7
Alta	3,685	2.2	12.8	20.5	59.0	4.6	0.8
BC	5,105	2.1	13.6	13.9	57.3	11.6	1.5
Canada	38,635	5.1	19.2	24.2	41.9	7.2	1.9

Female telephone employees accounted for 1.3% of the total Canadian labour force in 1971.

Source: Statistics Canada, 94-735, 1971 Census.

Table 36
Highest Educational Levels of Total Female Labour Force, By Province, 1981 (%)

		<9	9-13 Without Certi-ficate	9-13 With Certi-ficate	Trade Certi-ficate	Some Univ. Without Degree	Some Univ. With Degree	Univ. Degree
Nfld	83,990	14.6	25.8	11.6	17.6	11.2	12.0	7.2
PEI	22,780	9.5	2.8	11.2	11.6	13.3	19.3	7.4
NS	148,130	8.0	28.7	10.5	14.5	11.3	16.6	10.3
NB	117,275	13.4	25.8	16.9	8.4	9.9	16.5	8.8
Que	1,211,205	14.6	15.7	21.7	9.8	10.8	18.8	8.5
Ont	1,878,295	9.9	26.6	17.4	7.1	12.5	16.6	9.8
Man	207,355	11.1	31.3	12.6	6.9	13.3	15.8	8.9
Sask	174,010	9.7	30.9	11.4	9.0	13.2	18.3	7.5
Alta	476,245	6.0	29.4	14.9	8.4	14.1	16.7	10.4
BC	566,565	6.0	27.3	16.1	8.1	15.8	17.4	8.8
Canada		10.3	24.4	17.4	8.6	12.5	17.3	9.4

Highest Educational Levels of Female Employees, By Province, 1981 (%)

		<9	9-13 Without Certificate	9-13 With Certificate	Trade Certificate	Some Univ. Without Degree	Some Univ. With Degree	Univ. Degree
Nfld	810	0.6	31.9	16.6	21.5	14.1	10.4	4.3
PEI	320	6.3	41.3	17.5	9.5	6.4	12.7	7.9
NS	1,885	0.0	37.8	18.6	14.6	14.6	11.4	3.2
NB	1,295	2.3	23.6	38.9	5.4	9.6	14.3	6.2
Que	14,895	4.1	13.1	39.2	6.6	15.6	17.4	3.8
Ont	19,560	1.7	25.0	33.0	20.0	15.4	14.5	8.3
Man	2,140	0.9	38.3	27.1	4.7	16.4	9.8	2.8
Sask	2,425	1.2	38.8	27.5	3.9	16.1	9.7	2.9
Alta	6,555	0.6	29.4	31.9	6.4	18.2	9.8	3.6
BC	7,670	1.2	23.9	32.8	4.3	23.5	11.3	3.0
Canada		2.0	23.8	33.4	5.7	17.4	12.3	5.2

Source: Statistics Canada, 94-735, 1971 Census.

support the following inferences: a faster relative growth in demand for telecommunications services will increase educational requirements in the work-force, all other things constant; and there has been an increase in the average educational attainment of the telecommunications work-force over the period 1971-81.

With respect to specific occupational categories, Statistics Canada's *Telephone Statistics* permit a time series examination of the telephone companies' labour force by four occupational classes: "accounting, engineering and administration," "commercial and traffic"; "plant"; and "other." These data are summarized in tables 37 to 40, which detail the share of the telephone company work-force and the share of total telephone company wages and salaries on a provincial basis for select years between 1978 and 1984 for each of the four occupational classifications.

The data show that the proportion of the total work-force attributable to each broad occupation varies across provinces as well as over time. In a number of cases, the variation is quite substantial. One might be tempted to conclude that the elasticities of substitution are quite high across different categories of labour in the industry; however, the variability may also be an indication that the basic data are unreliable, especially for the smaller provinces where reporting errors can be quite large in relative terms. Given the previously cited admonition in the Ford and Associates report about the potential unreliability of Statistics Canada's telephone industry data, we are hesitant to draw any strong inferences from tables 37 to 40, especially for individual provinces. The aggregate series for Canada may be more reliable. These data indicate that the relative shares of employment and wages accounted for by "accounting, engineering and administration" and "commercial and traffic" personnel decreased over the period 1978-84, while the shares increased slightly for "plant" workers and quite dramatically for the "other" category over the same period.[5]

INFLUENCES ON THE LEVEL AND MIX OF EMPLOYMENT

The employment of labour in the industry reflects the influence of three interrelated factors: (1) the growth in real output, (2) the substitution of material and capital for labour, and (3) increases in productivity. A detailed discussion of real output growth and productivity growth was provided in chapter 3. Our discussion here is drawn from a recent survey by Kiss and Lefebvre,[6] which examines several flexible aggregate econometric cost models of AT&T and Bell Canada which have been estimated over the last ten years. We will confine our discussion to the Bell Canada models, which

Table 37

Accounting/Engineering and Administration Employees' Share of Telco Work-Force and Wages, By Province, for Selected Years

	1978		1980		1982		1984	
Shares	Work-force	Wages	Work-force	Wages	Work-force	Wages	Work-force	Wages
Nfld	21.8	21.8	22.0	21.9	16.5	16.3	16.7	16.3
PEI	12.3	14.2	14.1	15.7	0.0	0.0	18.0	25.6
NS	30.9	34.5	30.6	31.5	25.9	26.8	28.7	27.2
NB	28.4	29.6	27.6	30.6	43.4	45.2	42.9	44.7
Que	29.1	29.5	14.5	11.2	13.6	10.0	12.6	9.8
Ont	28.8	28.8						
Man	40.6	38.9	48.9	45.2	55.7	41.3	55.3	35.3
Sask	29.5	31.4	33.8	31.7	45.1	45.6	47.1	48.8
Alta	27.4	28.6	23.1	23.8	22.4	24.9	27.4	28.4
BC	23.1	19.4	14.1	18.8	39.3	17.1	35.6	30.6
Canada	28.4	28.2	18.9	17.5	22.8	17.3	22.8	19.5

Source: Statistics Canada, *Telephone Statistics*, various issues.

Table 38

Commercial and Traffic Employees' Share of Telco Work-Force and Wages, By Province, for Selected Years

	1978		1980		1982		1984	
Shares	Work-force	Wages	Work-force	Wages	Work-force	Wages	Work-force	Wages
Nfld	44.8	43.7	42.9	43.0	32.2	31.7	33.0	31.8
PEI	33.5	24.4	33.2	24.5	79.5	77.7	81.9	74.4
NS	31.8	25.1	31.6	24.2	67.4	64.4	39.4	36.0
NB	54.4	52.9	55.2	50.8	53.4	47.7	54.1	51.3
Que	25.0	24.6	12.5	13.3	13.3	14.6	13.3	14.5
Ont	24.4	24.6						
Man	25.5	23.0	20.3	19.4	22.1	24.2	22.4	21.7
Sask	29.2	23.6	26.3	25.3	20.5	16.5	18.5	17.8
Alta	21.5	14.6	20.6	14.1	18.9	14.2	17.9	12.9
BC	33.8	23.4	46.1	23.1	20.0	23.3	24.4	22.6
Canada	27.3	23.9	21.6	17.1	19.6	18.8	18.7	17.7

Source: Statistics Canada, *Telephone Statistics*, various issues.

Table 39
"Other" Employees' Share of Telco Work-Force and Wages, By Province, for Selected Years

	1978		1980		1982		1984	
Shares	Work-force	Wages	Work-force	Wages	Work-force	Wages	Work-force	Wages
Nfld	4.4	4.6	5.0	4.9	28.9	29.8	27.6	29.6
PEI	0	0	9.5	15.7	0.6	1.1	0	0
NS	3.1	1.3	4.4	5.5	4.3	5.7	3.3	4.1
NB	17.2	17.5	17.2	18.6	3.1	7.1	2.9	4.0
Que	6.2	6.3	28.0	29.6	28.9	30.8	29.8	30.8
Ont	7.0	6.9						
Man	0	0	0	0	0	0	0	0
Sask	0	0	0	0	0	0	0	0
Alta	17.4	18.2	20.1	20.7	26.2	26.9	21.2	21.9
BC	0.1	1.6	2.2	1.8	2.2	2.1	1.9	1.9
Canada	6.6	6.7	19.0	20.4	21.0	21.9	19.9	20.9

Source: Statistics Canada, *Telephone Statistics*, various issues.

Table 40
Plant Employees' Share of Telco Work-Force and Wages, By Province, for Selected Years

	1978		1980		1982		1984	
Shares	Work-force	Wages	Work-force	Wages	Work-force	Wages	Work-force	Wages
Nfld	28.8	29.8	29.9	30.0	22.4	22.2	22.8	22.2
PEI	54.2	61.4	51.7	58.3	19.8	21.1	0	0
NS	34.1	39.1	33.3	38.8	2.3	3.0	28.8	33.0
NB	0	0	0	0	0	0	0	0
Que	39.6	39.6	45.0	45.9	44.1	44.5	44.3	44.9
Ont	39.6	39.6						
Man	33.7	38.1	30.7	35.4	22.2	34.5	22.4	43.0
Sask	41.4	44.9	39.9	41.3	34.5	37.8	34.4	33.3
Alta	33.7	38.6	36.2	41.4	32.5	33.8	33.4	36.6
BC	43.0	57.1	39.6	57.9	40.4	59.4	39.8	46.5
Canada	37.7	41.1	40.4	45.1	38.8	41.9	38.6	41.7

Source: Statistics Canada, *Telephone Statistics*, various issues.

show a fairly high degree of consistency in their estimates of the aggregate economic characteristics of the production of telecommunication services.

The Kiss and Lefebvre survey concludes that the demand for factors of production is price inelastic. With respect to labour, the demand elasticity varied between -0.3 and -0.6 for single output models; between -0.1 and -0.5 for two output models and between -0.4 and -0.6 for three output models. The own price elasticity estimates of demand for material were similar to those for labour. The demand for capital was found to be "substantially more price inelastic than demand for labour or material in nearly all the surveyed models."[7] A second conclusion based on the survey revealed that both labour and capital, and labour and materials are substitutes in the production of Canadian telecommunications services.

In all the models surveyed, the production structure was found to be homothetic, implying that input mix changes are caused by changes in relative prices and technology. Technological change can be either input neutral, input saving or input using. In the majority of models surveyed, technological change was found to be labour saving, capital using and material neutral.

In light of the discussion of productivity change in chapter 3 and of employment determinants in this chapter, it can be concluded that the telecommunications industry has enjoyed significant rates of productivity growth that are directly and indirectly linked to labour-saving technological change. The labour-saving bias of technological change and a higher price sensitivity for labour input help to explain why labour employment grew more slowly than the use of other factor inputs over the 1970s. Increased productivity potentially affects not only the overall demand for labour but also the mix of occupations. In this regard, the issue of "bimodalism" has attracted a great deal of recent attention in the policy literature.

THE ISSUE OF BIMODALISM

Bimodalism refers to the employment implications of a declining manufacturing sector, specifically, the loss of middle income earners due to the emergence of service and "high tech" industries with their "bipolar" wage structure, i.e., larger proportions of high and low income earners. It is argued that this industrial shift will lead to a declining middle class. Bimodalism is a recent policy issue and to date there have been few studies. Three recent U.S. studies, using different worker classification schemes, derive three different results.

A macroeconomic study by Rosenthal,[8] using occupational data, found both middle and lower occupation classes had declined as a percentage of

total employment between 1972 and 1982. However, there was a greater decline in the lower occupation class. In contrast, a study by Lawrence[9] using income data found the proportions of high and low income earners increased over the period 1968-83. When comparing results, one must keep in mind the differing classifications (occupation versus income) and time periods (1972-82 versus 1968-83).

To examine the possibility that the different results could in part be due to income distributions within occupational classes becoming increasingly "bipolar," McMahon and Tschetter[10] stratified workers by occupation and income in each of two years, 1973 (benchmark year) and 1982 (base year). They classified both occupation and earning categories into high, medium and low and calculated the proportions of workers in each of these cells for 1973 and 1982. Across all occupational classes, McMahon and Tschetter found weak evidence of the bimodalism phenomenon. Specifically, between 1973 and 1982 the proportions of high income earners increased 0.2 percent, middle income earners fell 1.3 percent, and low income earners increased 1.2 percent. Across all earnings classes, the only evidence of bipolarization occurred in the "low" occupational class. On balance, this evidence does not support the bipolarization hypothesis.

Nevertheless, there remains a concern about the employment impacts of a migration of economic activity toward "high technology" and services and the resulting skill requirements of workers in these industries. As Rosenthal notes, concern has been expressed about bipolar employment effects in specific high technology service industries. Since telecommunications is conventionally thought of as a technology-oriented service sector, an examination of telecommunication employment characteristics is warranted. Data limitations force us to follow the approach taken by Rosenthal to classify workers by occupation. There are four broad occupational categories for telephone workers in published Statistics Canada data: "administration," "commercial," "plant" and "other." Table 41 reports the total number of full-time employees in each broad category and their average annual income for the years 1978 and 1985, the earliest and latest year for which the data are available. Table 42 presents the proportions of full-time workers ranked by occupations based on 1978 earnings and rankings based on 1985 earnings.

There are two observations worth noting. First, the occupational rankings change over the period 1978-85. "Commercial" moves from the bottom to the third position, and "administration" moves from the third to the bottom of the rankings. Second, the data offer no support for the bimodalism hypothesis. Taking the distribution in 1978 as the base year, it is seen that the percentage of employees in the top category (plant) in-

Table 41
Average Incomes for Occupational Categories in the Telephone Industry

Category	1978 Number of Employees	Average Annual Salary and Wages
Plant	34,990	$18,701
Other	6,158	17,284
Administration	26,399	17,028
Commercial	25,326	15,073

Category	1985 Number of Employees	Average Annual Salary and Wages
Plant	36,515	$35,526
Other	20,527	34,629
Commercial	16,840	33,256
Administration	20,252	28,312

Source: Statistics Canada, *Telephone Statistics*, various issues.

creases 1.1 percent. The percentage of employees in the bottom category (commercial) decreases 9.4 percent, while the percentage of employees in the middle two categories (other and administration) increases 8.3 percent. Calculation of the relative change in occupational distribution using 1985 as the base year reveals the percentage of employees in the highest earning class (plant) increases 1.1 percent. The percentage of employees in the bottom category (administration) decreases 6.9 percent. The percentage of employees in the middle two classes increases 5.8 percent.

In short, the data suggest a movement of workers from low and middle earnings to high earnings occupations. This conclusion must be tempered by the very broad occupational categories for which data are available. Notwithstanding this caveat, the results presented and discussed in table 42 are consistent with the data reported in tables 33 to 36. Attained educational levels of employees in the telephone industry increased for both males and females over the period 1971-81. To the extent that attained education represents an important manifestation of human capital investment, one would expect a movement into higher occupational categories over time.

Table 42
Proportions of Full-Time Workers Ranked by Occupations (1978 and 1985) Based on 1978 Earnings

	1978	1985
Plant	37.7	38.8
Other	6.6	21.8
Administration	28.4	21.5
Commercial	27.3	17.9

Proportions of Full-Time Workers Ranked by Occupations (1978 and 1985) Based on 1985 Earnings

	1978	1985
Plant	37.7	38.8
Other	6.6	21.8
Commercial	27.3	17.9
Administration	28.4	21.5

Source: Table 41.

The result is also consistent with an examination by Denny and Fuss of the effect of automation on the occupational demand for four categories of labour in Bell Canada: telephone operators, plant craftsmen, clerical workers and white collar employees (a residual group). The measure of technological change was the percentage of telephones installed that had access to direct distance dialing. They found that technical change was capital using and labour saving, with the labour-saving impact being felt most severely by the least skilled occupations, the operators category. The impact was least significant for white-collar workers, presumed to have higher skill levels.[11]

PERSPECTIVE ON EMPLOYMENT OUTLOOK

The data described in this section point to certain implications for employment trends in the telecommunications industry. One is that the overall growth of this sector will open up employment opportunities requiring above-average education levels. To the extent that these are more favoured

jobs in the priorities of policymakers, there is a more pressing rationale to eliminate regulatory barriers to the industry's growth. A discussion of such barriers, along with their impacts on economic efficiency, appears in chapter 6.

The rapid rate of technological change that characterizes the industry also has important implications. While, on balance, technological change in the telecommunications industry will likely reduce overall employment requirements for any given level of output, it will also likely encourage a shift in demand away from relatively unskilled occupations toward relatively skilled occupations. Abstracting from the macroeconomic issue of how and where displaced, less-skilled workers will be reabsorbed into the work place, it would seem that the telecommunications sector represents a source of new employment that contradicts the popular stereotype of employment trends in the service sector, e.g., counter work at fast food outlets. In this regard, regulatory and other government imposed barriers to implementing new technology could mitigate the employment opportunities for skilled, educated workers that are created by the major technological changes outlined previously.

NOTES

1. See D.A. Ford and Associates Ltd., Study of Employment in the Communications Industry, op. cit., p. 9.
2. Ibid., p. 8.
3. Ibid., p. 10.
4. Data was collected from firms accounting for $275 million in annual telecommunication expenditures and employing 615 individuals in various capacities related to the telecommunications function. The particular functions were not specified. See Ibid., pp.13-14.
5. Unfortunately, a more detailed breakdown of these occupational categories is unavailable.
6. F. Kiss and B. Lefebvre, "Econometric Models of Telecommunication Firms: A Survey," *Revue Economique*, Vol. 38, No. 2, March 1987, pp. 307-37.
7. For a complete summary of all the economic properties of the estimated cost functions, see Kiss and Lefebvre, op.cit., table 6, pp. 356-357.
8. N.H. Rosenthal, "The Shrinking Middle Class: Myth or Reality," *Monthly Labor Review*, U.S. Department of Labor, Bureau of Labor Statistics, Vol. 108, No. 3, March 1985, pp. 3-10.
9. Robert Lawrence, "Sectoral Shifts and the Size of the Middle Class," *Brookings Review*, Fall 1985, pp. 3-10.
10. Patrick J. McMahon and John H. Tschetter, "The Declining Middle Class: A Further Analysis," *Monthly Business Review*, September 1986, pp. 22-26.
11. Michael Denny and Melvyn Fuss, "The Effects of Factor Prices and Technological Change on the Occupational Demand for Labour: Evidence from Canadian Telecommunications," *Journal of Human Resources*, Vol. 17, 1983, pp. 161-175.

CHAPTER 5

DEMAND FACTORS

The preceding chapter concluded that employment in the telecommunications industry is primarily a function of the growth in overall demand for telecommunications services and productivity change in the industry, including a labour-saving bias in technological change. In this chapter, the factors that influence the overall demand for telecommunications services will be considered.

GENERAL DEMAND PATTERNS

Residential subscribers (households) and business subscribers constitute the major customer classes for telecommunications services. Each category accounts for roughly 50 percent of total revenues earned by telecommunications companies. Each also accounts for a roughly proportionate share of the two main revenue categories, i.e., local service and long-distance service. Specifically, residential subscribers accounted for approximately 44 percent of all local revenue earned by Telecom Canada member companies in 1983 and around 62 percent of all toll revenue.[1] Nevertheless, the average residential subscriber is a much less intensive long-distance caller than the average business subscriber. This is illustrated by (among other things) the following statistic: a survey of Ontario residential subscribers found that around 6 percent of all calls made per week, on average, were long-distance calls. For a sample of small business survey respondents, the percentage of all calls that were long distance averaged around 18 percent.[2] In a similar vein, Telecom Canada estimated that the average number of toll calls per month per residential customer in 1983 ranged from 0.9 to 19 (depending upon the customer's income level). The average number of toll calls per month per business customer ranged from 51 to 1,089 (depending upon the size of the business).

For some businesses, expenditures on local service are also significant. In particular, banks, trust companies and other organizations with widespread branch networks depend heavily on local telephone service, and

much of their telecommunications expenditures are in this area. Travel and real estate agencies similarly generate a high volume of local traffic, as do firms involved in information intensive industries such as telemarketers and market research companies. The concentration of local usage among a relatively small number of businesses is suggested by Bell Canada data which indicate that approximately 50 percent of private branch exchange (PBX) traffic is generated by only 12 percent of business subscribers with PBXs; 22 percent of users of key telephone systems generates 50 percent of the total traffic of such users. And individual line business usage is similarly distributed.[3]

For most large, multiplant Canadian companies, the bulk of their telecommunications-related expenditures are for various kinds of long-distance services. Expenditures in this area are also highly concentrated. For example, 5 percent of Bell Canada's customer accounts generate 58 percent of the company's message toll service (MTS) revenues, and another 5 percent of its accounts generate 41 percent of total wide area telephone service (WATS) revenues. In B.C. Tel the concentration is even higher: 5 percent of customers generate 72 percent of business MTS revenues, and 1 percent of the company's customers generate 100 percent of WATS revenues.[4]

Available evidence indicates that telecommunication costs for Canadian firms constitute, on average, a relatively small portion of the total cost of doing business. Specifically, input-output tables for 1981 indicate that, on average, Canadian firms' expenditures on telephone and telegraph services were 0.7 percent of their total expenditures in 1981, up from 0.54 percent in 1961.[5] Table 43 reports the ten industries with the largest absolute expenditures on telecommunications in 1981, while table 44 reports the ten industries with the highest percentage of expenditures devoted to telecommunications.

Tables 43 and 44 illustrate a number of points. One is that the usage of telecommunications in business varies across different sectors, both in absolute and relative terms. The ten industries listed in table 43 accounted for about 62 percent of the approximately $4 billion spent by all industry sectors included in the Statistics Canada Input-Output tables.[6] A second point worth noting is that the most intensive users of telecommunications services are all service sector organizations.

Distinctions in telephone usage patterns are also evident by size of business. Based on a survey of approximately 40 large businesses across Canada, D.A. Ford and Associates found that public (message toll service) and private long-distance voice services account for 33 percent of total telecommunications expenditures, while local voice services account for about 29 percent of their expenditures. Together, data, satellite and special

Table 43

Telephone and Telegraph Expenditures for Top Ten Industry Sectors, 1981

(Absolute Expenditures)

Industry	Expenditures ($ millions)
Other Financial, Insurance and Real Estate	555
Wholesale Trade	461
Retail Trade	335
Health Services	209
Banks and Credit Unions	201
Miscellaneous Services to Business	191
Railway Transport	148
Truck Transport	132
Accommodation and Food Services	123
Communications Industries	106
Total	2,461

Source: *Federal-Provincial Examination of Telecommunications Pricing and the Universal Availability of Affordable Telephone Service*, p.303.

Table 44

Telephone and Telegraph Expenditures for Top Ten Industry Sectors, 1981

(Relative Expenditures)

Industry	Percentage of Total Expenditures Devoted to Telecommunications
Radio and TV Broadcasting	5.2
Health Services	3.0
Banks and Credit Unions	2.8
Railway Transport	2.7
Miscellaneous Services to Businesses	2.4
Advertising Services	2.3
Wholesale Trade	2.1
Other Finance, Insurance and Real Estate	2.0
Construction – Other	2.0
Insurance	1.7

Source: *Federal-Provincial Examination of Telecommunications Pricing and the Universal Availability of Affordable Telephone Service*, p.303.

assembly or non-tariffed services account for just over 38 percent of their telecommunication expenditures.[7] In another survey, Ford and Associates looked at telecommunications expenditures of 40 small- and medium-sized businesses in the Ottawa area. Message toll service accounted for 45.1 percent of total communication costs, while private line voice was 10.4 percent. Thus, total long-distance voice services accounted for 56.5 percent of total telecommunications costs. Total local service was 33.2 percent of total telecommunications costs.[8]

SPECIFIC DETERMINANTS OF DEMAND

The specification of demand functions for telephone service involves considerations beyond the usual variables of price and income. Furthermore, individual demand for telephone service represents demand for final output, i.e., the completed call provides "utility" directly. On the other hand, business demand for telephone service is a derived demand as telephone service is an input into the firm's production function. In the case of either type of consumer, the correct specification of telephone demand functions requires the incorporation of the various characteristics of telephone service that influence demand for the service. The resulting specifications can potentially be quite complex. While it is beyond the scope of this report to detail the various theoretical approaches, we will summarize the main considerations in modelling telephone demand.[9]

From a theoretical viewpoint, four characteristics of telephone service should be accounted for to yield correctly specified telephone demand functions. First, the interdependence of preferences across subscribers implies a consumption externality. This externality arises in two ways: (1) the connection of a new subscriber will benefit existing subscribers as the number of connections is increased (access externality), and (2) participation of a second party is required for the completion of a call (use externality). The interdependence of preferences suggests that the telephone is an illustration of a public good. Second, connection to the telephone system indicates a willingness to pay for the option to make or receive calls although this option may never be realized. Hence, option demand is a characteristic of telephone demand. Third, the attributes of telephone calls—type, time of day, distance and duration—must be included in the demand for telephone service. Finally, access demand must be distinguished from use demand. The former refers to demand for access to the system and the latter to demand for use of the system once access has been secured.

A substantial amount of econometric modelling has been done of the demand for telephone services, mostly with regard to Bell Canada sub-

scribers. The most comprehensive, recent study of which we are aware estimates demand models for the following output categories: customer dialed long-distance message service (peak and off-peak hours), residence access service, and business access service.[10]

The key results can be summarized as follows. The price elasticity of demand for the customer-dialed peak category of message toll service is -0.44; this indicates that demand is inelastic with respect to price. The elasticity of demand with respect to real income (real gross domestic product) is 0.38, indicating that this category of service is characterized as being income inelastic. The elasticity coefficient for market size equals 0.73, where market size is represented by weighted potential toll connections. The market size variable proxies the external benefits to individual subscribers from having access to a greater number of potential connections. This latter variable had the strongest statistical influence on toll demand and therefore bears some consideration. In contrast to the often used telephone subscriber or population measures of market size, the potential toll connections variable explicitly reflects the interdependence of toll calling among subscribers. In effect, increases in the number of telephone subscribers result in proportionately higher increases in the number of potential toll connections.

Empirically, therefore, increases in potential toll connections result in less than proportionate increases in the demand for customer dialed long-distance calls in the peak period; however, the coefficient implies that growth in network access lines results in more than proportionate increases in long-distance calling.

The customer-dialed off-peak category of message toll service (MTS) had two prices in the model to account for changes in the weekend discount structure which took place during the sample period. For the primary price variable, the elasticity coefficient was -0.43. The income elasticity coefficient was 0.41;[11] and the elasticity coefficient for market size was 1.0. Hence, the results for customer-dialed off-peak MTS parallel those for on-peak MTS.

Residence access service is taken to be the basic local service offered by Bell Canada. The price elasticity coefficient was -0.048; the income elasticity coefficient was 0.20, and the elasticity with respect to market size was 0.81.[12] The other major category of basic local service is business access services measured as a weighted sum of business main services plus additional lines, PBX trunk lines and Centrex CO lines. The long-run price elasticity coefficient for this service category is -0.16; the long-run income elasticity coefficient is 0.78, and the long-run elasticity coefficient for market size is 0.58.[13]

In summary, these Bell Canada studies suggest that demand for all categories of telephone service in Canada are price and income inelastic. Demand is especially price inelastic for local service. The major variable influencing demand for telephone service, over time, is the number of potential connections which ultimately proxies the overall population of residences and business establishments.

These Bell Canada studies are consistent with an extensive number of other studies of the demand for telephone service in North America. In particular, all available studies suggest that the demand for local service is relatively insensitive to price changes.[14] The magnitudes of the estimated price elasticity coefficients for local service found in these and other studies are quite similar to the magnitude of the coefficients reported in the Bell Canada study. However, there is some conflicting evidence with respect to business demand for long-distance services. A number of studies find that business demand for message toll service and WATS is price elastic.[15] Adjudication of the conflicting evidence is beyond the scope of this study; however, the price elasticity of demand for long-distance service has important public policy implications which are reviewed next.

POLICY IMPLICATIONS OF PRICE ELASTICITIES OF DEMAND

A basic issue facing telecommunications regulators is rate rebalancing. That is, given apparent reductions in the costs of long-distance services relative to local services, the regulated price structure, which has kept long-distance tariffs from declining commensurate to the decline in the costs of providing these services, is becoming increasingly inefficient. It has also been recognized that regulated long-distance rates serve as an inducement for intensive callers to bypass the common carrier system, even if the real costs of using the common carrier's network is less costly.

A major reservation about mandating lower long-distance rates on the part of the federal regulator is the perception that lower rates will lead to lower long-distance revenues earned by the telephone companies. If costs do not decline proportionally, profits of the telephone companies will also decline. In order to maintain required returns to capital, local service rates will need to be increased in order to compensate for the loss in long-distance revenues. This rebalancing of prices, in turn, has raised concerns about "adverse" redistribution effects; i.e., the costs of a relatively small number of businesses will decline, while the costs of a relatively large number of residential subscribers will increase. It has also raised a concern that

certain residential subscribers will be forced "off-the-network" by higher access charges.[16]

The price elasticity of demand for long-distance service obviously figures critically in this reservation about rate rebalancing. Specifically, if long-distance demand is price elastic, lower long-distance rates will lead to increased rather than reduced revenues. This basic argument has been made by CNCP Telecommunications in proposals to the CRTC to provide inter-exchange services to telephone subscribers in competition with Telecom Canada members. As noted above, unresolved methodological issues related to estimating the price elasticity of demand for long-distance service prevent an unequivocal resolution of this debate. There is less debate, however, about the likely impact of higher local rates. The evidence is persuasive that access will be relatively unaffected by higher flat-rates for local service since demand for access is extremely price inelastic.

Notwithstanding the average price inelasticity of demand for access to basic telephone service, concern has been expressed that specific groups of customers (mainly the elderly, the low-incomed and the handicapped) will be forced to drop their subscription to basic telephone service if local rates increase substantially. Unfortunately, detailed estimates of local services price elasticities are unavailable by specific demographic and income groups; however, concern about unfair burdens being placed on specific groups of local subscribers can be mitigated to a large extent by the implementation of local measured service (LMS) pricing, a system of pricing whereby local rates are tied directly to the intensity of calling done by the subscriber. LMS pricing is discussed in more detail in chapter 6.

MAKE VERSUS BUY

Various studies of demand for telephone service provided by common carriers implicitly consider the tradeoff between using the facilities of common carriers and transporting information in other ways, including establishing in-house telecommunications facilities. Specifically, the estimated price elasticity coefficients should reflect the availability of substitutes, including in-house facilities. The problem is that the price elasticity coefficient per se is a relatively crude measure of the make-versus-buy decision. In particular, to the extent that regulatory restrictions on private ownership of telecommunications facilities are relaxed, there could be a shift toward in-house ownership of telecommunications facilities for reasons not directly related to relative prices of in-house services versus common carrier services. For example, security considerations may be of primary importance. This is apparently the motivation for private ownership of microwave

facilities on the part of public utilities such as Ontario Hydro, B.C. Hydro and the Toronto Transit Commission. These companies monitor sensitive equipment using on-line telecommunications facilities, and they apparently feel that security of the equipment as well as fast response time for repairs is best assured by ownership of the system.[17]

It is very difficult to identify the number and nature of privately owned telecommunications systems in Canada. The available evidence is qualitative rather than quantitative and suggests that utility companies, transportation companies and pipelines are the major owners of private telecommunications systems (primarily microwave systems) for purposes of monitoring the performance of their physical plants. As noted in chapter 2, an increasing number of companies are buying their own subscriber equipment rather than renting such equipment from the carriers; however, the actual carriage of telecommunications traffic largely remains the exclusive preserve of licensed carriers.

The regulatory environment restricting the carriage of telecommunications traffic has two important protagonists. One is the federal Department of Communications, which has the authority to license spectrum use. Historically, the DOC has been loath to authorize the construction of private microwave systems, partly out of concern for the preservation of signal quality as spectrum use intensified and partly (perhaps mainly) out of concern for preserving business telephone traffic on the common carrier networks. The government sees business telephone traffic as providing an important subsidy to the local telephone subscriber, and any significant movement towards developing in-house systems would threaten an important component of the revenue base upon which the subsidy structure is built.

The other important protagonist is the CRTC, which regulates conditions under which public telecommunications systems can be used. In particular, the CRTC can determine the conditions under which a system is deemed to be public versus private, which in turn can significantly affect the economic advantage of a subscriber's make-versus-buy decision. For example, a number of oil companies have considered establishing their own satellite communications system for remote data transmission, i.e., to link their frontier exploration facilities to head office and regional offices. The net advantage of internalizing this telecommunications function would be enhanced to the extent that the major companies could share the facilities and resell any excess capacity to third parties. Hence, CRTC decisions regarding allowable sharing and reselling activity can have an important bearing on the net advantage of internalizing telecommunications carriage. As noted in chapter 1, the rules regarding what is allowable with respect to

sharing and reselling are currently unclear to many business subscribers as well as to potential competitors of the common carriers.

To the extent that restrictions on reselling and sharing are relaxed, it may be anticipated that an increasing number of companies will consider establishing in-house telecommunications networks. However, interviews conducted by the author suggest that most large industrial and financial companies prefer to leave the management of large telephone networks to specialized suppliers.[18] This preference primarily reflects their view that acquisition of the specialized skills required to install and manage one's own communications network is uneconomic given current demand patterns and common carrier tariffs; however, this perspective may change if the costs of network equipment continue to decline faster than long-distance prices. Furthermore, to the extent that fibre optics are used as the primary transmission medium, concerns about "spectrum congestion" cannot be used as a rationale for restricting the establishment of private networks. One can imagine the possibility of court challenges to the DOCs policy of restricting licences for privately-owned telecommunications networks when the applicant can demonstrate that no public inconvenience is created by the network.

NOTES

1. Memo from J.G. McGregor to S. Globerman, dated March 15, 1984.
2. See Coopers and Lybrand Consulting Group, "Survey of Local Telephone Pricing and Usage Issues among Customers in Ontario," Volumes I and II, prepared for the Ontario Government, Ministry of Transportation and Communications, mimeo, October 1985 and February 1986.
3. See Federal-Provincial Examination of Telecommunications Pricing and the Universal Availability of Affordable Telephone Service, op.cit., p. 301.
4. Ibid., p. 301.
5. Ibid., pp. 302-303.
6. Ibid., p. 304.
7. See D.A. Ford and Associates, "The Impact of International Competition on the Canadian Telecommunications Industry and Its Users," Ottawa, mimeo, August 1986.
8. Ibid.
9. For a complete review, the reader is referred to L.D. Taylor, *Telecommunications Demand: A Survey and Critique*, (Cambridge, Mass: Ballinger Publishing Company) 1980.
10. See Bell Canada, "Econometric Models of Demand for Selected Intra-Bell Long Distance and Local Services," Bell (CRTC), 11 April 86-1713, mimeo, Attachment I. Price deflated revenues are used as the measure of quantity demanded in the various models.
11. The income variable in the off-peak period was measured as retail sales in Ontario and Quebec to reflect the discretionary purchasing patterns of residential customers.
12. In this model, the measure of market size is the number of households in Ontario and Quebec.
13. All of the foregoing results are taken from Bell Canada, op.cit.
14. For a review of these studies, see Steven Globerman, "Economic Factors in Telecommunications Policy and Regulation," paper presented at IRPP Conference on Competition and Technological Change, Toronto, September 25-26, 1984, and Lester Taylor, op.cit.
15. See Taylor, op.cit., p. 99.

16. Many of these issues are discussed in Steven Globerman and William T. Stanbury, "Changing the Telephone Pricing Structure: Economic, Political and Social Considerations," *Canadian Public Policy*, Vol. XII, March 1986, pp. 214-226.
17. Author's interviews with Ontario Hydro and B.C. Telephone.
18. See Steven Globerman, in conjunction with Techno-economic Research Unit, "A Marketing and Economic Evaluation of the Potential for Resale and Sharing," report submitted to the Department of Communications, mimeo, 1984.

CHAPTER 6

POLICY ISSUES

INTRODUCTION

The changing structure of the Canadian telecommunications industry from a regulated monopoly to regulated competition, the convergence of telecommunications and computer technology, and the desire to establish international rules for trade in service industries raise a host of political, social and economic issues for Canadian telecommunications policymakers. In this chapter the major public policy issues surrounding the telecommunications industry are discussed and related, where possible, to characteristics of the industry described in preceding chapters. No suggestion is implied here that all relevant issues have been discussed since the list of issues in this critical and highly regulated industrial sector is virtually endless. Nevertheless, most economists who have studied the telecommunications industry would probably also identify the following issues as among the most important and compelling ones facing policymakers. As will be evident from the following discussion, the issues identified are inextricably linked.

DEREGULATION

Perhaps the most critical issue facing Canadian policymakers is the extent to which telecommunications services in Canada should continue to be subject to extensive regulation, with respect to both prices and the companies that are allowed to provide specific services. Given a tentative decision to move towards a deregulated industry structure, a corollary issue is how to move currently regulated services into the set of market-determined activities. This includes a number of related considerations. Should constraints be placed on who can compete in market-oriented sectors? Should constraints be placed on the behaviour of any of the competitive participants? How quickly should the transition from a regulated to a competitive structure take place?

One broad policy approach is to allow open entry into all telecommunications sectors, allow product and service offerings to be determined completely by private sector participants, and allow prices to be set completely in the marketplace. This might be considered the epitome of deregulation. The approach has attracted a number of criticisms. Perhaps the most fundamental concern remains that the industry is a natural monopoly and that, without regulation, telephone subscribers will be gouged by the established carriers. As noted previously, available evidence does not support the notion that the telecommunications industry is a natural monopoly. In particular, economies of scale seem pronounced only in the local loop portion of the industry. Hence, concern about long-run anti-competitive pricing seems relevant, if at all, only for local subscriber services.

A related concern that has been expressed is that competition in sectors of the industry that are nominally contestable (or capable of inter-firm rivalry) will be thwarted by predatory behaviour on the part of established carriers. In particular, critics have suggested that established carriers will subsidize predation in the openly competitive sectors of the industry with profits earned in the regulated sectors. This argument rests critically upon the assumption that common carriers routinely earn more than their cost of capital on regulated activities.[1] Evidence for Canadian terrestrial carriers does not support this assumption.[2] Furthermore, the rapid diversification of Bell Canada Enterprises out of the traditionally regulated sectors of the telecommunications industry suggests that it may not be earning significantly more than its cost of capital in those activities, on the margin.

Yet another reservation that has been expressed about deregulating entry restrictions into the MTS (switched long-distance voice) market is that the current pattern of pricing, in which long-distance callers subsidize local subscribers, will encourage entry by "arbitrageurs" who are not necessarily as efficient as the existing common carriers. Since entrants do not necessarily subsidize the local segment of the industry, they presumably can afford to undercut the long-distance prices of the common carriers, in effect arbitraging the difference between regulated long-distance prices and the marginal costs of providing long-distance service. In this context, presumably it would be more efficient in terms of real resources used to allow the common carriers to provide the incremental long-distance service if they could do so at lower cost than new entrants.

The relevant response to this concern would seemingly be to allow telephone rates to adjust toward cost in both the local and long-distance sectors so they do not act as incentives for "inefficient" entry. This suggestion has been made by Bell Canada, among others, as part of an emerging

policy debate on so-called rate rebalancing, i.e. moving local rates up toward the average cost of providing local service and moving long-distance rates down toward the average cost of providing long-distance service.[3] To date, concern about the adverse redistribution effects of such a rebalancing of rates has stifled any significant move in this direction by the regulator. In particular, there is a concern that most local subscribers will have to pay substantially higher local rates, while the benefits of lower long-distance rates will largely be captured by a handful of business subscribers. This redistribution issue will be considered more closely later in this chapter.

First, let's consider the reverse side of the deregulation issue. What are the potential costs of failing to deregulate the telecommunications sector in a timely manner? In this regard, the concern expressed by the telephone companies is that large business customers will increasingly turn to alternatives to the common carrier network for their long-distance needs. Since direct competition in the industry is restricted, the most likely alternative is some form of bypass of common carrier facilities. Bypass could occur through the establishment of private networks; however, limited numbers of terrestrial rights-of-way and restrictions on private ownership of satellite transponder capacity makes this alternative of limited relevance for the present

Of more immediate concern is the possibility of cross-border bypass. The possibility for Canada to Canada traffic being carried through the United States arises with a network having two nodes in Canada. Double border crossings of this nature are prohibited by Canadian tariffs and regulatory policies; however, private network arrangements have been designed to circumvent the border-crossing policies established by the major Canadian and U.S. carriers as part of their interconnecting agreements. The normal arrangement between Canadian and U.S. carriers is that the border crossing for provisioning purposes is the one (out of 11 designated border crossings) which is nearest the straight line joining the points of origination and termination of the private line. This is significant because, unlike message toll services which are billed on an end-to-end basis, private line services are billed by each carrier, Canadian and U.S., independently, and the distance to the border from the point of origination or termination is the basis for rating. Lower private line rates in the U.S. provide an incentive for users to establish "dummy nodes" in the U.S. immediately adjacent to the established border crossing point nearest the Canadian origination point of the circuit in order to maximize the use of U.S. facilities.[4]

Another potential form of international bypass involves cross-border reselling. As noted previously, this alternative allows subscribers to access U.S.-based facilities by dialing a number in a nearby U.S. calling zone and then "patching into" one of the discount U.S. services. To date, any such form of resale has been strictly for calls terminating in the U.S., since it is illegal for any Canadian carrier to form a Canada to Canada circuit through the United States. Nevertheless, it is conceivable that such Canada to Canada connections could be made through the use of independent cross-border resellers operating in different regions of Canada. Thus, a caller in Vancouver would dial a switch in Bellingham, Washington, and then dial the number of a telephone switch located in Buffalo, New York, belonging to another Canadian reseller. Once patched into that switch, he would dial a number in Toronto to complete the Canada to Canada connection. In effect, cross-border resellers would operate the "dummy nodes" that large private companies might presumably operate for themselves.

The obvious consequence of bypass is that revenues that would have been captured by Canadian carriers are diverted to U.S. carriers, although there is some offset in the form of increased traffic to and from local border crossings. The revenue base to subsidize local and rural subscribers will erode in any case. Net revenue that might have gone toward funding research and development and innovation in Canada will be dissipated in bypass activity.

A survey by D.A. Ford and Associates of 44 of Canada's largest companies across 27 industry sectors found a very small amount of direct or indirect bypass activity compared to what could be occurring in view of the extent of the U.S. and overseas business dealings of these major telecommunications users and the lower U.S. telephone rates. Ford concludes that almost all long-distance voice services and all data services are provided by established Canadian carriers, although access to discount telex providers is more prevalent because of the larger discounts available.[5]

A number of reasons were given for the limited bypass activity currently being undertaken. The dominant reason offered was that bypass is against company policy since it would contravene Canadian telecommunications regulations or policies. Another reason prominently cited is that resellers are an unknown quantity, and it is therefore risky to entrust critical telecommunications functions to them. A third set of reasons is that current volumes of traffic do not justify the set-up expenses associated with bypass or no viable bypass alternative was currently available or the respondent was unaware of bypass alternatives.[6]

The Ford study estimates that the revenue loss from Canadian carriers to cross-border resellers is not more than $1.5 million Canadian per year,

while the revenue loss to discount telex providers is approximately $3.1 million Canadian per year.[7] The relatively limited use of the bypass alternative is a consequence of several factors. One is that total telecommunications expenditures represented a relatively small share of purchased inputs for the companies interviewed. Hence, demand could be expected to be relatively price inelastic. Second, at current exchange rates the cost savings associated with international bypass apparently do not justify the lower quality of service and the inconvenience resulting from having to make two calls in order to complete one. Nevertheless, Ford concludes that if the Canadian and U.S. dollars were at par, large positive financial incentives to use cross-border resellers would exist and significantly more resale activity would be expected.[8]

There is no reason to necessarily expect that the Canadian and U.S. dollars will move towards parity in the near future. However, the Ford study does underscore the potential for a significant amount of telecommunications activity to "migrate" south of the border if Canadian telephone rate structures move increasingly out of line with the rate structure in the United States. It should also be noted that even in the absence of bypass, the current telephone rate structure induces inefficiencies in the use of telecommunications capacity. Specifically, underpricing local service leads to excessive usage of local capacity. That is, usage of local capacity will be made, on the margin, where the social costs of providing the incremental service exceed the social benefits of the service provided. This bias toward excessive use of local service is accentuated by the fact that local service is priced at a flat rate. Hence, there is no price-related incentive to economize on the time spent on local communications transmissions.[9] On the other hand, the overpricing of long-distance service leads to an under-utilization of long haul telecommunications capacity. That is, long-distance calls are suppressed where the social value of those calls may exceed the true costs of provisioning the calls.

The social welfare losses associated with an inefficient telephone pricing structure depend on the price elasticities of demand for local and long-distance service. A number of U.S. economists have estimated the annual loss from overpricing toll calls and underpricing residence access. They conclude that the main efficiency gains from rate rebalancing come from lower message toll rates. This is because demand for long-distance service is much more price elastic than demand for basic access to the telephone system.[10] Using the U.S. estimates as a guideline, Globerman offers a crude estimate of the welfare losses from telephone cross subsidies in Canada of around $2 billion per year.[11] This order of magnitude estimate is in rough agreement with the estimate of a more recent study that a 40 percent across the board toll rate reduction would have provided a net gain in consumer

surplus of over $0.6 billion per year in Canada in 1982.[12] It should be emphasized that all welfare loss estimates are static in nature. They do not allow for the possibility that increased competition in the industry would promote innovation and other manifestations of dynamic efficiency. Since competition in Canada's long-distance sector is being denied, ostensibly to protect current cross subsidies in the pricing structure, extant cross subsidies are arguably extracting a heavy toll in the form of allocative inefficiencies.

INTERNATIONAL TRADE

The issue of international trade in services has received a tremendous amount of attention since 1980 when the U.S. began making a strong diplomatic effort to have services included in the next round of multilateral trade talks. At this time, it is still a contentious issue whether and how governments should negotiate internationally traded services. Canadian concern is heightened by the current Canada/U.S. free trade talks, slated to include the service sector, and by the increasing risk of international bypass.

Consideration of international trade issues insofar as telecommunications is concerned is complicated by two factors. There is no universally accepted definition of telecommunications trade, and basic data on trade flows for various segments of the industry are lacking. With respect to the first point, trade in telecommunications service is ultimately bound together with formal and informal restrictions on the ownership of facilities and with trade in telecommunications equipment. While there are no explicit restrictions on foreign ownership of basic telecommunications carriage facilities in Canada, most are Canadian-owned.[13] Furthermore, it is unlikely that a takeover of a Canadian carrier by a foreign-based company would be approved by the government under the Investment Canada Act. Therefore, given existing restrictions on competition in the provision of basic local and long-distance services, the only international competition possible in these services takes the form of cross-border bypass described above.

The Canadian market for enhanced services was ostensibly opened to entry in August 1984. However, effective barriers to entry still exist, given the reluctance of the Department of Communications to authorize applicants the right to construct private microwave transmission systems. Furthermore, there are limits to bypassing Canadian networks by using U.S.-based value added networks. For example, the Canadian government insists on local data processing for banking data, and the government and the common carriers have longstanding policies that limit the cross points

for telecommunications from the U.S. to Canada to official network carriers. These rules make it impossible to rely on U.S. value-added networks to handle data shipped from a Canadian origin to a Canadian destination, although one way traffic in either direction is permissible.

Given a careful focus on trade in telecommunications services, it will be difficult for Canadian policymakers to avoid U.S. charges of having erected direct and indirect barriers to trade through de facto ownership restrictions. Such charges may be especially vocal since U.S. policymakers apparently see existing ownership patterns and regulations in the Canadian telecommunications industry as non-tariff barriers to trade in telecommunications equipment. Specifically, U.S. equipment suppliers see the ownership link between Bell Canada and Northern Telecom as leading to a preferred supplier relationship for Northern. Given that Bell Canada enjoys regulatory protection of its major share of the basic services market in Canada, U.S. suppliers see the Canadian market for network equipment basically closed to them. According to AT&T Canada Inc. Vice-President Don Morrison, "his firm intends to break the preferred supplier arrangement in Canada under the auspices of the free trade talks."[14] At the same time, officials of Northern Telecom have charged that telcos in the U.S. have preferred supplier arrangements with AT&T, although divestiture of the Bell Operating Companies from AT&T could gradually erode the historical purchasing preference for Western Electric equipment. More recently, the Senate Finance Committee passed an omnibus trade bill containing a telecommunications trade act.[15] Under this provision, if U.S. trade representatives identified foreign practices that limited U.S. entry into foreign telecommunications markets, U.S. retaliatory action could be approved.

The paucity of data regarding international trade in telecommunications services makes it difficult to evaluate the current status of bilateral trade flows, let alone to assess the potential impact of freer trade on such flows. Statistics Canada publishes data on trade in communications services; however, these data suffer from two shortcomings. First, the communications data include telephone, telex, telegraph, data transmission, courier and postal transactions, which is too broad a definition for our purposes. Second, there is no distinction made between basic and enhanced services, which constitute two very different markets particularly with regard to regulatory conditions. For the aggregate communications services category, Canada enjoyed a trade surplus with the United States for 1983 and 1984 equal to $66 million in each year. For those same years, there was a deficit with the EEC of $30 million and $20 million respectively, and a surplus with "other" countries of $8 million in 1983 followed by a deficit of $4 million in 1984. Total exports were $238 million in 1983 and $304 million

in 1984; total imports were $194 million in 1983 and $262 million in 1984.[16]

Recent data from External Affairs Canada indicates an equipment trade deficit with the U.S. in 1985, with exports valued at $22 million and imports valued at $23 million. They do not provide a breakdown for transborder billings but merely report these to be $550 million in 1985.[17] Given that telecommunications is a subset of these trade flows, it is apparent that bilateral trade in telecommunications services is relatively limited compared to overall domestic demand for such services. With the elimination of specific regulatory restrictions noted above, it is likely that imports of these services will increase. Unfortunately, there are no publicly available studies that evaluate the implications of freer trade in telecommunications services on domestic common carriers. However, available evidence indicating that smaller carriers, such as Alberta Government Telephones, enjoy productivity levels comparable to those of Bell Canada suggest that differences in domestic market size do not necessarily dictate that Canadian carriers would be at an inevitable comparative disadvantage given current demand levels.

DISTRIBUTIONAL EQUITY

While most observers agree that the current telephone pricing structure induces significant inefficiencies in the utilization of the telephone network, some would argue that such inefficiencies should be tolerated in the interests of social equity or fairness. The more specific concern is that lower long-distance rates will primarily benefit large business subscribers, while higher local service rates will primarily harm residential subscribers. Moreover, subscribers in densely populated urban areas will presumably gain from a movement toward cost-based pricing, while rural subscribers will presumably see their telephone costs increase. Concern has also been expressed that the imposition of cost-justified access charges will cause certain underprivileged members of society to discontinue their telephone service. A critical issue facing policymakers, therefore, is to ensure that the efficiency gains from a more economically rational pricing structure are widely shared and that specific underprivileged groups in society do not suffer unduly from the relative price changes that take place.

The precise distributional impact of any repricing scheme is difficult to determine since it depends, in complex ways, on a number of economic variables, including:

- the price and income elasticities of demand for access to the network, local calls and long-distance service, respectively;

- the distribution of use (among various classes of customers) of local exchange and long-distance services;
- the responsiveness of customers to peak/off-peak pricing of metered services; and
- the elasticities of supply for local and long-distance services, respectively.

In the absence of detailed quantitative estimates of these relationships, certain implications can be drawn from the available evidence on demographic usage patterns. One is that an increase in local service revenues, offset by an equivalent increase in toll revenues, will on balance redistribute income from lower to higher income individuals. This result is suggested by the observation that total toll calls and toll conversation time are more sensitive to increases in income at lower income levels than are local calls and local conversation time. It is also suggested by the observation that over 90 percent of all calls made in Canada are local calls, while long-distance residential calling tends to be highly concentrated among a relatively small number of residential and business subscribers.[18] Furthermore, approximately 30 to 40 percent of residence customers make no long-distance calls in any given month. Since the poor and the elderly are not much different from the average residential subscriber in this regard, rate rebalancing does raise some non-trivial concerns about vertical equity, although the absolute increases in local service costs will be relatively small even given substantial (e.g., 100 percent) increases in average local subscriber rates. Available data also show that the proportionate increase in local monthly residential bills across income classes is nowhere near as marked as in the case of toll bills, and that both rural residential and business subscribers do more toll calling than their urban counterparts, although rural local bills are disproportionately lower than urban local bills.[19] These data therefore suggest that simple rate rebalancing schemes could have a regressive impact upon income distribution and, on balance, could worsen the relative income positions of rural subscribers.

The aforementioned represent direct effects of rate rebalancing. Potentially important indirect effects should also be considered. The latter are associated with pass-throughs of lower business telecommunications costs in the form of lower prices. The income distributive impacts of these indirect consumer benefits are unclear; however, one cannot necessarily presume that they will be income progressive.

While a detailed discussion of possible approaches toward mitigating any undesirable distributive consequences of rate rebalancing cannot be undertaken here, a number of guidelines for policymakers can be suggested. One is that it is usually more efficient to subsidize targeted groups of

callers directly through welfare allowances to maintain a certain minimum level of telephone service than to subsidize a broad group of individuals through a complex, and somewhat invisible, system of cross subsidies embedded in the pricing structure. Second, the potential for sharp increases in local rates associated with rate rebalancing can be mitigated through the implementation of usage sensitive pricing schemes in place of flat monthly amounts for unlimited calling in a defined geographic area. One such general approach is identified in the literature as local measured service (LMS) pricing. The basic feature of LMS pricing is that charges for local calling are linked to the marginal costs created by the subscriber's use of the local network. The latter will be influenced by characteristics such as quantity of calls, duration of calls, timing of calls and so forth.[20]

Within the context of the current telephone rate structure, LMS is a vehicle that can serve at least three purposes. First, it can be expected to improve allocative efficiency in the provision of local services by bringing marginal cost and marginal revenue into closer alignment. Second, LMS can improve fairness by requiring bigger users (cost causers) to pay more for local service than those who impose lower costs on the system by their smaller volume of use. Third, LMS can provide a way of lessening the impact of rate rebalancing on the price of local exchange service.

With respect to the first point, by suppressing marginal calls whose values to callers are less than their incremental costs, LMS can reduce the capacity costs of the local telephone network, thereby freeing up resources to produce higher valued services. This potential efficiency gain is becoming increasingly relevant over time with increased on-line use of home computers. The efficiency gains to LMS are greatest when usage prices during peak periods equal the incremental costs of usage plus the incremental costs of measurement and billing, while usage prices during off-peak periods are kept at zero.[21] But, in any case, the allocative efficiency gains in the local network per se will be small given the inelastic demand for local service.

The best "guesstimates" are that 60 percent of extant subscribers would pay the same local bill or less under an LMS system compared to a flat rate system that raised the same amount of local revenue.[22] Furthermore, the evidence does not suggest that moving from flat rate pricing to LMS pricing per se would substantially alter the distribution of income in any adverse way. There is no basis for concluding that local calling patterns are consistently related to levels of household income. Available evidence also indicates that the elderly, the handicapped and other shut-ins make fewer social and business calls than the average telephone customer. Thus, LMS affords the elderly, the handicapped and shut-ins a cost savings, on average,

over current flat rates. The main losers in a move from flat rates to LMS pricing are families with teenaged children and businesses that rely heavily upon telephone solicitation. On balance, therefore, the distributive consequences of higher local rates appear more favourable under LMS than under flat rate pricing.

In sum, even in the absence of rate rebalancing, there are compelling arguments for implementing an LMS approach toward local service pricing. This is not to deny the complexities attached to such a move. One is the propensity of many local users to overestimate the frequency of their local calling. Another are the costs associated with monitoring and metering local calling. Potential competition from within and without the telecommunications industry is increasing dramatically. The evidence suggests that the benefits of competition are most fully captured in a deregulated environment. Ostensibly, the major (and perhaps the only intellectually credible) reservation to deregulating the long-distance segment of the industry is the skewed distribution of benefits relative to costs. The imperative for policymakers would therefore seem to be to find and implement policies that would share the benefits of deregulation more broadly without inducing serious biases in the telephone pricing structure.

CONCLUSIONS

The Canadian telecommunications industry is facing increasing competitive pressures as a result of technological changes and deregulation in the United States. The increasingly competitive environment is rendering the historical practice of value of service pricing untenable. Under value of service pricing, long-distance services subsidize local services and urban subscribers subsidize rural subscribers. Over time, the structure of cross subsidies will encourage uneconomic bypass and cross-border reselling. The latter will become an increasing reality as competition in the long-distance sector of the U.S. industry expands.[23] An increase in the value of the Canadian dollar will hasten the process.

If there is one government policy that is critical to the efficient future performance of the Canadian telecommunications system, it is the implementation of rate rebalancing whereby prices for specific telecommunications services reflect the costs of providing those services. Coincident with the implementation of a rate rebalancing programme should be a clear enunciation by the government of a commitment to open entry and price deregulation in the long-distance sector of the industry where the federal government has the jurisdiction to do so.[24] A timetable should be established and legislated. Clearly, the implementation of such

legislation will not be an easy task, as vested interest groups will raise the spectre of large numbers of subscribers dropping off the network. However, failure to make the appropriate policy changes now will lead to even greater pressures on policymakers to act in the future to plug an ever increasing number of leaks in the cross subsidy system. At that point, a legacy of inefficient bypass investment may be well entrenched in Canada.

NOTES

1. Recent literature has developed conditions under which factors such as reputation can enhance the likelihood of successful predation. However, the motives for predation in the regulatory context still derive from regulatory imperfections as manifested in the Averch-Johnson bias. A full presentation and analysis of the predation arguments as they have been applied to the telecommunications industry can be found in Steven Globerman, "Predation and Foreclosure Issues in the Telecommunications Industry," *Telecommunications Policy*, December 1985.
2. Ibid.
3. Economists have developed optimal pricing rules for regulated services which are captured in the so-called Ramsey pricing rule. This rule basically suggests that prices for different services should be inversely related to the price elasticities of demand for those services. Rate redistribution pricing schemes such as those proposed by Bell Canada move the pricing structure in the direction suggested by the Ramsey rule; i.e., prices for the more elastic long-distance service will decline; prices for the less elastic local service will rise.
4. This discussion of the economics of alternative bypass strategies is taken from D.A. Ford and Associates Ltd., "The Impact of International Competition on the Canadian Telecommunications Industry and its Users," Ottawa, mimeo, August 1986, p. 20.
5. See D.A. Ford and Associates Ltd., "The Impact of International Competition on the Canadian Telecommunications Industry and its Users," op.cit., p. 27.
6. Ibid., pp. 27-28.
7. No estimates are available of the revenue loss to Canadian carriers due to users "off-ending" from private lines or private networks in the U.S. or due to the use of "dummy nodes" to reduce private line costs. Ibid., p. 31.
8. Ibid., p. 23. Given that governments and Crown corporations are large long-distance subscribers in Canada, Ford's conclusion must be tempered by the realization that a large portion of the long-distance market in Canada may be motivated by nationalistic commitments to Canadian carriers.
9. This inefficiency is becoming increasingly significant as greater numbers of subscribers use computers to transmit voice and data informa-

tion over telephone lines. The growth of telemarketers and other telephone-based marketing research techniques is also exacerbating overuse of the local network.

10. For a review of some of these studies, see Steven Globerman, "Economic Factors in Telecommunications Policy and Regulation," paper presented for IRPP Conference on Competition and Technological Change: The Impact on Telecommunications Policy and Regulation in Canada, September 25-26, 1984, Toronto. The multiplicity of local and long-distance services, presumably characterized by different demand elasticities, raises questions about the precise reliability of social welfare loss estimates. Nevertheless, the direction and orders of magnitude of the biases created by the current pricing structure seem quite plausible.
11. Ibid., p. 61.
12. See Peat Marwick, "Impacts of Competition in Message Toll Telephone Services," a study carried out for the Department of Communications and Provincial Governments, Toronto, mimeo, September 1984, pp. VI-17.
13. Two exceptions are B.C. Telephone Company and Quebec Telephone, both of which are indirectly owned and controlled by U.S.-based G.T.E. Corp.
14. See "Nortel CEO Adamantly Opposes AT&T's Free Trade Posture in Preferential Affiliate Supply Pacts," *Canadian Communications Network Letter*, Vol.6, No. 38, November 17, 1986, p. 5. A policy proposed in July 1987 would restrict foreign ownership in terrestrial and satellite common carriers to 20 percent.
15. See Jennifer Lewington, "U.S. proposals to toughen trade rules watered down by worrying to Canada," *The Globe and Mail*, May 13, 1987, B24.
16. See Statistics Canada, *Canada's International Trade in Services*, Ottawa: Supply and Services Canada, 1986.
17. See External Affairs, Canada, "Telecommunications," mimeo undated.
18. It is estimated that the top 20 percent of residential subscribers account for around 68 percent of long-distance revenue, while the top 20 percent of business subscribers account for around 89 percent of long-distance revenue in the business sector. See Globerman, *Economic Factors in Telecommunications Policy and Regulation*, op.cit., p. 47.
19. See Globerman, op.cit., p. 69.

20. There are many different types of LMS pricing rules, and experiments with some have been carried out in the United States. This literature is too diffuse and extensive to review here.

21. This point is made in J.M. Griffen and T.H. Mayor, "The Impact of Local Measured Service on the Texas Consumer," unpublished paper, Texas A&M; University of Houston, September 1983.

22. This estimate ignores the welfare effects of call suppression. However, given the relatively low elasticities of demand for access and for local calling, the thrust of the foregoing statement is undisturbed by considerations of call suppression. For a more detailed consideration of this point, see Steven Globerman and W.T. Stanbury, "Local Measured Service Pricing or Rate Rebalancing?: Efficiency and Distributional Considerations," paper delivered at the CSRI/CRTC Conference "Local Telephone Pricing: Is There a Better Way?," Montreal 2-4, 1984.

23. A recent court decision allows the local operating companies to compete in the long-distance sector.

24. As shown in earlier sections, the CRTCs jurisdiction extends over Bell Canada and B.C. Tel territories which encompass over 70 percent of Canada's telephone subscribers. Nevertheless, we do not wish to minimize the potential problems created by a fragmented regulatory regime. Indeed, a number of observers argue that Canada's balkanized regulatory regime is a major barrier to implementing nationwide rate rebalancing and long-distance competition. A constitutional ruling from the Supreme Court of Canada on the jurisdiction of the federal government in the area of telecommunications is expected within the next two years. See Lawrence Surtees, "Telecommunications deal expected today," *The Globe and Mail*, April 3, 1987, B5.

    A recently announced telecommunications policy did little to clarify the federal government's intentions insofar as competition is concerned. Specifically, Ottawa said it will establish two categories of telecommunications carriers. The first, called Type I, include members of Telecom Canada, CNCP Telecommunications and Teleglobe Canada. Type I carriers will be allowed to compete among themselves, but new entrants will be limited "to prevent unnecessary duplication of costly facilities." All other companies, called Type II carriers, can lease facilities from the national carriers, then sell enhanced services such as mobile radio or electronic databases to the public. Unfettered competition will be allowed in this business with no foreign ownership restrictions. Under the new regime, CNCP is included as a Type I car-

rier, but it still cannot sell long-distance services in competition with other Type I firms. See Richard Blackwell, "Telecommunications Policy Promotes Some Competition," *The Financial Post*, July 27, 1987, p. 3.