

Enabling Canada's Economic Potential: ICT and National Economic Performance

**The Economic Impact of the
Information/Communications/Technology Sector
on Achieving Canada's Economic Potential**

1 June 2005



Report prepared by:
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Executive Summary

The forthcoming review of telecommunications regulation. In the 23 February 2005 federal budget, the Government announced that it will be forming a panel to review Canada's telecommunications policy and regulatory framework.² In committing to launch a review panel, the government recognised "the critical importance of the telecommunications sector to Canada's future well being."

Canada's economic record from 1950 to the present. In the 1950s and 1960s Canada's economy grew faster than that of the U.S. and progressed in closing the gap in per capita incomes. However, beginning in the 1970s both economies experienced a major drop in productivity growth. Productivity growth is one of the most important factors in generating an increased living standard. As productivity growth declined, Canada (and the U.S.) lost some of its former competitiveness, and major sectors of the economy were unable to continue to support their traditional job bases -- Canada's economy was in the process of a major upheaval and transition. In the 1990s, our economy renewed its productivity growth and underwent a major economic transformation, with the generation of 1.3 million new jobs, many of which replaced those lost in traditional manufacturing and resources.³ In 2001, Canada's economy again slowed, but outperformed that of the U.S. and productivity growth remained high.

The role of productivity growth in economic prosperity. In using the record of the past to guide policy for the future of Canada's economy, key questions that must be addressed include:

- What fuelled the 1990s economic powerhouse?
- What caused economic growth to slow after 2000?
- What does Canada need to do to enable its full economic potential?

The latter is of great importance as Canada wishes to support a high wage economy while remaining competitive in global markets. We desire a sustainable economy without a loss in standard of living, and we face the challenge of supporting an ageing population. Each of these issues are multifaceted and there are no simple answers. However, in the last few years there has been growing evidence that a major role has been played by the information and communications technology industries, or the ICT sector as it has come to be known. Not only has this sector grown to account for 5.4% of the national economy (up from only 4.0% as recently as 1997), but its impact on other sectors of the economy has been strongly positive, enhancing their performance.

The role of ICT and Telecommunications in enhancing national productivity and economic performance. This report examines the evidence regarding whether the performance of Canada's

² Minister David Emerson announced the formation of the panel on 11 April 2005.

³ These sectors experienced major increases in productivity, supporting increased economic output, but now based on a smaller job base.

ICT sector in general, and its telecommunications component in particular, has been a major factor in national economic prosperity and performance. The report then addresses the potential for telecommunications to drive further economic improvements in Canada.

Key results of this study include:

- There is strong evidence that Canada's ICT sector in general and its telecommunications sector in particular have played a strong *and causal* role in Canada's economic growth and prosperity.
- The ICT sector has grown steadily over the years, and now, accounts for 5.4% of Canada's Gross Domestic Product (GDP), up from 4.0% as recently as 1997.
- While there have been methodological arguments among researchers regarding whether and by how much telecommunications increases national economic performance beyond its 5.4% direct contribution to national GDP, recent studies and data have addressed past criticisms and continue to find a strong, causal and enduring impact of ICT investment and performance on national economic well being, far beyond its 5.4% share.
- For example research has indicated that in Canada, telecommunications has accounted for 11-14% of Canada's average annual GDP growth, more than double the size of this sector.
- One of the most important measures of long term economic performance is productivity. It is productivity which enables the nation to enjoy increases in income per capita. Research has shown that ICT contributes 25-33% of national productivity growth, even though it accounts for only 5.4% of the economy.
- The separate effect of telecommunications has also been investigated. One major study of data on 21 OECD countries found that one-third of economic growth by OECD countries can be attributed to investment in telecommunications.
- The impact of ICT generally, and telecommunications specifically, is not confined to the macroeconomic measures provided above. ICT and telecommunications are of great importance to the productivity performance and competitiveness of key sectors of our economy. Of special importance are the strategic industrial clusters which form the basis of our exports. While Canada has several strategic industrial clusters, special attention has been given to aerospace in Quebec, autos in Ontario, alternative energy sources in B.C., energy in the Western Prairies and the Maritimes, and agribusiness and resources throughout Canada. These sector all have undergone dramatic transformations which have been enabled by the deployment of ICT, and their future success will depend on further deepening their use of ICT in general and telecommunications in particular.

There is strong evidence that Canada's ICT sector in general, and its telecommunications sector in particular, have played a strong *and causal* role in Canada's economic growth and prosperity.

... ICT contributes 25-33% of national productivity growth, even though it accounts for only 5.4% of the economy.

- While much attention has been given in the media to reduced levels of telecommunications investment in Canada since 2001, in fact the sector continues to make major investments. Sector investment in 2004 was expected to have been 70% of the level in 2001, continues to greatly exceed the level which prevailed in 1990, and showed a 4.5% increase in 2004 relative to 2003.

Telecom can further enhance Canada's economic performance. The report also addresses the issue as to the future opportunities to use telecommunications to enable Canada's full potential for economic growth and productivity. While Canada achieved strong productivity growth in the 1950s and 1960s which narrowed the economic gap with the U.S., since then, our economy has not kept pace with the U.S. A major difference between the two countries is the slower rate of investment and use of telecommunications technologies in Canada. Canada appears to lag behind the U.S. by up to four years in its rate of deployment and adoption of ICT. This report finds that if Canada were to accelerate its rate of ICT investment and service deployment by two years (closing half of the gap in the Canada-U.S. gap in speed of ICT deployment), it would increase GDP by \$65-85 billion in net present value over a 10-year period. For 2005 alone, the annual increase in GDP per capita is \$495, or almost \$2000 per family of four.

This report finds that if Canada were to accelerate its rate of ICT investment and service deployment by two years (half of the Canada-U.S. gap in speed of ICT deployment), it would increase GDP by \$65-85 billion in net present value over a 10-year period.

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The report closes by discussing the key role of the regulatory environment in the performance of Canada's strategic industrial sectors. The evidence put forth in Section 4 of this report is that performance of the telecommunications sector (as with many other sectors of the economy) is strongly influenced by the regulatory regime. When and where the telecommunications sector has been governed by smarter regulatory approaches, including those which level the playing field among competitors, performance increased quickly and dramatically. Further, improved telecommunications performance drives higher performance in many other sectors of the economy which adopt and use telecommunications technologies in their own production and service delivery processes.

Smart regulation with a level playing field among competitors can be a key enabler to unlocking Canada's economic potential. While it is beyond the scope of this report to make detailed recommendations on the needed regulatory policies for Canadian telecommunications, some general comments can be made.

- First, the historical evidence from adopting smarter regulatory approaches in Canada and abroad

Smarter approaches to regulation, including those which level the playing field among all competitors, has been shown to increase performance quickly and dramatically.

makes clear that priority must be placed on having a level economic and regulatory playing field for all market participants.

- Second, where regulation exists, it must be light handed and transparent. Regulation must react quickly to changing market and technological conditions.
- Third, regulation should operate in an “ex-post mode”, not an “ex-ante mode.” Regulation should be utilised when problems arise, but should not require pre-approval of innovations by carriers in terms of new service offerings, reduced or incentivied pricing, etc.

Improved regulatory design is a win-win policy. Properly designed and implemented regulation benefits industry, via higher productivity and greater responsiveness to market changes, and users benefit from lower prices and better service. Through these outcomes, the economy ultimate benefits and experiences higher growth.

1.0 Introduction

1.1 The Telecommunications Policy Review

In the 23 February 2005 federal budget, the Government announced that it will be forming a panel to review Canada's telecommunications policy and regulatory framework. In making the announcement, the government recognised "the critical importance of the telecommunications sector to Canada's future well being." In announcing this review panel the government recognised that telecommunications policy is to benefit consumers and industry.

The panel was formed in an announcement of 11 April 2005 by Industry Minister David Emerson. He indicated that the mandate of the panel is to make recommendations for a 21st century model of regulation for Canada's telecommunications sector. The objective set for the panel was stated as follows:

The government's objective is to ensure that Canada has a strong, internationally competitive telecommunications industry, which delivers world class affordable services and products for the economic and social benefits of all Canadians in all regions of Canada."

This report seeks to underscore the importance of this review by putting forth evidence that the performance of the telecommunications sector is a strong driver of overall economic performance.

1.2 Telecommunications and the Economy

Telecommunications is part of the "high tech" sector of the economy referred to as ICT – Information and communications technology. This high growth and high wage sector of the economy has often been targeted by communities (and nations) as part of their economic development strategies. Knowledge based ICT jobs are desirable as part of a region's job base, and perhaps even more importantly, the ICT sector provides the infrastructure base which enables higher productivity and improved competitiveness in many other sectors of the economy.

Modern communications and information systems facilitate the economic transformation of traditional industries. By lowering costs, increasing productivity, and dramatically improving customer service response times, ICT enables traditional economic sectors such as resources, agriculture and manufacturing to increase their competitiveness -- even as global buying patterns have otherwise been shifting to favour low cost producers in developing countries. **Indeed, deployment of ICT is often the only means by which Canada's traditional industries can maintain their export base in today's unrelenting**

Deployment of ICT is often the only means by which Canada's traditional industries can maintain their export base with today's unrelenting global competition.

... ICT is also the underpinning of fast growing new sectors of the economy, such as alternative energy, medical and bio technologies, and other knowledge based sectors.

global competition. However, the impact of ICT is not confined to traditional economic sectors. It is the underpinning of fast growing new sectors of the economy, such as alternative energy, medical and bio technologies, and other knowledge based sectors.

This report examines the evidence for a linkage between the growth and performance of the ICT sector in general, and telecommunications in particular, to the past and future performance of Canada's overall economy. Policy and regulatory reform cannot be based only on anecdotal evidence and conventional wisdom. This report will look at the growing empirical evidence from within Canada and around the world regarding

- a) the performance of the ICT sector, and
- b) the linkage of general economic performance with the performance of the ICT sector.

The report begins with a review of the productivity performance of the Canadian economy since 1945.

1.3 Economic Transformation

It is productivity growth which sustains increasing standards of living. In the twenty five years following World War II, 1945-1970, Canada achieved strong economic growth, driven in part by strong growth in productivity. For example, from 1961 to 1973, Canadian total factor productivity grew on average 2.5% per year, compared to 1.6% in the U.S.⁴ During this period, Canada narrowed the gap with the U.S. in terms of productivity levels and income per capita.

Beginning in the 1970s, both Canada and the U.S. experienced a major reduction in productivity growth. However the slowdown in productivity growth was more severe in Canada than in the U.S. As a result, this period witnessed a slowing in growth of income per capita, and relative to the U.S., Canada lost ground. A frequently used term during this period was *stagflation*, reflecting the unexpected combination of a stagnating economy and historically high inflation rates. The economy did not respond to traditional approaches to stimulating the economy, such as increased government spending and faster growth in the money supply. In fact, these monetary and fiscal measures seemed to make things worse in many ways. With an ageing population, concerns were raised as to whether Canada would be able to sustain its current standard of living, much less close the gap with the U.S.

Canada's Economic Performance

- 1945-early 1970s
strong performance
- 1970s – early 1990s
stagnation, low productivity growth, lost competitiveness
- 1990s
renewed economy, productivity gains, economic transformation
- post 2000
economic slowdown

⁴ Gu, W. and Ho, M. (2000), "A Comparison of Industrial Productivity Growth in Canada and the United States", *American Economic Review*, Vol. 90, No. 2.

To make matters even worse, the traditional manufacturing and resource base of Canada's economy was no longer competitive. Economic dislocation was the frequent headline as hundreds of thousands of jobs were lost in Canada's traditional industries, such as steel production, forestry, mining, and transportation. Resource prices plummeted as developing countries brought inexpensive forest products to market; as Australia, Chile and others brought major new low cost mines into production; and as Japan and other developed nations developed more efficient steel producing capabilities. Japan, and then China and other emerging economies were rapidly displacing North American production of autos, textiles and other manufactured goods.

However, in the 1990s, productivity growth picked up noticeably in both Canada and the U.S. The sluggish economy which prevailed since the 1970s was reinvigorated. Record numbers of jobs were created. In the 1990s, Canada created 1.3 million new jobs. The new economy was absorbing workers in displaced industries and wages began to rise. The last half of the 1990s saw productivity growth rates not seen since the immediate post-World War II period. Incomes per capita rose and many governments were able to convert deficits into surpluses, freeing up capital for private sector investment.

By early 2001, however, the decade long economic powerhouse slowed again. In March 2001, the U.S. entered a recession, and while Canada avoided a recession its economy slowed considerably. While both economies rebounded within a few quarters, the recovery did not initially generate new jobs as previous post war recoveries had done. Labour productivity continued to increase, especially in the U.S., allowing Gross Domestic Product (GDP) to initially grow following the slowdown without the need to add new labour. This higher productivity in turn helped maintain export competitiveness in a number of sectors, providing a base for sustained economic performance.

1.4 The Key Questions for Policy Makers

As we examine the record of Canada's economic performance, a few key questions arise:

- What fuelled the turnaround in the economic performance of the Canadian economy in the 1990s and created the economic powerhouse?
- What changed in 2000 which caused the powerhouse to slow down?
- What do we need in order to achieve Canada's full economic potential?

Related to the above key questions are other issues which must be addressed by Canada's policy makers:

- How can Canada support a high wage economy, while facing competition from low cost producers overseas?
- What can we do to achieve a sustainable economy without a loss in standard of living?

Key Policy Questions

- What fuelled the 1990s economic powerhouse?
- What caused the economic slowdown after 2000?
- What do we need to achieve Canada's full economic potential?

- How can we economically support an ageing population?

Each of these questions have many facets and unfortunately there are no simple answers. However, in the last few years, evidence has been growing that a major role has been played by the information and communications technology sector, or the ICT industry as it has become known. In the 1990s, there were many proponents of the view that ICT was the driving force behind the renewed economy. Sceptics, however, said the evidence was weak, citing the fact that ICT had been around for years and had been one of the 'darling' sectors of the economy during the 1970s but the economy nevertheless experienced stagflation.⁵

1.5 ICT and the Macro-economy

In the past few years, however, new evidence has come to light. Economists have undertaken new research and many sceptics have modified their views. The evidence today is very strong that ICT has played and continues to play a major role in the macroeconomic health of our economy. Notable among the changes which have led to the view that ICT is a major driver of economic renewal are:

- Since the Year 2001, investment in ICT dropped by roughly 30%,⁶ and this corresponded with the economic slowdown of recent years, suggesting a link of the macro economy to ICT investment.⁷
- While ICT has 'been around for a long time', the ICT sector of the 1970s was unlike that of the past decade and a half. In the 1970s, the sector was small and to a large extent the domain of a technological elite. By the 1990s, the ICT sector had grown to a much larger share of economy, and was no longer a tail wagging the dog. Further, ICT was now touching the lives of an increasing share of the workforce and the everyday lives of Canadians through cell phones, personal computers, the internet, MP3 players integrated to our computers and downloadable libraries of music, home entertainment systems embodying computer horsepower many times that of the Apollo spacecraft, the ability to access on-demand and on-line choices of movies, and grocery and retail store scanners that not only automatically reorder product but print out coupons tailored to the individual consumer's spending habits.

⁵ Another argument put forth by the sceptics was that the 1990s was driven largely by a one time event, the widespread penetration of the internet, which won't be repeated and hence ICT cannot be the major driver of future economic productivity. We note in passing that this sounds vaguely similar to the claim of Charles H. Duell, U.S. Patent Commissioner, who reportedly said in 1899 that "everything that can be invented, has been invented."

⁶ In 2004, ICT investment was expected to be \$10.8 billion per annum (Industry Canada estimate for the year) compared with \$ 13.9 billion in 2000 and \$15.2 billion in 2001. The 2004 expected level of investment would be 4.5% higher than the 2003 level. Source: Industry Canada, ICT Branch - ICT Statistical Overview, March 2004.

⁷ For economists and statisticians, nothing provides clarity better than observations which deviate from trends. While unfortunate, a change (downturn) in the economy does provide an 'influential observation' to test hypotheses.

- Analysis of the impact of the first stages of the restructuring and liberalisation of the regulatory regime for the telecommunications sector revealed how greater freedom for carriers resulted in increased investment by service providers and higher sectoral productivity. Further, the lower prices brought about by increased regulatory freedom resulted in greater adoption of new telecommunications technologies throughout the economy and a general surge in productivity and economic output.
- Evidence on differences between Canada and the U.S. in terms of ICT investment suggest that in Canada, where ICT investment dropped by a greater degree than in the U.S., weaker productivity performance may be linked to its lower rate of ICT investment.⁸
- The recent recession in the U.S. was accompanied by unprecedented growth in labour productivity, suggesting that the very high rates of ICT investment in the 1990s was having a lagged, multi-year impact.

The latter two points are of special importance – i.e., the dual role of ICT in increasing productivity throughout the economy, often with an enduring effect. Not only has ICT grown as a high productivity economic sector in its own right, its impact on the economy is amplified by its productivity enhancing impact on many other sectors. In an important sense, the ICT sector plays the role of an integrated circuit in the economy, taking moderate to weak impacts of other sectors and amplifying their impact.⁹

1.6 The Productivity Enhancing Impact of ICT on Canada's Economy

The purpose of this report is to discuss the impact of the ICT sector on Canada's economy, and its potential to drive future productivity and standard of living gains for Canadians. The report reviews the scientific evidence on whether ICT increases productivity in other economic sectors, and if so, by how much. As will be seen, the evidence reveals that ICT does have such an impact, increasing general productivity in the economy by as much as 0.7% per annum, contributing 0.7% per annum of the growth in Canada's Gross Domestic Product (GDP).

The report examines the linkages from ICT to the economy. Performance of the ICT sector in terms of level of investment and prices for its services are key drivers of the use of ICT technologies in other sectors, which in turn drives their own sectoral productivity and economic performance.

Finally, the report looks at the critical role which regulation of telecommunications plays. As will be seen, the development of new approaches to regulation have supported increased ICT investment and resulted in lower prices, via increased competition on a level playing field.

⁸ Again, another influential observation for statisticians.

⁹ We note that the transistor, the key to today's integrated circuits and other technologies, was an invention of Bell Labs, and won the Nobel prize for its inventors, John Bardeen, Walter Brattain and William Shockley

Telecommunications is separated out from the overall ICT sector and its unique impacts are identified. The evidence on the role of new telecommunications regulatory approaches is reviewed. We close by examining the question as to what can be done to maximise the potential of the Canadian economy via removing regulatory disincentives for investment in the telecommunications sector.

This report is organised as follows:

- Section 2 of the report describes in more detail the importance of ICT sector and the telecommunications sub-sector.
- Section 3 of the report examines the impact the ICT sector has on economic growth.
- Section 4 of the report describes regulation of the telecommunications sub-sector, and its impact on performance.
- Section 5 of the report attempts to quantify the potential further impact of telecommunications on the economy and comments on the linkage between regulatory design and enabling Canada's achievement of its full economic potential.

2.0 The ICT sector

2.1 What is the ICT Sector?

ICT stands for Information and Communications Technology. The ICT sector can be broadly defined as the manufacturing and services industries that are involved in the capturing, processing, storing and communicating of voice and data information. This sector includes computer and communications equipment manufacturing, electronic components, software and computer services, and telecommunications and cable services.

2.2 How Important is the ICT Sector in Canada?

ICT is an important sector of the economy, that continues to grow in both size and importance. According to Industry Canada, the Canadian ICT sector contributed significantly to economy in terms of GDP, employment, wages, investment and R&D spending, as shown in **Table 2-1**.¹⁰

Table 2-1
Importance of ICT in Canada's Economy

GDP	In 2003, the ICT sector contributed \$55 billion to Canadian GDP . This represents 5.4% of Canada's total economy, up from a 4.0% contribution as recently as 1997.
Employment	Over 542,000 workers were employed by the ICT sector in 2003. Employment in this section has increased by 22% since 1997 , outpacing the 15% employment growth in total Canadian economy. This strong employment growth is in spite of widespread media reports of layoffs in the ICT sector when the economy slowed down in 2001.
Wages	The Canadian ICT sector is a high wage sector . In 2003, the average ICT worker earned \$52,600 per annum, 47% higher than the average Canadian wage .
Investment	The Canadian ICT sector capital investment for 2004 reached \$11 billion , or 6.7% of total Canadian capital expenditures.
R&D Expenditures	The Canadian ICT sector's expenditures on R&D in 2004 were expected to have reached \$5 billion, representing approximately 40% of Canadian private sector R&D expenditures .

¹⁰ Source: Industry Canada: Canadian ICT Sector Profile, Information and Communications Technologies Branch, Nov 2004.

2003 GDP and employment figures are the most recent available annual data.

The strong 22% growth in employment since 1997 should especially be noted, given widespread press coverage of employment reductions at Nortel and some other ICT employers. While adjustments have been made at individual firms, the sector overall has continued to generate stronger employment growth than Canada's overall economy -- all the more remarkable given the widely publicised restructuring in the sector.

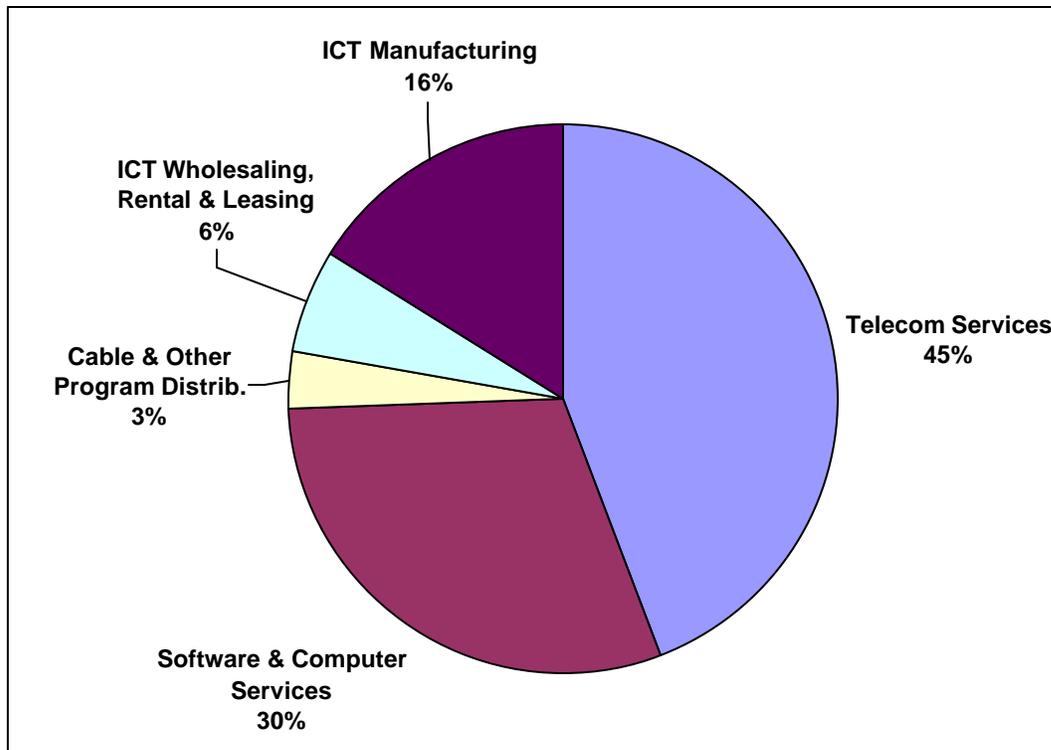
ICT employment grew by 22% from 1997 to 2003, much faster than the 15% employment growth in the overall economy.

... This strong employment growth is all the more remarkable given the widely publicised restructuring in the sector.

2.3 The Composition of Canada's ICT Sector

Figure 2-1 shows the breakdown of Canada's ICT sector by component. As can be seen, measured in terms of GDP, telecoms accounts for 45% of the ICT sector and is the largest single industry within ICT.

Figure 2-1
GDP by ICT Sub-Sector in Canada, 2003

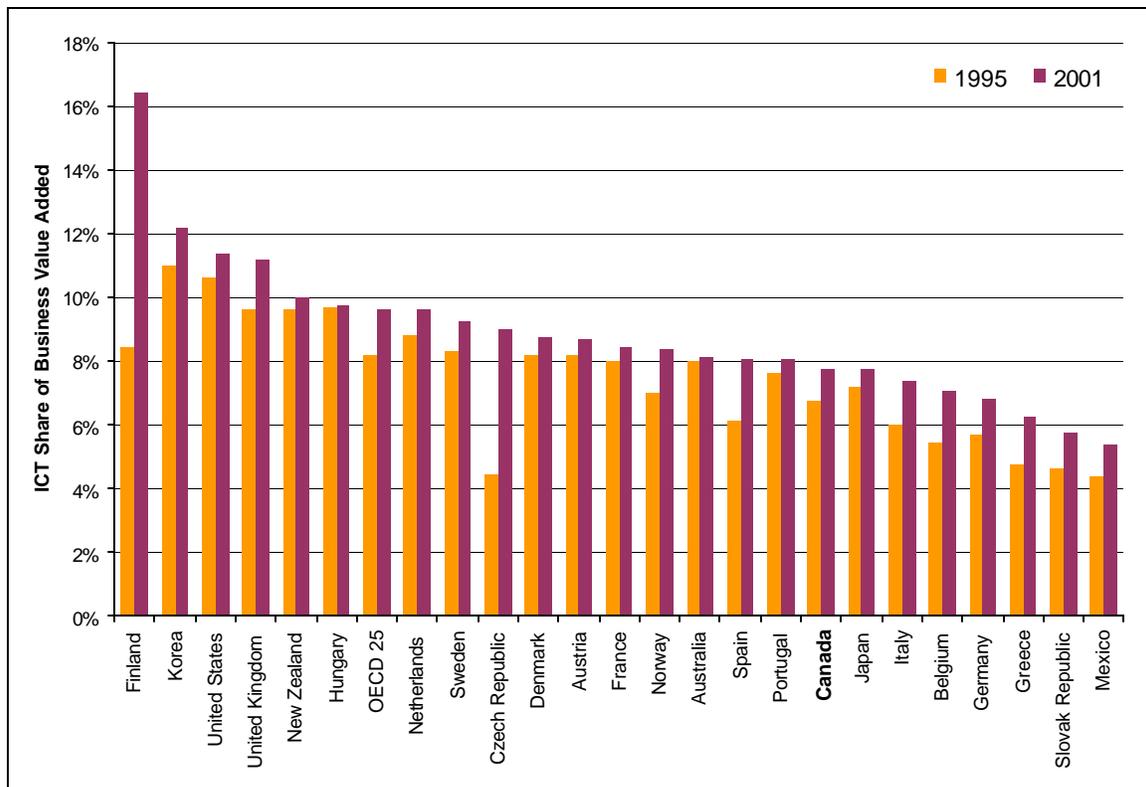


Source: Industry Canada, ICT Branch, Canadian ICT Sector Profile.

2.4 Canada's ICT Sector versus ICT in Other Nations

World-wide, the ICT sector has become an important source of economic activity, as found by a recent OECD study of 25 nations. **Figure 2-2** indicates that there are a large number of nations for which ICT accounts for 7-12% of national business value added.¹¹ As well, in all the countries listed, the ICT share of total business valued added increased between 1995 and 2001. This chart also indicates the growth potential of the Canadian ICT sector, as its share of business valued added is below that of many other nations. The ICT share in Canada is 32% below that of the U.S. and 19% below the OECD average (based on 2001 shares).

Figure 2-2
ICT Share of Total Business Value Added, 1995 and 2001



Source: OECD estimates, based on national sources; STAN and National Accounts databases, March 2004.

Figures based ICT share of business value-added rather than total economy value-added, therefore the ICT share for Canada is higher than in the previous table.

¹¹ National measurement of value added takes the value of economic output and removes materials and services purchased from abroad. It is roughly equal to value of labour and capital. A country which imports completed subassemblies and other parts, and merely undertakes final assembly and packaging would have high economic output (the value of the goods it sells), but relative low value added, since most of the 'work' was done overseas on the subassemblies.

2.5 How is Canada's Telecommunications Sector Structured?

Economists look at the structure of the industry in terms of the number of service providers, the markets they serve and compete in, and changes in technology which drive changes in how consumers substitute one service for another. In Canada, as elsewhere, the structure of the industry has been shaped not only by market forces, but also by historic government policies.

Industry Canada and the Canadian Radio-television and Telecommunications Commission (CRTC) have tended to segment the telecommunications industry into historical product segments or technologies, specifically wireline, wireless, resellers of services, satellite, and 'other' services. Similarly, they have segmented broadcast distribution into cable TV, direct-to-home satellite, and multipoint.¹²

While the CRTC/Industry Canada segmentation is interesting from an historical point of view, economists look at markets differently. For economists concerned with the nature of competition in a sector, a key issue is the degree to which consumers will substitute between different product or service offerings.¹³ With the convergence of telecommunications technologies, consumers are showing themselves to be willing to substitute between the traditional market segments. For example, wireless is increasingly being accepted by consumers as

an acceptable substitute for wireline services. Bell Canada reports that while traditionally the number of new wireline installations exceeded the growth in new housing (by up to a three to one ratio), since 1999 new wireline installations have dropped to half the growth in housing.¹⁴ This indicates how consumers are willing to substitute wireless and other technologies for traditional wireline services. The substitution is not confined to wireline versus wireless.¹⁵ There is also substitution between IP delivered or cable delivered telephony services and traditional wireline

The traditional segmentation of the telecommunications industry into historical product segments or technologies is of limited relevance today.

... consumers are willing to substitute wireless and/or VoIP for wireline services, largely rendering useless the traditional market segmentation.

¹² Multipoint would include services such as video conferencing linking multiple locations.

¹³ The elasticity of supply is also a factor in how economists look at competition in markets. In markets where a modest price increase strongly induces new entrants or expanded supply by incumbents (i.e. elastic supply), then it is difficult for a firm to exploit market power.

¹⁴ See, for example, "Remarks of Lawson Hunter" to the Insight Canadian Telecommunications Forum, 27 October 2004, Ottawa.

¹⁵ Substitution is not confined to wireline vs. wireless vs. VoIP. There are a large number of resellers of various telecommunications services who inject further substitution and competition into markets.

services.¹⁶ IP/cable telephony services are gaining widespread acceptance for both business and residential use.

With consumers increasingly willing to substitute wireless and/or IP delivered or cable delivered telephony services for traditional wireline services, the market segmentation used by CRTC/Industry Canada appears anachronistic and increasingly irrelevant to actual consumer behaviour. What is more important is who the various telecommunications providers are and how they compete with each other.

Industry Canada recently provided an overview of the telecommunications/broadcast distribution sector and highlighted five major players.¹⁷ A few dimensions of these companies are highlighted in **Table 2-3**, which shows the large degree of overlap in services among several service providers.

With consumers increasingly willing to substitute wireless and/or VoIP services for wireline services,

... the traditional market segmentation used by the CRTC is anachronistic and increasingly irrelevant to actual consumer behaviour.

Table 2-3
Overview of Services of Selected Service Providers

	Bell	Videotron Quebecor	Rogers	Shaw	Telus
Wireless	Yes	Yes	Yes		Yes
Wireline	Yes	Yes			Yes
VoIP	Business only, e.g., Aliant	Yes	announced		Business only
Internet retail	Yes, Sympatico	Yes	Yes	Yes	Yes
Internet backbone	Yes			Yes	Yes
Broadcast distribution	Satellite (ExpressVu) Announced wireline distribution	Cable	Cable	Cable satellite (Star Choice)	Announced wireline distribution

¹⁶ IP delivered telephony transmits via the internet, rather than via a traditional wireline.

¹⁷ These are not the only participants in Canada's telecommunications/broadcasting sector. See "Telecommunications Services in Canada: An Industry Overview," Industry Canada, Hull, 6 October 2004.

2.6 How is Canada's Telecommunications Sector Regulated?

Telecommunications regulation in Canada is entirely a federal matter. Regulation of the industry is provided for in the 1993 *Telecommunications Act* (the Act)¹⁸ The Act provides a statement of telecommunications policy which articulated nine objectives which might be summarised as:

- Orderly development;
- Reliable and affordable services of high quality;
- Enhanced efficiency and competitiveness;
- Ownership of Canadian carriers by Canadians;
- Use of Canadian transmission facilities;
- Reliance on market forces and efficient and effective regulation, where required;
- Stimulation of research and development;
- Response to economic and social requirements of users; and
- Protection of privacy.

The Act assigns regulation of the sector to the Canadian Radio-television and Telecommunications Commission (CRTC), an independent quasi-judicial body made up of a maximum 13 full time Commissioners, and a staff of over 400 that is also responsible for regulating the broadcasting sector. While the CRTC is an independent commission, the federal Cabinet does have the power to overturn any CRTC telecom decision and to give the CRTC directions on broad policy matters.

The Cabinet Minister with responsibility for telecommunications is the Minister of Industry. The Minister's department, Industry Canada, has responsibility for spectrum allocation and a number of other telecom regulatory matters, including establishing technical standards for telecommunications equipment. Yet, the bulk of regulation in the sector is made by the CRTC.

The Act makes a distinction between 'facilities-based carriers' and 'non-facilities based service providers'. Any telecommunications service provider who owns telecommunications facilities, such as fibre or transmission equipment, is required to be owned and controlled by Canadians.¹⁹

In addition to facilities based carriers, Canada allows 'resellers' of telecommunications services. Resellers do not need to be Canadian owned and controlled. Resellers can operate in a variety of business formats. For example, they may purchase long distance capacity from facilities based providers at wholesale rates (which are regulated) and resell the capacity to individual subscribers. The reseller uses the local wireline (or wireless) connections of the facilities based carriers to access its customers.

¹⁸ The Act was amended in 1998 to deal with issues regarding Teleglobe Canada and undersea cables.

¹⁹ Canadian ownership must be at least a majority of the voting shares.

The Act requires the CRTC to regulate the rates, terms and conditions of all telecom services sold to the public when offered by a facilities based carrier. The primary tool used to achieve this objective is the requirement for all facilities based carriers to only offer services in conformity with tariffs that have been reviewed and approved by the CRTC.

However, the CRTC has the discretion to waive the requirement for pre-approved tariffs, either in whole or in part, with or without conditions. The CRTC has used this “forbearance” power to remove the tariff requirements for all retail services offered by non-dominant carriers (e.g., new entrants), although often the carrier’s waiver is subject to the requirement to adhere to certain ongoing conditions. In addition, a non-dominant carrier may be subject to regulation and the tariff requirements for some (but not all) interconnection and wholesale services.

For the incumbent local exchange wireline telephone companies such as Bell Canada and Telus, the CRTC has conditionally waived the tariff requirements for some services such as retail Internet, wireless, long distance and many data products because the CRTC determined that there was sufficient competition to protect the interest of users. These waivers (forbearance orders) are often subject to similar (or even stricter) conditions as those placed on non-dominant carriers when they are forborne from regulation. For all other services, the incumbent carriers are not allowed to introduce a new price point or change a term or condition without first obtaining CRTC approval. This introduces delay in market entry and new product offering, due to the requirement for incumbents to tariffs for each regulated service. Their rates for regulated services must be “just and reasonable” and may not “unjustly discriminate or give an undue preference toward any person”.

While the CRTC policy has evolved to exempt certain services from regulation, such as wireless telephone services, it also constrains the traditional wireline carriers in some new markets until after sufficient competition has emerged. Theoretically, such constrained carriers are not denied the ability to serve these markets. But in practical terms, if one service provider is regulated and one is not, the latter will always be able to under-price the former and out compete in other ways. This may have the unintended consequence of denying the regulated carrier the ability to effectively compete in new and emerging markets during the high growth development phase of such markets.

The CRTC regulates incumbent carriers’ retail services through a price cap mechanism, which establishes the maximum price that is permitted for a given set of services. Previously the CRTC had used traditional rate-base rate-of-return regulation.

The price cap is established through a complicated formula that is designed to change each year to reflect the inflation rate and productivity improvements the carrier is expected to achieve each year. In addition to the price cap, the CRTC establishes floor prices for these services (generally the long run incremental cost of the service, or in some cases the tariff price of a service component that is part of a package) below which the carrier is not allowed to lower its rates. As such, every time an incumbent carrier wishes to lower its rates, it must submit a cost study (called an imputation test) demonstrating that the new lower rate is above cost – or it will not receive CRTC approval for the rate reduction. If the proposed rate is above the price floor and below the price cap, it is generally found to be “just and reasonable” and approved by the CRTC.

In order to promote competition, the CRTC has also established some marketing restrictions that, for example, do not allow an incumbent carrier to contact a residential customer for 12 months after she has switched her local phone service to another provider.

On the wholesale side, the CRTC regulates the terms of interconnection between all carriers in the industry, regardless of market power. Rates for interconnections services are set at the long run incremental cost of the incumbent carrier plus a 15% mark-up as a proxy contribution to the incumbent's fixed and common cost.

Further, the CRTC mandates the "unbundling" of a number of services offered by incumbent carriers, the most important of which is local loops (the access line that runs from a customer premise to the incumbent's local switch, called a wire centre). Local loops and many other wholesale services that have been found by the CRTC to be an essential input to a competitor, are required to be provided by incumbents to competitors at such cost based rates. Still other wholesale services are regulated by the CRTC at rates set below retail rates, but above cost (generally referred to as Category II services). For all these services, the incumbent is required to obtain tariff approval before offering these rates in the market. This tariff requirements means that no incumbent can make a deal with a competitor for a wholesale regulated service without having to put on the public record the terms of the deal by filing a tariff and receiving CRTC approval for that tariff.

Finally, it is important to note that all service providers are required to contribute to a fund that is used to subsidise residential local phone rates in certain high cost areas.

3.0 The Large Contribution of ICT to Economic Growth

3.1 Introduction

This section discusses the evidence on the contribution of the ICT sector to the performance of the overall economy. While the importance of this sector may be intuitively obvious, this report examines the scientific evidence which has emerged in recent years.

This section begins with some background describing the linkages of ICT to the economy. It also introduces some terminology important to the discussion which follows, including the distinction between ICT producing and ICT using industries. It then examines the scientific evidence on ICT's contribution.

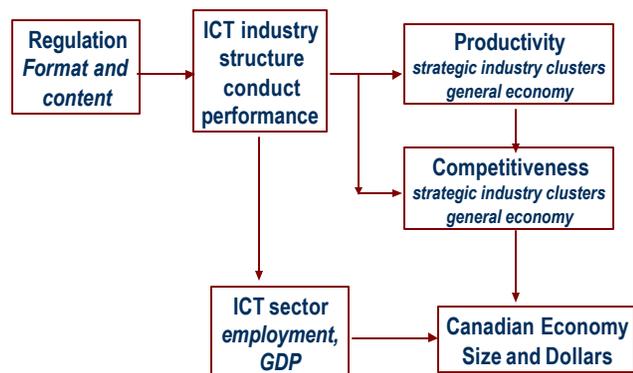
3.2 ICT Linkages to the Economy

When economists discuss the economic impact of a sector, they generally describe its share of national economic output, GDP, or employment, as was done in section 2.1 of this report. However, the ICT sector's impact goes beyond its own employment base. ICT is a key component of many other sectors of the economy. Improvements in ICT, or simply the adoption of current ICT technologies by other economic sectors raises their productivity, sometimes dramatically.

Thus improvements in the ICT sector have two separate impacts on the economy. First, growth and productivity improvement by the ICT sector in its own right directly improves national economic performance.

Second, and perhaps more importantly, the adoption of ICT technologies and services indirectly improves national economic performance by enhancing the performance of other sectors of the economy. The indirect impact works in two ways. The adoption of ICT in sectors such as retail, financial services and certain manufacturing sectors increases their productivity and contribution to the Canadian economy. ICT allows the same number of workers to produce either a greater volume of output or services in other sectors, or increases the value of these products. Thus ICT amplifies the impact of sectors.

ICT Linkages to Economy



ICT also improves the competitiveness of Canadian goods and services, and thereby contributes to Canadian exports. This in turn increases the size of key export sectors and further enhances their impact on the Canadian economy.

The diagram summarises this two-fold impact of ICT on the Canadian economy. First, the direct impact of the sector on the economy, as a generator of employment, economic output and value added. Second, the impact of ICT on the productivity and competitiveness of other industries, amplifying their separate impacts on the economy.

3.3 ICT Production versus ICT Use

Chapter 2 showed that ICT is major sector of the economy, supporting over half a million Canadian jobs. As discussed in 3.1 above, the impacts of ICT on the national economy are both direct and indirect.

In the economics literature investigating the impact of the ICT sector on the overall economy it has become common practice to differentiate ICT producing and ICT using sectors of the economy:

- **ICT-producing** industries, produce and supply ICT goods and services. This includes but is not confined to the computer manufacturing, computer software, major telecommunications suppliers, cable providers and computer manufacturing.
- **ICT-using** industries, use ICT in critical aspects of production, distribution or customer service. While all sectors of the economy make use of ICT, in a number of sectors ICT plays a critical role in their production or service delivery processes, and has played a strategic role in increasing productivity or customer service. ICT-using sectors include aerospace manufacturing, auto manufacturing, financial services, the retail and distribution sectors, etc. Sectors such as energy production are highly dependent on ICT for control of processes and control of distribution channels. Through the use of point of sale scanners and terminals, direct reordering and production to retail logistics networks, retail services have become an ICT-using sector where ICT allows reduction of inventories, greater specialisation of consumer products, vastly improved consumer information and reduced costs.

The following sections examine the scientific evidence on the economic contribution of ICT to productivity and economic growth through both the ICT-producing and ICT-using sectors.

3.4 Productivity Contribution of ICT

Productivity is a general term referring to the amount of economic output generated by a given quantity of inputs. Productivity growth refers to the ability to produce the same amount of output with fewer inputs, or equally, more output with the same amount of inputs. Productivity growth is key to economic growth. It is the means by which per capita incomes grow and economies generate wealth and economic security. As the Conference Board of Canada puts it, "productivity

growth is the key to maintaining and improving living standards – it gives us the biggest bang for the buck.”²⁰

Recent studies have found strong evidence that ICT is a major driver of productivity growth both through its own productivity improvements and also in the way it enables productivity growth in other (ICT-using) sectors. A study by Van Ark, Inklaar and McGuckin (2003) examined the labour productivity contribution of ICT in Canada, the United States and the European Union, the findings of which are provided in **Table 3-1**.²¹ The findings from the study are worth highlighting:

Recent studies have found strong evidence that ICT is a major driver of productivity growth

- **both through its own productivity improvements**
- **and also in the way it enables productivity growth in other (ICT-using) sectors.**

- **The ICT-producing sector is highly productive.**

In Canada, the U.S. and the E.U., labour productivity growth in the ICT-producing sector was four to six times that of the overall economy. For example, in Canada, labour productivity in the ICT-producing sector grew by 7.1% per annum, while labour productivity in the overall economy grew by only 1.8%. The ICT-producing sector alone is responsible for 24-33% of the total labour productivity growth in the economy, even though it represents only 5-7% of the total economy.

- **ICT enabled higher productivity rates in ICT-using industries.**

In Canada, the U.S., and Europe, labour productivity in the ICT-using sectors grew at a faster rate than the overall economy and many times faster than the non-ICT-using sector.²² In Canada, labour productivity in ICT-using industries grew at nearly twice the rate of the overall economy and four times as fast as the non-ICT-using sector.²³

A number of other studies have demonstrated the strong link between the use of ICT and productivity growth, using data largely from the 1990s from both Canada and the U.S. Some of these examined the productivity contribution of ICT-using industries while others examined the impact of both the ICT-producing and ICT-using sectors, as summarised in **Table 3-2**.

²⁰ “Performance & Potential.” *Conference Board of Canada*. 1997.

²¹ Van Ark, B.; Inklaar, R. and R.H. McGuckin (2003), “The Contribution of ICT-Producing and ICT-Using Industries to Productivity Growth: A Comparison of Canada, Europe and the United States”, *International Productivity Monitor*., Spring 2003.

²² The ICT-using sector was defined as industries with intensive ICT use, while those that did not use ICT very intensively were defined as non-ICT using.

²³ This study observes that productivity grew faster in the ICT-using sectors than in the rest of the economy or in the non-ICT-using sector. However, this is not to say that all of the productivity growth in the ICT-using sector is attributable to ICT; other factors may also apply.

Table 3-1
Average Annual Growth Rate in Value Added per Person Employed
in Canada, the U.S. and E.U., 1995-2000

Contribution to the overall growth rate given in brackets

	Canada	U.S.	E.U.
ICT-producing sector	7.1% (24%)	10.1% (30%)	8.7% (33%)
ICT-using sector	3.2% (47%)	4.7% (56%)	1.6% (29%)
Non-ICT-using sector	0.8% (30%)	0.5% (14%)	0.7% (34%)
Average for entire economy	1.8% (100%)	2.5% (100%)	1.4% (100%)

Source: Van Ark, Inklaar and McGuckin (2003).

Table 3-2
Impact of ICT on Productivity Growth

Study	Contribution to Overall Productivity Growth		Comments
	ICT-producing sector	ICT-Using sector	
Armstrong et al (2002) ²⁴	-	24%	Canada, 1995-2000 labour productivity growth
Khan and Santos (2002) ²⁵	-	26%	Canada, 1996-2000 labour productivity growth
Jorgenson, Ho and Stiroh (2001) ²⁶	17% 22%	22% 32%	U.S. 1973-95 labour productivity growth U.S. 1995-2000 labour productivity growth
Oliner and Sichel (2002) ²⁷	27% 32%	30% 42%	U.S., 1991-95 labour productivity growth U.S., 1996-2001 labour productivity growth

²⁴ Armstrong et al. (2002), "A Comparison of Canada-U.S. Economic Growth in the Information Age, 1981-2000: The Importance of Investment in Information and Communication Technologies." *Statistics Canada*. 2002.

²⁵ Khan, H. and M. Santos (2002), "Contribution of ICT Use to Output and Labour-Productivity Growth in Canada." *Bank of Canada*, Working Paper No. 2002-7..

²⁶ Jorgenson, D; Ho, M; and K.Stiroh (2002), "Projecting Productivity Growth: Lessons from the U.S. Growth Resurgence." *Federal Reserve Bank of Atlanta Economic Review*, Q3 2002.

²⁷ Oliner, S. and D. Sichel (2002), "The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?" *Federal Reserve Bank of Atlanta Economic Review*, Q3 2002.

While the exact numbers vary somewhat, the consistent message delivered by these studies is that ICT has had a major impact on productivity growth. Productivity growth in the ICT sector alone accounted for 22-32% of overall productivity growth in the latter half 1990s. In addition, use of ICT contributed another 24-42% to productivity growth.

Overall, these studies indicate ICT is responsible for somewhere in the region of one half to two thirds of overall productivity growth.

Overall, these studies indicate ICT is responsible for somewhere in the region of one half to two thirds of overall productivity growth. These findings clearly demonstrate that ICT has had a central role in enabling productivity growth. Interestingly, the study by Jorgenson, Ho and Stiroh (2001) indicates that ICT's contribution to productivity growth was not just a late 1990s, dot-com phenomenon, as they find that between 1973 and 1995, ICT was responsible for 39% of productivity growth.

3.5 Economic Growth Contribution of ICT

Productivity growth is a key driver of economic growth. It is difficult to overstate the importance of productivity growth for the long-run health of the economy. Over the years, virtually all economic progress has come from productivity growth. Therefore, it is not surprising that ICT has been found to have been a major contribution to economic growth. **Table 3-3** summarises the findings from a large number of studies conducted world-wide which demonstrate not only the link between ICT and economic growth, but the large magnitude of ICT's contribution to economic growth. **In Canada, two studies have estimated that ICT's contribution to economic growth is in the region of 11-14%.** In the U.S., the contribution of ICT is even greater, accounting for 19-25% of the total growth in the economy. In other countries, ICT's contribution ranges from 14% up to 33% of economic growth.

Table 3-3:
The Link Between ICT and Economic Growth

Country /Study	Overall Economic Growth Rate	Percentage Point Contribution of ICT	ICT Contribution to Economic Growth	Period
Canada				
Armstrong, et al. (2002)	4.9%	0.7	14%	1995-2000
Khan and Santos (2002)	4.75%	0.5	11%	1995-2000
United States				
Jorgenson, et al. (2002)	4.6%	1.3	28%	1995-2000
Pakko (2002)	4.3%	0.8	19%	1995-2000
Japan				
Motohashi (2002)	1.5%	0.5	33%	1995-2000
Germany				

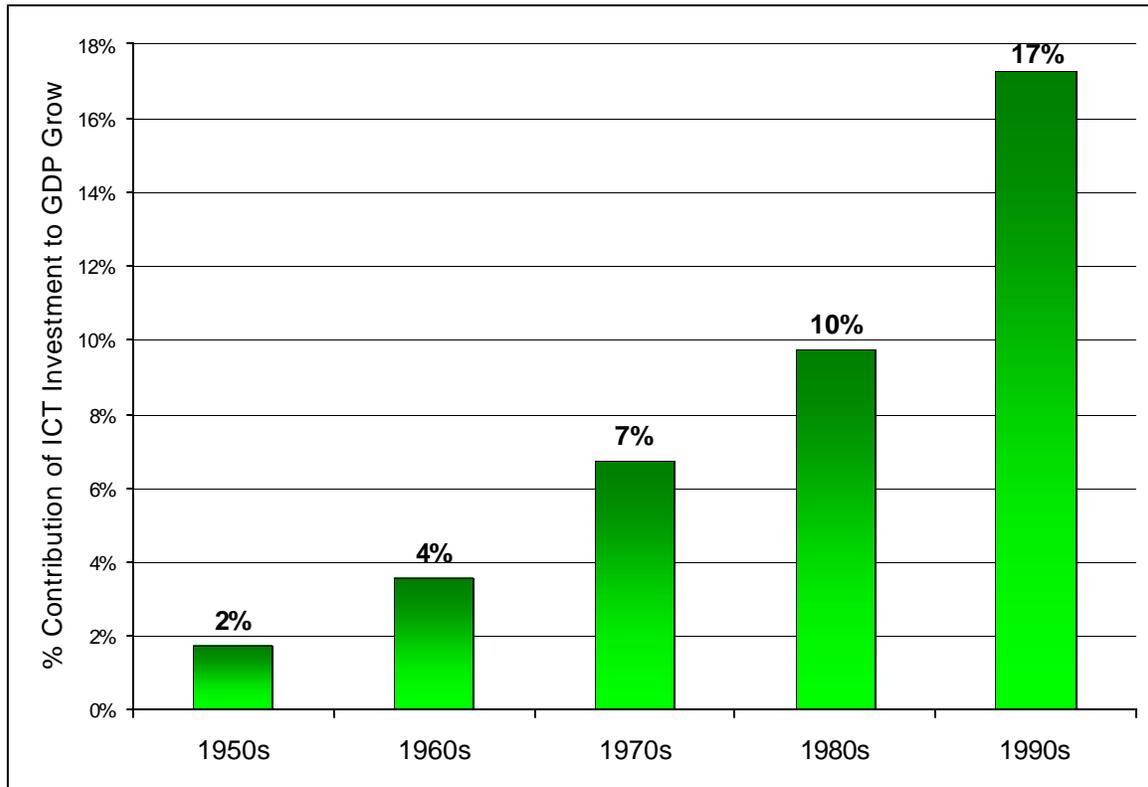
Country /Study	Overall Economic Growth Rate	Percentage Point Contribution of ICT	ICT Contribution to Economic Growth	Period
RWI and Gordon (2002)	2.5%	0.5	20%	1995-2000
France				
Cette, et al. (2002)	2.2%	0.3	14%	1995-2000
United Kingdom				
Oulton (2001)	3.1%	0.6	19%	1995-2000
London Economics	3.2%	0.8	25%	1992-2000
Australia				
Simon and Wardrop (2001)	4.9%	1.3	27%	1995-2000
Belgium				
Kegels, et al. (2002)	2.8%	0.5	18%	1995-2000
Korea				
Kim (2002)	5.0%	1.2	24%	1995-2000

Not only is ICT a major contributor to economic growth, but the evidence is that its contribution is growing. A study by Pakko (2002) estimated the contribution of ICT investment to GDP growth in the U.S. since the 1950s, and found that the sector's contribution had increased from less than 2% of GDP growth to 19% of GDP growth by 2000 (see **Figure 3-1.**) From the analysis it becomes evident that as time passes, the ICT sector's contribution steadily increases. The enormous impact of ICT in the late 1990s was not merely that from a 'dot-com' bubble, as some might claim, but rather part of a long term trend of steadily increasing contribution to the national economy.

Not only is ICT a major contributor to economic growth

... but the evidence is that its contribution is growing.

Figure 3-1
The Growing Contribution of ICT Investment to GDP Growth in the U.S.



Source: Pakko (2002).

Note that the 1990s average is 17%. For the period from 1995-2000, the ICT contribution was estimated as 19%. This latter figure is provided for comparability to other studies which focus on the latter half of the 1990s.

3.6 The Debate About the Contribution of ICT

After reviewing the results listed in the previous sections, it is clear that there are a number of studies documenting that ICT makes a significant contribution to economic growth and productivity. However, some researchers have called for re-examination of these results:

- certain experts in the field have attempted to downplay the estimated contribution of ICT, and
- some claim a potential measurement problem exists that could skew the results of studies.

Economist Robert Gordon, for example, while conceding that ICT contributes to economic growth, claims that some studies have exaggerated its impact, and that the ICT investment experienced in the late 1990s may have been transitory and unsustainable, e.g., largely due to the one time adoption of the internet by businesses and consumers. Dean Parham, the assistant commissioner

of the Productivity Commission in Australia also views that some studies may have overstated the contribution of ICT and the acceleration in productivity growth.²⁸

One of Gordon's reasons for believing ICT's impact may have been overestimated is his view that some studies have unrealistically assumed that the productivity payoff is instantaneous upon the initial investment in the ICT goods and/or services. However, recognising a lagged impact of ICT on national productivity could result in even higher estimates of ICT's overall effect. A study by Brynjolfsson and Hitt (2000) finds that the returns from ICT investment are up to five times larger over periods of 5 to 7 years than over a 1-year period.²⁹

In fact, in 2000-2002, the U.S. economy declined and the Canadian economy slowed. Reduced ICT investment may have been a contributing factor to the slowdown. However, productivity performance in this slowdown did not follow the usual declining pattern. To the contrary, this recession saw continual increases in productivity growth. This is consistent with the impacts of ICT investment not being fully realised until several years after the initial investment. The productivity growth experienced from 2000 to 2002 may have been the lagged effect of high ICT investment in the late 1990s. While Gordon may be right regarding the instantaneous impact of ICT investment on the economy, he should also measure and attribute the lagged impacts of ICT. In fact, the Australian productivity commission reports did precisely that, and found an almost identical impact of ICT investment on national productivity.

While there have been critics of aspects of the methodology used to assess productivity impacts of ICT, **looking at the big picture there is considerable evidence that points towards a significant contribution of ICT to productivity growth.** In the words of ICT researchers Baldwin, Harchaoui, and Tarkhani,

There is considerable evidence that points towards a significant contribution of ICT to productivity growth

"as the price of computing power continues to decline at the rates seen over the last few decades, Canadian businesses are likely to continue their investment and substitution toward ICT. Under this scenario, the rapid accumulation of ICT will likely remain an important contributor to the growth in overall output and productivity of the Canadian business sector."³⁰

²⁸ Parham, D. (2002), "Productivity Gains from Policy Reforms, ICTs and Structural Transformation." *Productivity Commission – IAOS Conference on the New Economy*.

²⁹ Brynjolfsson, E. and L. Hitt (2003), "Computing Productivity: Firm-Level Evidence." *MIT Sloan School of Management Working Paper*.

³⁰ Baldwin, J.; Harchaoui, T. and F. Tarkhani (2002), "The Importance of Information Technology: A Canada-U.S. Comparison." *ISUMA, Vol. 3, No. 1*.

3.7 The Impact of Telecommunications on National Productivity

The above sections discussed the impact of the broad ICT sector on national productivity growth. It is useful to consider whether the strong impacts that were found could be due solely to information technologies with little, if any impact from telecommunications. However, there is evidence that this is not the case. Telecommunications, by itself, is a strong driver of national productivity.

University of Toronto Professor Len Waverman, has studied the productivity performance of this sector for over 25 years. In a recent study he used evidence from 21 OECD countries over a 20-year period to investigate the effects of telecommunications infrastructure on economic growth.³¹ Using an econometric model and controlling for country-specific fixed effects and direction of causality,³² Professor Waverman and his co-author L.H. Roller, find evidence that a significant positive causal relationship exists between telecommunications infrastructure and economic growth. They also find that communication investments are subject to a critical mass phenomenon, implying the majority of the economic growth impacts of telecommunications occur above a certain threshold level of telecommunications infrastructure. Once this critical mass level is attained, telecommunications investment has a larger impact on economic growth per dollar of investment than other types of investment because the telecommunications infrastructure exhibits network externalities (i.e. the value of the network rises with the number of connections to the network).

With respect to the link between investment in telecommunications infrastructure and economic growth, the authors find that **between 1971 and 1990 approximately one-third of the economic growth (GDP per capita) experienced by OECD countries can be attributed to investments in telecommunications** (0.59 percentage points of 1.96%). The specific results for

Between 1971 and 1990 one-third of economic growth by OECD countries can be attributed to investments in telecommunications.

³¹ Roller, L-H. and Waverman, L. (2001), "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach", *The American Economic Review*, Vol. 91, No. 4.

³² The Roller and Waverman (2000) study has an excellent discussion of the results of a number of previous studies and criticisms that have been made. One key criticism has been that earlier studies failed to distinguish between telecom (and other infrastructure investments) causing economic growth versus economic growth causing growth in required telecommunications investment. Another criticism of previous studies is that of econometric or statistically 'simultaneity' bias. Yet a third is that of controlling for unique differences between countries, with a recommendation for use of 'fixed effects' estimators. While it is beyond the scope of this report to discuss these technical issues in detail, it is sufficient to say that the Roller and Waverman study corrects for all of these criticisms and still finds that there is a strong, statistically significant and causal impact of telecommunications on national productivity. While the abstract criticisms levied against earlier research (such as that of Aschaeur) is of concern, at least for telecommunications, making the changes in methodology still results in a strong finding that telecommunications has a strong influence on national productivity. The author of this report comments that fixed effects estimators have their own limitations, as they involve conditional inference, which may not be warranted when addressing questions such as whether telecommunications investment explains differences *between* nations in national economic performance.

Canada, the U.S., the U.K., and Australia are displayed below in **Table 3-4**. Telecommunications impacts account for 30% of growth in GDP per capita, on average in OECD countries, and in Canada, has accounted for 44% of GDP per capita growth.

Table 3-4:
Telecommunications Contribution to GDP per capita Growth, 1971-1990

Country	Annual Average GDP per capita growth	Annual Average Contribution of Telecommunications	Percentage Contribution of Telecommunications
Canada	2.16	0.95	44%
United States	1.26	0.21	17%
United Kingdom	2.11	0.94	45%
Australia	1.48	0.73	49%
OECD Average	1.96	0.59	30%

Source: Roller, L-H. and Waverman, L. (2001).

3.8 Canada vs. the U.S. – Differing ICT Investment and Productivity Growth Impacts

Much has been made of the productivity gap between the U.S. and Canada. As indicated in Section 1, prior to the early 1970s, Canada was actually closing the productivity and standard of living gap with the U.S. With stagflation and the 1970s slowdown, Canada failed to keep up and the gap began to widen. More recently, between 1995 and 2000, labour productivity in the U.S. increased by 2.5% per annum while that in Canada increased by only 1.8% per annum.³³ GDP per capita (a standard measure of wealth) in Canada is currently approximately 15% lower than that in the United States.³⁴ Higher productivity growth is needed if Canada is to close the gap.

Part of the recent gap in productivity growth may be attributable to ICT. In Canada and the U.S., the ICT sectors and the general economies continued to grow. However, the U.S. ICT sector grew more substantially, and had a larger impact on national productivity growth. Van Ark et al (2003) examined the cause for lower contribution in Canada. **Table 3-5** shows the percentage point contribution of the ICT-producing and ICT-using sectors to productivity growth in the U.S. and Canada between 1995 and 2000.

³³ Source: van Ark et al (2003).

³⁴ Source: OECD (2004).

Table 3-5
ICT contribution to productivity growth
Canada vs. U.S., 1995-2000

	Canada	U.S.
Labour Productivity Growth	1.76%	2.49%
ICT Contribution to Labour Productivity	1.25%	2.14%
Source: van Ark et al (2003)		

As can be seen, **ICT-producing and ICT-using sectors contributed 1.25 percentage points to Canada's 1.76% productivity growth rate.** But this contribution was less than the corresponding sectors in the U.S. It appears that the recent difference in productivity growth between Canada and the U.S. was largely due to differences in the ICT induced contributions, with Canada's ICT contribution less than two thirds that of the U.S. Had Canada achieved the U.S. performance in ICT, it would have exceeded overall U.S. productivity growth by roughly 0.15% per annum.

ICT-producing and ICT-using sectors contributed 1.25 percentage points to Canada's 1.76% productivity growth rate.

Van Ark further commented that while that some of the contribution gap was due to a smaller contribution from Canada's ICT-producing sector, the main cause was due to a smaller contribution by our ICT-using sector. In other words, some of the gap can be explained because Canada has a relatively smaller ICT-producing sector, but most of the gap is because ICT-using industries have not achieved the same benefits from ICT as their U.S. counterparts. The authors speculate that this may be due to less ICT investment in some Canadian ICT-using industries.

... but the U.S. achieved more rapid productivity growth,

- **in part due to a larger ICT-producing sector,**
- **but largely because Canada's ICT using industries have invested less in ICT.**

Armstrong et al (2002) looked at the differing contributions to GDP growth, as shown in **Table 3-6**.

Table 3-6
ICT contribution to GDP growth
Canada vs. U.S., 1995-2000

	Canada	U.S.
GDP Growth	4.8%	4.9%
ICT Contribution to GDP growth	0.7%	1.1%
Source: Armstrong et al (2002)		

3.9 Conclusion

This section has highlighted the critical role that ICT and telecommunications have played in achieving national productivity and economic growth. By reviewing a number of academic and government studies it can be seen that ICT has been a major contributor to our national economy. On the all important national productivity measure, ICT has contributed 25-33% of national productivity growth, even though it represents only 5-7% of the national economy. In terms of GDP growth, evidence suggests that ICT contributes roughly 11-14% of national GDP growth. This is somewhat less than the roughly 20-25% ICT contribution to the U.S. economy, with the evidence suggesting that the Canadian shortfall may be due to the ICT using rather than ICT producing sectors.

The evidence also examined the contribution of telecommunications sector by itself. Research indicates that telecommunications has made a strong contribution to economic growth in most developed nations, with a particularly strong contribution of telecommunications in Canada.

4.0 Regulation and Telecommunications Performance

4.1 Introduction

Section 3 examined the scientific evidence for the contribution of ICT to national productivity and national economic growth. There it was found that ICT has a strong impact on national economic performance, both directly through the ICT-producing sector, as well as indirectly through ICT induced productivity gains in many other sectors of the economy, referred to as ICT-using sectors. The specific contribution of telecommunications was also examined, and again, it was found to have a major impact on national economic performance – an impact several times larger than the sector itself.

The question now is what is the potential for ICT in general, and telecommunications in particular, to further enhance the performance of the Canadian economy, especially on the extremely important measure of productivity. As indicated in Section 2.5, the telecommunications sector in Canada is regulated. Historically, telecommunications has been subject to very strict regulation, but recently, a lighter regulatory hand has been applied, at least for some services. Nevertheless, regulation is uneven; for example wireline carriers are constrained in their ability to invest in and price new services, especially the fast growing VoIP services.³⁵ A key question is what role, if any, new approaches to regulation have had in the recent strong impact of telecommunications on the economy. This is the subject of this section of the report.

4.2 New Approaches to Regulation of Telecommunications has Led to Lower Prices, Better Service and Greater Investment

Until fairly recently, the telecommunications sector has been heavily regulated by governments in most countries around the world, including Canada. Government control spanned virtually all aspects of business activity: ownership, pricing, product offerings and the entry and exit of firms in the market. In the 1980s, some governments began to recognise that this burdensome and intrusive form of regulation was not performing well. Heavy-handed regulation was impeding the telecommunications industry from rapidly responding to changes in market demand and the evolution of telecommunications and information technology. Prices were higher than necessary, investment was lower, consumer choices were fewer and the industry was generally under-performing, relative to its potential.³⁶ High prices, fewer service options and slower investment in

³⁵ In 2004, the CRTC issued a preliminary view that VoIP services by the incumbent large wireline carriers should be regulated just as wireline telephone services are regulated, even though their competitors in this service segment are unregulated. It has not yet issued its final decision.

³⁶ It should be clarified that telecommunications has been a sector with high productivity growth relative to other sectors. The issue is whether even higher growth could have been achieved.

turn led to lower rates of adoption of new technologies in the ICT-using industries of the economy, thus lowering what could have been achieved in productivity and national economic growth.

As with many other sectors of the economy, some governments started to enact and implement new approaches to telecommunications regulation. The UK was an early enactor of major reforms in telecommunications, which started liberalising its telecommunications sector in 1984. The UK approach eventually evolved from an *ex ante* format to an *ex post* regulatory approach. In the former, regulators must approve in advance, what service telecommunications carriers may offer, what prices may be charged, what investments will be allowed, etc. The basis for *ex ante* regulatory design is the presumption that absent regulation the incumbent carrier has and will abuse market power, suppressing competition.³⁷

The U.K. has evolved its approach to telecommunications regulation ... from an *ex post* regulatory format to an *ex ante* format, which provides a more level playing field for telecomm service providers.

In contrast, an *ex post* regulatory design leaves to management the key decisions of investment, pricing, service offerings etc. Regulatory intervention is used only when market power is present and found to have been abused. An *ex post* approach focuses on the conditions for competition, a level playing field for all market participants, and freedom for carriers to innovate and invest.

Many other countries have enacted various regulatory changes during the 1980s and 1990s, including Australia, Canada, Germany, France, Ireland, Japan, Mexico and the United States. These reforms generally eliminated or reduced restrictions on pricing, service and product offerings, as well as restrictions on the entry and exit of firms into and out of the market.³⁸ However, not all reforms resulted in a level playing field for all competitors and none could be considered as full deregulation.

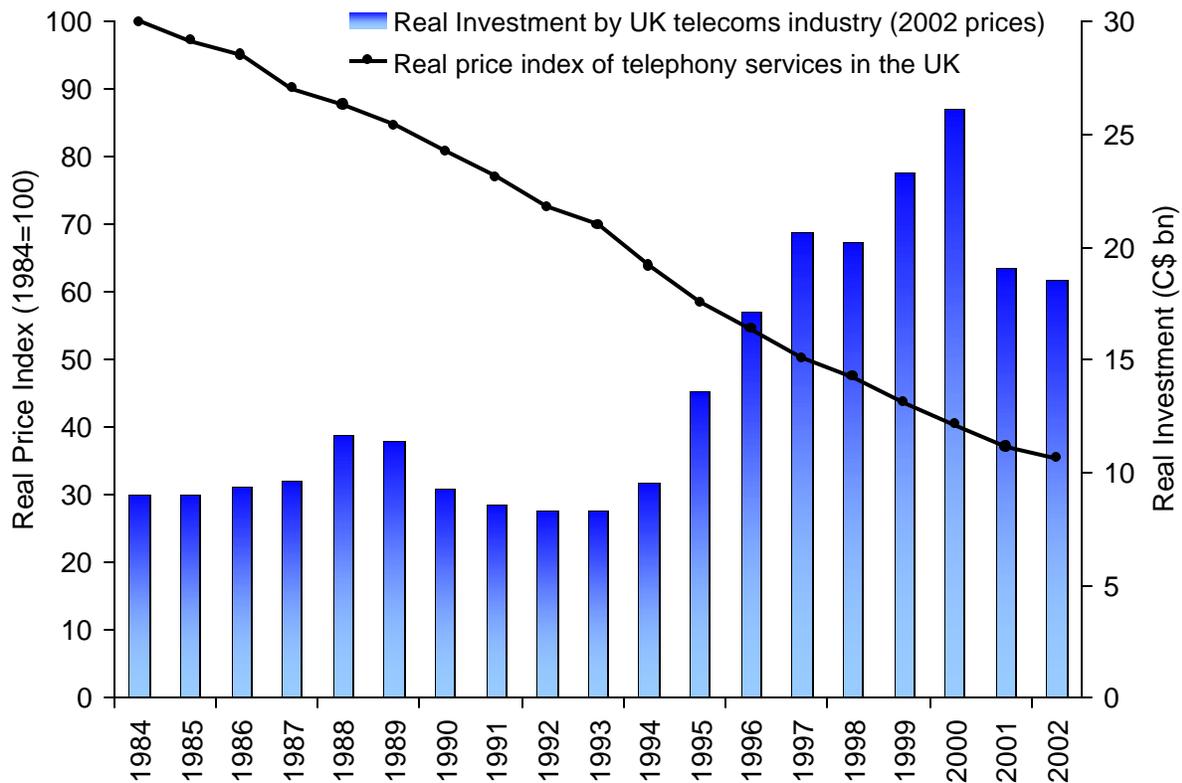
In many cases, the effect of these regulatory reforms can reasonably be characterised as dramatic. As a result of the industry's new freedom to respond to the market and technology developments, prices fell substantially, service quality improved, and investment in infrastructure and new technologies expanded, sometimes dramatically. Most importantly, the use of telecommunications increased substantially, enabling higher national economic performance. Higher investment in (and use of) telecommunications was a major factor in the reversal of the 1970-1990 sluggish growth of productivity in Canada, the U.S. and various other countries.

³⁷ Some would argue that the *ex ante* approach to regulatory design is based on the premise that a high market share by itself is anti-competitive and necessarily leads to abuse of a dominant position. In contrast, other economists consider market share to be evidence which might warrant further investigation of the nature of competition, but that high market share by itself does not necessarily lead to abuse of a dominant position.

³⁸ In some countries, such as the UK and Australia, formally state-run telecommunications companies were privatised. In Canada and the U.S., the federal government had no holdings in the telecommunications companies, although some states and provinces did, and occasionally still do.

An illustration of the impact of regulation reform is provided in **Figure 4-1**, which shows telecommunications prices and investment in the UK following liberalisation in 1984. Between the start of reforms in 1984 and 2002, prices in the UK telecommunications industry declined by 65% in real terms (i.e., after adjusting for inflation). Annual investment also grew substantially during that period. From a base of just over C\$8 billion in 1984, annual telecommunications investment peaked in 2000 at C\$26 billion (in constant 2002 dollars), accounting for over 10% of total UK capital expenditure). Even with the general economic and telecommunications sector slowdowns in 2000/2001, annual telecommunications capital expenditure in the UK was still just above C\$18 billion in 2002, nearly double the pre-liberalisation investment level in 1984. This latter point is important. While much press attention has been given to the global slowing of telecommunications investment after 2000, it is still roughly double the investment levels prior to liberalisation.

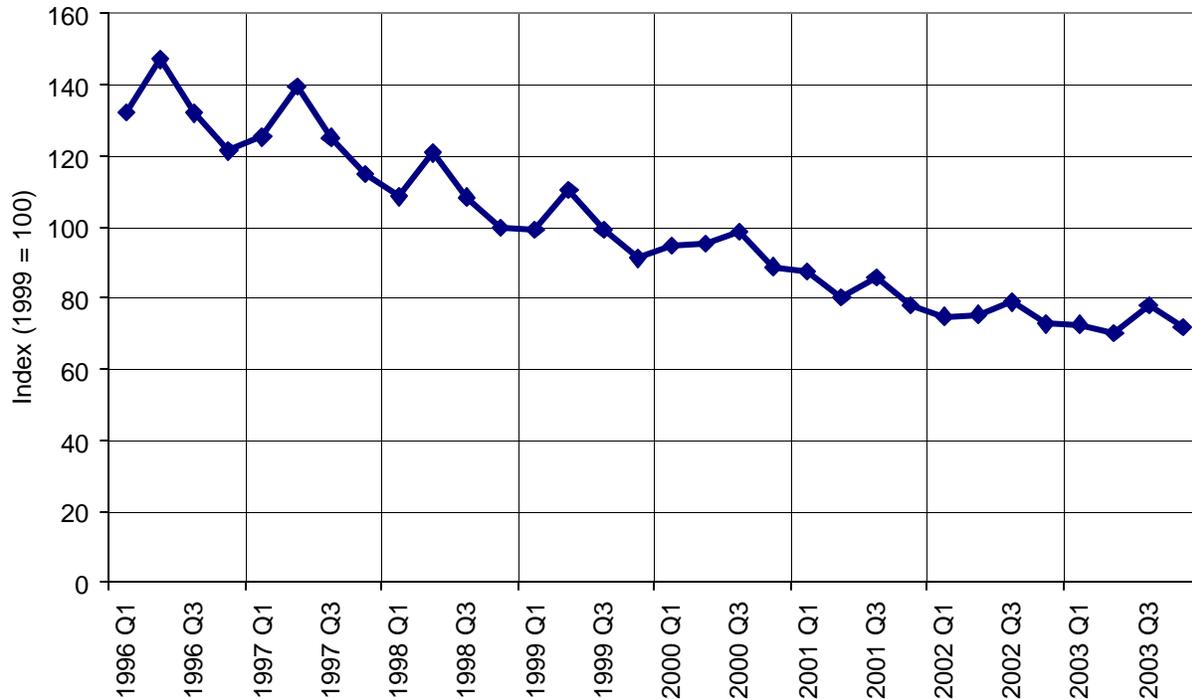
Figure 4-1
Declining Prices and Increased Investment in the UK Telecommunications Industry



Source: OFCOM (UK Regulator). Real price index reflects the inflation-adjusted price of a weighted basket of services.

Similar data is not available for Canada for the same time period, but **Figure 4-2** displays the available data on the trend in average price for telecommunications services in Canada during the period 1996-2002.³⁹ Nominal telecommunications prices in Canada fell by 45% from 1996 to 2002. In real terms the drop in prices was even more dramatic.

Figure 4-2
Canada Telecommunications Price Index
1996-2002

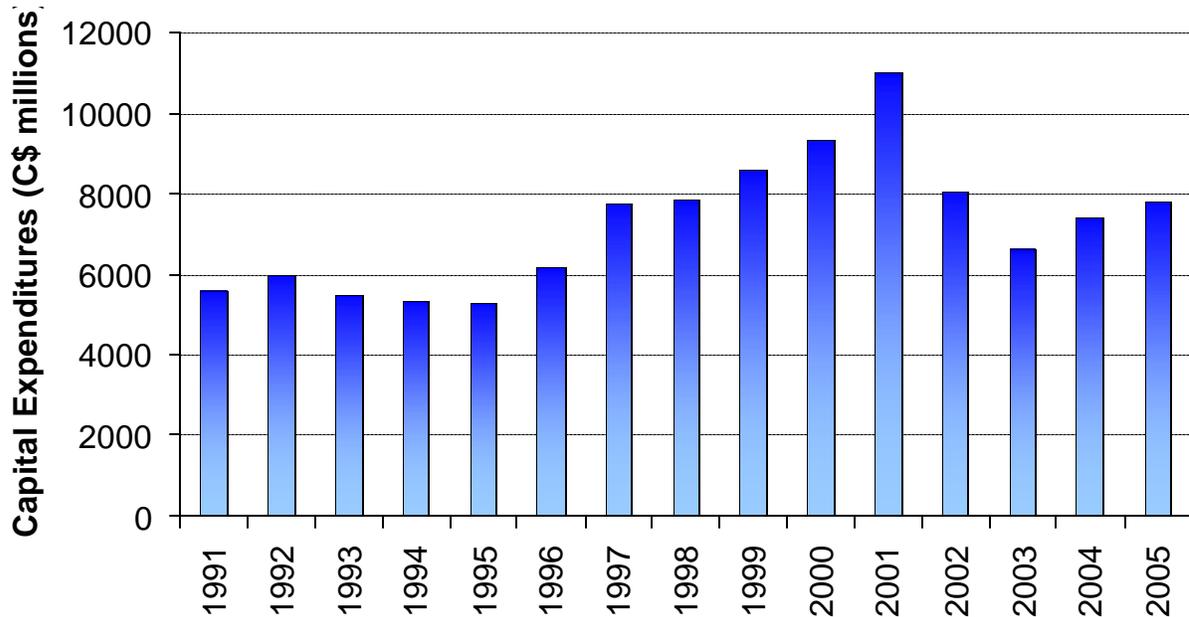


Source: 1999-2002: Statistics Canada (CANSIM), Table 326-0019: Telecommunications services price indexes, quarterly. 1996-1999: Statistics Canada (CANSIM), Table 326-0011: Telecommunications services price indexes, yearly. The two series were chain linked at the fourth quarter.

Figure 4-3 shows the record for investment in Canadian telecommunications for 1991 to 2005. The increase in investment in the mid to late 1990s is clear. As well, while investment declined following the peak in 2001, a) it is still high relative to the early 1990s, and b) has been steadily recovering since 2003. Investment in 2005 is expected to be 71% of the 2001 peak level, and is almost 40% higher than investment levels in the early 1990s.

³⁹ Statistics Canada began reporting data on telecommunications prices on an annual basis in 1996, and quarterly in 1999. A price index for the higher industry level is not reported.

Figure 4-3
Investment in Canadian Telecommunications and Broadcasting
1991-2005



Source: Statistics Canada Table 029-0013 - Capital and repair expenditures, industry sector 51, information and cultural industries, annual. The data in this table represents capital expenditures (starting in 1991) and repair expenditures (starting in 1994) using the North American Industrial Classification System (NAICS). These series exclude adjustments and historical revisions made in the national accounting system.

Similar results have been found in different countries that have enacted regulatory reform. **A number of studies have found a clear linkage between changes in regulatory approaches and improved performance in the telecommunications industry.** Boylaud and Nicoletti (2001), for example, undertook a study of regulation, market structure and performance in telecommunications across a large number of countries in the OECD with differing levels of market liberalisation and regulation.⁴⁰

Using statistical analysis of data from 23 countries in the 1990s, the authors found empirical evidence that increased liberalisation of the telecommunications sector led to higher productivity

A number of studies have found a clear linkage between regulatory reform and improved performance in the telecommunications industry.

⁴⁰ Boylaud, O. and Nicoletti, G. (2001), "Regulation, Market Structure and Performance in Telecommunications", *OECD Economic Studies*, No. 32.

levels in the industry, lower prices for users and better quality service. They conclude from their research:

“From a policy point of view, these results confirm that the economic benefits of liberalisation and regulatory reform in the telecommunications industry are large and relatively quick to come about.”⁴¹

As mentioned above, one of the key benefits of new approaches to telecommunications liberalisation has been the unleashing of a flood of new investment in the sector. This investment has had a major impact on the sector, resulting in:

- the development of lower cost technology and lower prices for users;
- increased system capacity;
- improved system reliability and functionality; and
- the development of new and important innovations in the telecommunications sector.

Investment, which includes research and development (R&D), has been one of the major factors behind the productivity, price and service improvements recently achieved in the telecommunications sector. New approaches to telecommunications regulation can spur investment in a number of ways:

- Poorly designed regulatory policies can impose additional costs on the carriers, through cumbersome and time consuming approval processes (i.e., red tape), making investment less attractive and often introducing a delay in the investment process. In the fast moving world of telecommunications, delay can be particularly damaging.
- Poor regulatory design often imposes limits on the rate of return firms can earn from an investment. This was certainly true in the era when rate regulation was done via a rate-base rate-of-return regime (which still prevails in Canada for wholesale services), but even with price cap regulation, poor regulatory design affects achievement of an adequate rate of return. In order to spur innovation, firms must be able to achieve a higher rate of return that encourages risk taking in investment.

In a comparison of regulation and investment in OECD countries, Alesina et al (1993) found that moving away from tight regulation has led to greater investment.⁴² The study used data from telecommunications, electricity, gas, postal services, airlines, road freight and railways sectors in 21 countries. From their analysis of this data, the authors conclude:

⁴¹ Page 135.

⁴² Alesina, A., Ardagna, S., Nicoletti, G. and Schiantarelli (2003), “Regulation and Investment”, *National Bureau of Economic Research*, Working Paper 9560.

“There is considerable evidence that tight regulation of the product markets has had a large negative effect on investment, a key engine for growth. The data for sectors that have experienced significant changes in the regulatory environment suggest that deregulation is associated in the long-run with greater investment.”⁴³

The available scientific research supports the hypothesis that new approaches to regulation have been a key driver in the development of the telecommunications sector. There is an emerging consensus that liberalisation leads to improvements in the performance of the telecommunications sector, with benefits for its consumers and the wider economy. The views of a number of economists and industry experts regarding the impact that liberalisation has had in telecommunications performance are highlighted below:

The available scientific research supports the hypothesis that new approaches to regulation have been a key driver in the development of the telecommunications

- A study of the economic benefits of regulatory reform by the OECD, which reviewed the performance of five economic sectors including telecommunications concluded:

“... experiences across the OECD suggest that regulatory reform can contribute substantially to improvements in economic performance.”⁴⁴

- In a speech to the Canadian Telecommunications Policy Conference in 1998, Andre Lafond, Deputy Commissioner of Competition at the Competition Bureau stated that:

“The main cost of regulation is that it inhibits competition by denying regulated firms the pricing and marketing flexibility needed to react to changing market conditions. In an industry as dynamic as telecommunications, where the pace of change seems to be constantly accelerating, regulators cannot possibly be expected to make better decisions as to service offerings and prices, than those that would be arrived at through the competitive process. Regulation also imposes direct administrative costs upon the government and the regulated parties and these costs are not insignificant.”⁴⁵

“The main cost of regulation is that it inhibits competition by denying regulated firms the pricing and marketing flexibility needed to react to changing market conditions.”

*Andre Lafond
Deputy Commissioner of Competition*

- In 2002, the OECD remarked that:

“Experience across the OECD area suggests that appropriate regulatory reform can work. For

⁴³ Page 22.

⁴⁴ Blondal, S. and Pilat, D. (1997), “The Economic Benefits of Regulatory Reform”, *OECD Economic Studies No.28*.

⁴⁵ “Evolution of the Regulatory Process – The Impact of Deregulation”, Lafond, A., *Canadian Telecommunications Policy Conference Speech*, 11 February 1998.

proof, one only has to look at improved performances in road and air transport, distribution services, telecommunications, professional and financial services. Further regulatory reform of the telecommunications industry is particularly important for many services, as it helps to lower the costs of ICT.”⁴⁶

- A 2003 study by the OECD on the link between ICT and economic growth concluded in regard to policy that:

“...policy should foster market conditions that reward the successful adoption of ICT; a competitive market environment is key for this to happen.”⁴⁷

4.3 Properly Designed Regulatory Policies are Critical to Achieving Improved National Economic Performance

The evidence above supports the hypothesis that the performance of the telecommunications sector (as with many other sectors of the economy) is strongly influenced by the regulatory regime. When and where the telecommunications sector has been given a more flexible regulatory regime, its performance increased quickly and dramatically. Further, improved performance in the sector drives performance improvements in sectors of the economy which adopt and use telecommunications technologies in their own production and service delivery processes.

Because telecommunications has a dramatic impact on the entire economy, and not simply on the sector itself, regulatory policies for telecommunications are critical to national economic performance.

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Put differently, well designed economic regulatory policy for the telecommunications sector is critical to enabling Canada’s full economic potential – both in terms of closing the gap with the per capita income gap with the U.S and in terms of the competitiveness of Canada’s export and domestic industries vis a vis foreign producers.

While it is beyond the scope of this report to make detailed recommendations on the needed regulatory policies for Canadian telecommunications, some general comments can be made.

First, the historical evidence of regulatory change in telecommunications (and other sectors) in Canada and abroad makes clear that priority must be placed on having a level economic and regulatory playing field for all market participants. When regulation is applied unevenly, or only to some firms, then disincentives to invest are created. As was seen from the evidence in Section 3,

⁴⁶ Pilat, D. (2000), “No Longer Services as Usual”, *OECD Observer*, November 2000.

⁴⁷ “ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms” *OECD*, August 2003.

it is investment in telecommunications which has been a primary driver of enhanced sector and national economic performance.

Second, where regulation exists, it must be light-handed and transparent. Specifically, regulatory processes must eliminate lags in decision making which undermine investment and pricing decisions. Regulation must react quickly to changing market and technological conditions.

Third, this suggests that regulation should operate in an “ex-post mode”, not an “ex-ante mode.” Regulation should be utilised when problems arise, but should not require pre-approval of firm innovations, pricing decisions, etc.

Well designed economic regulatory policy for the telecommunications sector is critical to enabling Canada’s full economic potential

- **both in terms of closing the per capita income gap with the U.S.**
- **and in terms of competitiveness of Canada’s export and domestic industries vis a vis foreign producers.**

4.4 Conclusion

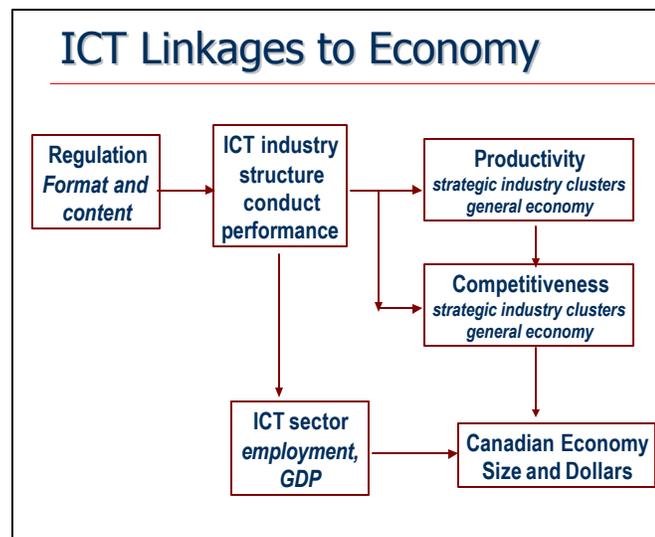
This section provided evidence that well designed telecommunications regulation leads to greatly improved economic performance. In the telecommunications sector, as in many other sectors, changed regulatory approaches have led to improved industry productivity levels, lower prices, better quality service and increased investment. Furthermore, there is evidence that the greater the degree of regulatory flexibility, the greater the benefits.

Improved regulatory design is a win-win policy. Properly designed and implemented regulation benefits industry, via higher productivity and greater responsiveness to market changes, and users benefit from lower prices and better service. Through these outcomes, the economy ultimate benefits and experiences higher growth.

5.0 The Potential for the Smarter Regulation of Canada's Telecommunications Sector to Enhance Canada's Economic Performance

5.1 Joining the dots: How telecom regulation reform can benefit the Canadian economy

Section 3.2 discussed how ICT has both direct and indirect impacts on national economic performance. (Flow chart reproduced at right.) In terms of direct linkages, the evidence showed that ICT accounts for 5.4% of Canada's GDP, up after only 6 years from 4% in 1997. This is a \$55 billion per annum industry which is achieving strong growth. In terms of productivity growth, the ICT sector has been achieving labour productivity growth between 4 and 6 times that in the overall economy: 7.1% per annum versus 1.8%.



An important point to note is that the industry continues to make major investments. The popular press has created the impression that since 2001, this industry has been in a meltdown. This is incorrect, as was shown in Figure 4-3. While industry investments peaked in 2001, the sector continues to invest heavily at rates more than 40% higher than 1990, and is already 70% of the level of the 2001 peak.

Regarding the indirect linkages, Section 3.4 reviewed the evidence of the impact of ICT on productivity in other sectors, and Section 3.5 reviewed the evidence regarding the impact on GDP growth.

- **On the all important national productivity measure, ICT has contributed 25-33% of national productivity growth, even though it represents only 5-7% of the national economy.**
- **In terms of GDP growth, evidence suggests that ICT contributes roughly 11-14% of national GDP growth.**

Canada's economy grows between 2.5% and 3% per annum in most years. This is a \$27-39 billion increase in real economic activity each year. With ICT contributing directly or indirectly to 11-14% of Canada's GDP growth, its impact is an incremental \$3-5 billion *each year*. That is, **not only does ICT account for \$55 billion in direct economic activity each year, it adds another \$3-5 billion each year in economic growth.** Over time, this growth impact cumulates and compounds.

For example, over a ten-year period, this cumulates to increasing the size of Canada's economy of between \$22 and \$31 billion.

Not only does ICT account for \$55 billion in direct economic activity each year, it adds another \$3 to \$5 billion each year in economic growth.

Over a ten-year period, this cumulates to increasing the size of Canada's economy of between \$22 and \$31 billion.

5.2 There are large benefits to Canada from further ICT investment and adoption

This section uses an analytical approach, based on the scientific research described in Sections 3 and 4, to estimate the economic benefits that could potentially be derived over the next 10 years from a liberalised Canadian telecommunications sector. Additional details on the methodology can be found in **Appendix B**.

5.2.1 Impacts based on historical performance of ICT / Telecommunications in Canada

We first begin by considering the impact of ICT and telecommunications based on the historical performance of ICT in Canada. As was discussed in Chapter 3, a study by Armstrong et al (2002) estimated that ICT increased economic growth in Canada by 0.7 percentage points per annum. This forms the primary basis for our estimate of future economic gains to Canada from ICT deployment. In our analysis, we have assumed that ICT will continue to contribute 0.7 percentage points to economic growth, although the potential could be even higher.

Armstrong et al also found that Canada had under-performed relative to the U.S. in ICT impact, in large part due to slower adoption of ICT innovations. Therefore, there is considerable scope for ICT to drive further economic growth in Canada, if the right regulation and right incentives are in place to allow innovations to reach the market quickly.

The Conference Board of Canada forecasts Canadian real GDP will grow by 2.6% per annum over the next two years. Therefore, if the ICT sector contributes 0.7% of this economic growth, the remainder of the economy contributes 1.9% (2.6% - 0.7%).

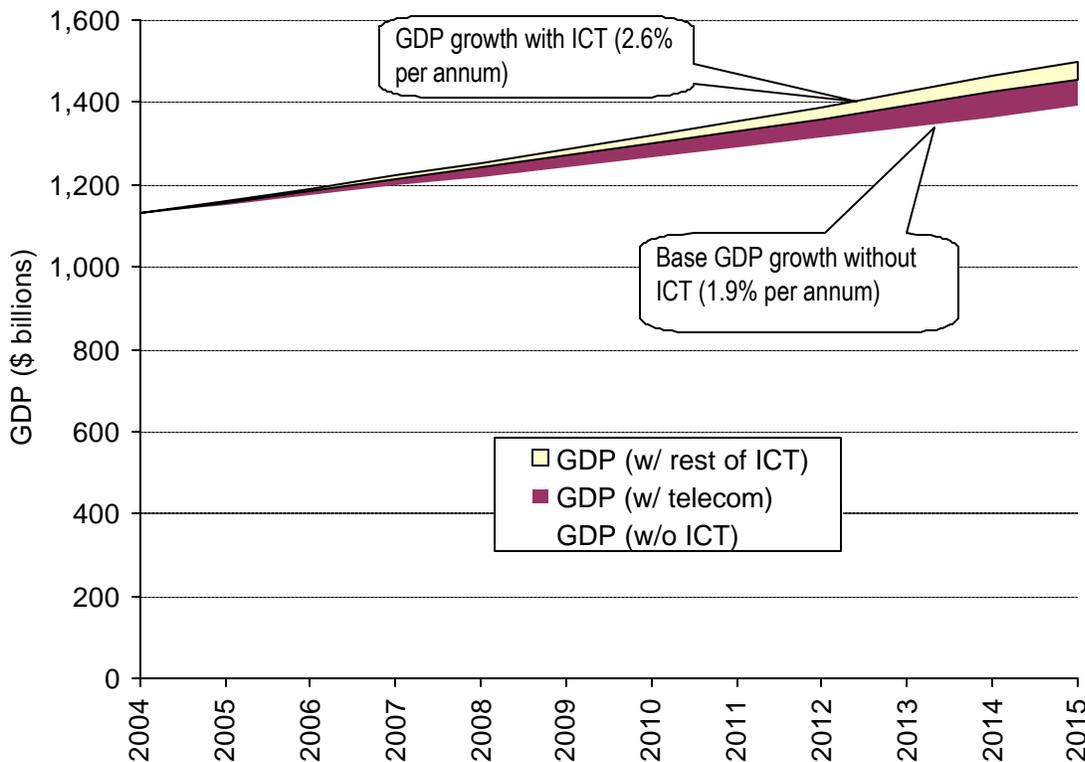
The next step is to estimate the contribution of the telecommunications sector as a portion of the 0.7% impact of ICT. Two methods have been used to do this:

- One approach allocates the overall ICT contribution between telecommunications and the other parts of ICT based on the current GDP share of the telecommunications in the ICT sector, 45%.⁴⁸
- A second approach increases the contribution of telecommunications to 60% of the ICT total by recognising the networking power of adoption of telecommunications innovations. For example, as the number of users of broadband wireless increases, it improves the economics of firms investing in broadband wireless applications. The powerful positive networking externality of telecommunications adoption is a well-known phenomenon.

Using the Armstrong et al research on the contribution of ICT to GDP growth over the next 10 years, the annual contribution of ICT to GDP in 2015 is \$109 billion (in 2004 dollars), 7% of total GDP in 2015. This share of GDP is consistent with the long-term trend whereby ICT has steadily increased its share of Canada's GDP.

Applying the two approaches toward breaking out the telecommunications contribution to this total impact of ICT, the contribution of telecommunications is forecast to be between \$49 billion and \$65 billion per annum, depending on whether the 45%, or 60% (contribution which recognises the positive networking externality effect) share is used. These findings are summarised in Figure 5-1.

Figure 5-1
Projected GDP Contribution of ICT and Telecommunications



⁴⁸ See Section 2.3.

The figure shows the base growth in GDP (1.9% per annum) without the historical contribution of ICT. The 0.7% contribution of ICT is the top line, with dark shaded area representing the upper bound of the unique contribution of telecommunications deployment and adoption.

It should be noted that the \$109 billion is only the projected annual contribution of ICT in 2015. The sector also contributes to economic growth in the intervening years as well. One can compute the cumulative impact of ICT's contribution to GDP growth by using the standard accounting method accumulated economic benefit by discounting the contributions in each year and summing to produce the Net Present Value (NPV). Using this approach, the NPV of ICT's contribution to economic growth, discounted at 8% per annum, is roughly \$340 billion, while the NPV of the telecommunications contribution is between \$150 and \$200 billion.

The potential contribution of telecommunications deployment and adoption to GDP growth over the next 10 years is roughly equivalent to 18% of the current size of entire Canadian economy in 2004 (\$1,131 billion). That is, if current telecommunications technology deployment were to be frozen as is today, over the course of ten years Canada would forego the equivalent of 18% of annual GDP.

if current telecommunications technology deployment were to be frozen as is today, over the course of ten years Canada would forego the equivalent of 18% of annual GDP.

5.2.2 Potential national economic impacts based on incentivised performance of ICT / Telecommunications

As observed by van Ark et al and other researchers, Canada's ICT sector has not equalled the performance of the sector in the U.S. or in other economies such as Finland. Van Ark et al attribute part of the weaker performance in Canada to a delayed adoption of technology or a slower rate of investment and use.

This section estimates the potential additional contribution of ICT and telecommunications to Canada's national economy if impediments were removed from the industry's ability to invest in and adopt new technologies, or if it were given incentives to adopt and invest in technologies more quickly. To do this, the approach we take is to compute the increase in impact from the elimination of Canada's delayed adoption of technology and investment. Our computations are

Accelerating Canada's 10 year stream of GDP impacts from earlier adoption of telecommunications technologies produces an increase in GDP of \$60-85 billion in NPV.

based on reducing Canada's delay in ICT/telecommunications adoption by two years.⁴⁹ Accelerating Canada's 10-year stream of GDP impacts from earlier adoption of telecommunications technologies produces an increase in GDP of \$65 – 85 billion in NPV.

The per capita impacts of this achievable higher economic performance is very large. For 2005 alone, the impact would be roughly \$500 per capita, or \$2000 per family of four. This impact increases with each year, and would contribute significantly to:

- Narrowing the gap with the U.S. in economic performance per capita, and
- Improving the competitiveness of Canada's export industries and our domestic industries that compete with foreign imports.

⁴⁹ Note that this might be viewed as a conservative approach, as estimates are that Canada lags by roughly 4 years from its rate of investment in and adoption of new technologies.

Appendix A: Literature Review

Productivity Growth

Van Ark, Inklaar and McGuckin (2003). The authors utilise a database containing information on value added and employment in 16 OECD countries for 51 industries between 1990 and 2000 to estimate the contribution of ICT investment to productivity growth. Because of a lack of ICT investment data at the industry level, the study focuses on labour productivity rather than total factor productivity.⁵⁰

This study breaks out the contribution of ICT investment to labour productivity growth into ICT-producing industries and ICT-using industries for the economies of Canada, the U.S., and the European Union (E.U.). The results for the second half of the 1990s are summarised below:

- *Canada.* ICT investment was responsible for 71% of the economy's labour productivity growth. This is astounding given the fact the Canadian ICT sector made up only 34% of nominal GDP in 2000. Worth noting is the fact ICT-producing industries accounted for 0.42 percentage points and ICT-using industries 0.83 of the 1.76% average annual growth over the period.
- *U.S.* ICT investment accounted for 86% of the economy's labour productivity growth, far exceeding the ICT sector's nominal GDP share of 38% in 2000. Broken down by type, ICT-producing and ICT-using industries contribute 0.74 and 1.4 percentage points to the 2.49% annual labour productivity growth, respectively.
- *E.U.* ICT investment accounted for 62% of labour productivity, much higher than the 38% share of nominal GDP the sector held in 2000.

Armstrong et al (2002). This study estimates the contribution of ICT capital deepening to labour productivity growth. Capital deepening refers to an increase in the capital labour ratio, or in this case more ICT capital per worker. The estimated contribution of ICT capital deepening was 0.4 percentage points of the 1.7% average annual growth experienced between 1995 and 2000.

It should be noted that this study only estimates the contribution of ICT capital deepening to labour productivity growth. ICT's impact on multifactor productivity is not included. For this reason, the spring 2002 Bank of Canada Review, adds the estimated contribution of ICT to total factor productivity (TFP) obtained from Muir and Robidoux (2001) to the capital deepening impact estimated by Armstrong et al (2002). Combining the two contributions results in an estimated contribution from ICT to Canadian business sector labour productivity growth of 0.6 percentage

⁵⁰ Total factor productivity or TFP is the quantity of output divided by the amount of all inputs used in production. The amount of all inputs used in production can be calculated in a variety of ways. One common way is to take a geometric-weighted average of the quantities of each of the inputs, where the weight on each input is its share in the total cost of production.

points of the 1.7 percentage point average annual growth for the period of 1995-2000. Below **Table A-1** displays the Bank of Canada Review's breakdown of ICT contributions towards labour productivity growth in Canada from 1995 to 2000. Approximately 35% (0.6 of 1.7) of labour productivity gains achieved over this period can be attributed to ICT production and use.

Table A-1:
Contributions from ICT towards Labour Productivity Growth – Canada
1995-2000

Contributions to Labour Productivity Growth	1995-2000
Labour Productivity Growth	1.7
(i) Capital Deepening	0.4
ICT	0.4
Non-ICT	0.0
(ii) Labour Quality	0.3
(iii) TFP Growth	1.0
ICT producers	0.2
Total Contribution from ICT	0.6

Source: Crawford, A. (2002)

Khan and Santos (2002). This study estimates the impact of Canadian ICT use on labour productivity growth. Using a simple growth-accounting exercise, the authors find that 0.45 percentage points of the 1.7% average annual increase in labour productivity growth from 1996 to 2000 is attributable to capital deepening by ICT using industries. This translates into a 26% contribution of ICT use capital deepening to labour productivity growth.

Jorgenson, Ho and Stiroh (2001). This U.S. study improves upon previous work which failed to account for both ICT-using and ICT-producing components. The authors found that approximately 54% of labour productivity growth between 1995 and 2000 was due to ICT production and use (1.27 percentage points of 2.36% average annual growth). The breakdown of this contribution estimate is displayed below in **Table A-2**, into capital deepening and total factor productivity.

Table A-2:
Contributions from ICT towards Labour Productivity Growth – U.S.,
1995-2000

Contributions to Labour Productivity Growth	1995-2000
Labour Productivity Growth	2.36
(i) Capital Deepening	1.40
ICT	0.76
Non-ICT	0.64
(ii) Labour Quality	0.17
(iii) TFP Growth	0.80
ICT	0.51
Total Contribution from ICT	1.27

Source: Jorgenson, Ho and Stiroh (2002).

Oliner and Sichel (2002). This U.S. study, like the others reviewed, uses a growth-accounting framework to decompose labour productivity growth into contributions from capital deepening, improvements in the quality of labour, and growth in total factor productivity (TFP). The results of this U.S. study suggest that 1.79 percentage points of the 2.43% average annual growth in labour productivity (1996-2001) is contributed by the IT sector. Thus, 74% of the labour productivity growth experienced is linked to the IT sector. Below **Table A-3** breaks down labour productivity growth into the three contributions.

Table A-3:
Contributions from ICT towards Labour Productivity Growth – U.S., 1996-2001

Contributions to Labour Productivity Growth	1995-2000
Labour Productivity Growth	2.43
(i) Capital Deepening	1.19
ICT	1.02
Non-ICT	0.17
(ii) Labour Quality	0.25
(iii) TFP Growth	0.99

Contributions to Labour Productivity Growth	1995-2000
ICT	0.77
Total Contribution from ICT	1.79

Source: Oliner and Sichel (2002).

Economic Growth

- **Armstrong et al (2002).** The authors estimate that the contribution of ICT capital services to Canadian output growth from 1995 to 2000 is 0.7 percentage points of the total average annual growth of 4.9%. This corresponds to a 14% contribution of ICT capital services to economic output growth in Canada in the late 1990s. What is very interesting about the post-1995 period is the recovery of total factor productivity, increasing to 1.0% per year from the 0.2% experienced during the 1981 to 1988 period.
- **Table A-4** below breaks down the various contributions to Canadian economic growth in the second half of the 1990s.

Table A-4:
Breakdown of Contributions to Economic Output Growth – Canadian Business Sector

Contributions to Labour Productivity Growth	1995-1999
Output (annual average growth rate)	4.8
Contribution of Labour Input	2.1
Contribution of Capital Services	1.7
Contribution of ICT	0.7
Contribution of other Machinery and Equipment	0.5
Contribution of Structures	0.6
TFP (annual average growth rate)	1.0

Source: Armstrong et al. (2002).

Khan and Santos (2002). This study looks specifically at the impact of ICT use on economic growth. The authors estimate that the ICT-using component of the ICT sector contributes 0.53 percentage points of the 4.75% average annual output growth in Canada from 1996 to 2000; which corresponds to 11% of total economic growth. However, it must be understood that this study only looks at the impact of ICT use, the production of ICT is not taken into account.

Pakko (2002). Below in **Table A-5**, the various contributors to GDP growth and their respective contributions are listed by decade. From 1995 to 2000, ICT investment is estimated to have contributed approximately 18% of the annual average GDP growth in the U.S.

Interestingly, this study addresses the issue of quality adjustment in the measurement of investment in the national income and product accounts (NIPA). The study adjusts investment data for sources of quality improvement that may have gone unmeasured in the Bureau of Economic Analysis (BEA) data. The methodology used is similar to that employed by Robert Gordon in a 1990 paper. Adjusting the data results in a marginal change from the unadjusted result. Adjusted ICT investment contributes 1% more to GDP growth than unadjusted estimate (19% versus 18%).

Table A-5:
Breakdown of Contributions to GDP Growth in the U.S.

	1950s	1960s	1970s	1980s	1990s	1995-00
GDP	3.53 (100%)	4.19 (100%)	3.23 (100%)	3.21 (100%)	3.25 (100%)	4.11 (100%)
ICT	0.04 (1%)	0.14 (3%)	0.21 (6%)	0.30 (9%)	0.55 (17%)	0.75 (18%)

Source: Pakko, M. (2002)

London Economics (2003). This study analyses the contribution of ICT investment to the performance of the U.K. economy. From 1992 to 2000, ICT's contribution to U.K. output growth was approximately 26%. The contribution is slightly higher, 32%, when looking at the period of 1997-2000.

Sectoral Growth

London Economics (2003). This is a UK study that breaks down the contributions of ICT to labour productivity and output growth by sector. They find that ICT investment makes its most important contributions to output growth in the large sectors of the economy, such as wholesale trade, retail trade and manufacturing. In fact, it is the manufacturing sector that has gained the most in terms of output growth from ICT investment. With respect to labour productivity growth, ICT has contributed significantly to non-ICT producing sectors.

Van Ark, Inklaar and McGuckin (2003). This study breaks down the contributions to aggregate productivity growth of various sectors, including: ICT-producing manufacturing industries, ICT-producing service industries, ICT-using manufacturing industries, ICT-using service industries, non-ICT manufacturing industries, non-ICT service industries, and non-ICT other. The results are provided for Canada, the U.S. and the E.U. from 1995 to 2000. For all three regions, the ICT-using services industries contribute the most towards aggregate productivity growth, however this sector's contribution in the U.S. is far greater than that in Canada and the E.U. For Canada, the U.S. and the E.U., the ICT-using services industries contribute 39%, 21% and 54%, respectively. When the ICT-using services sector is disaggregated, it is clear that Canada falls behind the U.S. when it comes down to the retail trade and securities trade industries.

Appendix B: Impact of Telecommunications and Regulation

In sections 5.5 and 5.6, the impacts of the Canadian telecommunications sub-sector and regulation within the sector on the economic wellbeing of Canada are discussed. The following outlines how these figures were calculated, and the methodologies this study relied upon.

1. **Derive the impact of differential GDP growth that is attributable to the Canadian Telecommunications sub-sector.** In this stage we estimated the net present value of economic gains contributed by the telecommunications sector between 2005 and 2015. To calculate this value we had to come up with growth projections including and excluding the telecom sub-sector. Including telecom and the other ICT sub-sectors, the forecasted growth rate of Canadian GDP was obtained from the Conference Board of Canada, which forecasts economic growth of 2.6% per annum between 2004 and 2025.

The baseline growth we assume which does not take into account ICT's impact is 1.9 percentage points ($2.6 - 0.7 = 1.9$). The 0.7 percentage points subtracted represents the annual contribution of ICT to economic growth, as estimated by Armstrong et al (2002). To calculate GDP growth (telecom included) involves adding telecommunications' share of ICT's contribution to GDP growth to the bottom line growth rate of 1.9%.

As previously mentioned, we have assumed lower and upper bound contributions of telecom to ICT of 45% and 60% respectively. We then scaled the ICT contribution to GDP growth by these telecom percentages and added these values to the baseline growth rate of 1.9%. Below, the lower and upper bound GDP growth rates which include the telecom sub-sector and their calculations are displayed.

- Lower Bound, 45%: $1.9\% + 0.45 \times (0.7\%) = 2.22\%$
- Upper Bound, 60%: $1.9\% + 0.60 \times (0.7\%) = 2.32\%$

With a baseline (no ICT sector contribution) and telecom included growth rates, we then calculated annual GDP projections. Below in **Table B-1**, annual projected GDP over the 10-year period is displayed with and without the telecommunications sub-sector's contribution.⁵¹ The formulas used to calculate these projected GDP values are displayed below for both scenarios, with and without the telecommunications sub-sector.

- With telecom: $GDP_t = GDP_{2004} \times (1 + r_{withTelecom})^{t-2004}$

⁵¹ Table A-1 displays the estimated annual contribution to total GDP of the telecommunications sub-sector based on the upper-bound estimate of 60%.

- Without telecom: $GDP_t = GDP_{2004} \times (1 + r_{withoutTelecom})^{t-2004}$;

where $r_{withTelecom} = 0.0232$ and $r_{withoutTelecom} = 0.019$.

The difference (or telecom impact) column lists the telecommunications sub-sector's contribution to projected GDP, while the discounted telecom impact column reports the net present value of the benefits attributable to the telecommunications sub-sector.

Telecom Impact = Projected GDP (w/ telecom) – Projected GDP (w/o telecom)

The annual net present value of telecom benefits are calculated as follows:

$$NPV_t = \frac{GDP_{t,withTelecom} - GDP_{t,withoutTelecom}}{(1 + r_{discount})^{t-2004}}; \text{ where } r_{discount} = \text{discount rate} = 0.08.$$

We have calculated the net present value (NPV) of telecom impacts between 2005 and 2015 for both the lower and upper bound scenarios. The estimated telecommunications impacts range between \$151 billion and \$202 billion for the 10-year period.

- Determine the impact of further regulatory reforms in the telecommunications industry.** Regulatory problems, in addition to lack of incentives, results in reduced innovation and investment in telecommunications. If further regulatory reforms were to be enacted, we assume innovation would increase substantially. To estimate this, the approach we take is to compute the increase in impact from the elimination of Canada's delayed adoption of technology and investment. We have employed a conservative 2-year estimate of the length of delay that is caused by strict regulation. Accelerating Canada's 10-year stream of GDP impacts from earlier adoption of telecommunications technologies produces an increase in GDP. The estimated impact of quicker adoption of technologies is displayed in **Table B-2**, which displays the upper and lower bound estimates of telecom regulatory reform impacts.

**Table B-1:
Projected Canadian ICT Sector Contribution to GDP, 2005-2015**

Year	Projected GDP (with Telecom)	Projected GDP (w/o Telecom)	Difference (Telecom Impact)	Discounted Telecom Impact
2004	\$ 1,131	\$ 1,131	\$ -	\$ -
2005	\$ 1,157	\$ 1,152	\$ 5	\$ 4
2006	\$ 1,184	\$ 1,174	\$ 10	\$ 8
2007	\$ 1,212	\$ 1,197	\$ 15	\$ 12
2008	\$ 1,240	\$ 1,219	\$ 20	\$ 15
2009	\$ 1,268	\$ 1,243	\$ 26	\$ 18
2010	\$ 1,298	\$ 1,266	\$ 32	\$ 20
2011	\$ 1,328	\$ 1,290	\$ 38	\$ 22
2012	\$ 1,359	\$ 1,315	\$ 44	\$ 24
2013	\$ 1,390	\$ 1,340	\$ 51	\$ 24
2014	\$ 1,423	\$ 1,365	\$ 57	\$ 27
2015	\$ 1,456	\$ 1,391	\$ 64	\$ 28
Total	\$ 15,445	\$ 15,084	\$ 361	\$ 202

**Table B-2: Economic Impact of Regulatory Reforms to the Canadian
Telecommunications Sub-sector, 2005-2015**

Telecom Contribution	Net Present Value of Telecom Impact	Impact of Telecom Regulatory Reforms
Lower-bound	\$ 151 billion	\$65 million
Upper-bound	\$ 202 billion	\$85 million

Bibliography

Alesina, A., Ardagna, S., Nicoletti, G. and Schiantarelli, F. (2003), "Regulation and Investment", *National Bureau of Economic Research Working Paper 9560*.

Armstrong, P., Harchaoui, T., Jackson, C. and Tarkhani, F. (2002), "A Comparison of Canada-U.S. Economic Growth in the Information Age, 1981-2000: The Importance of Investment in Information and Communication Technologies", *Statistics Canada Research Paper*, Ottawa, ON.

Baldwin, J., Harchaoui, T. and Tarkhani, F. (2002), "The Importance of Information Technology: A Canada-U.S. Comparison", *ISUMA*, 3(1), spring 2002.

Blondal, S. and Pilat, D. (1997), "The Economic Benefits of Regulatory Reform", *OECD Economic Studies* No. 28.

Boylaud, O. and Nicoletti, G. (2001), "Regulation, Market Structure and Performance in Telecommunications", *OECD Economic Studies* No. 32.

Brynjolfsson, E. and Hitt, L. (2002), "Computing Productivity: Firm-Level Evidence", *MIT Sloan School of Management Working Paper*.

Canadian Telecommunications Policy Conference (1998), *Evolution of the Regulatory Process "The Impact of Deregulation"*, Speech by André Lafond – Deputy Commissioner of Competition, Competition Bureau, Ottawa, ON.

Canada Transportation Act Review Panel (2001), *Vision and Balance*.

Cette, G., Mairesse, J and Kocuglu, Y. (2002), "Diffusion of ICTs and Growth of the French Economy over the Long Term, 1980-2000", *International Productivity Monitor*, spring 2002.

Conference Board of Canada (1997), *Performance & Potential*, Ottawa, ON.

European Foundation for the Improvement of Living and Working Conditions (2003), *The Impact of ICT on Europe's Fishing Industry: A Case Study Approach*.

Freeman, K., Oum, T., Tretheway, M. and Waters, W. (1987), *The Growth and Performance of the Canadian Transcontinental Railways: 1956-1981*, Centre for Transportation Studies, University of British Columbia.

Gordon, R. (2004), "Why Was Europe Left at the Station When America's Productivity Locomotive Departed?", *National Bureau of Economic Research*.

Jorgenson, D., Ho, M. and Stiroh, K. (2002), "Projecting Productivity Growth: Lessons from the U.S. Growth Resurgence", *Federal Reserve of Atlanta Economic Review*, Third Quarter 2002, Atlanta, GA.

Kegels, C., Van Overbeke, M. and Van Zandweghe, W. (2002), "ICT Contribution to Economic Performance in Belgium: Preliminary Evidence", *Federal Planning Bureau*, Working Paper 8-02, Brussels.

- Khan, H. and Santos, M. (2002), "Contribution of ICT Use to Output and Labour-Productivity Growth in Canada", *Bank of Canada Working Paper 2002-7*, Ottawa, ON.
- Kim, S. (2002), *The Digital Economy and the Role of Government: Information Technology and Economic Performance in Korea*, Program on Information Resources Policy, Harvard University.
- Lee, D. (2003), "An Assessment of Some Recent Criticisms of the U.S. Airline Industry", *Review of Network Economics*, March 2003.
- London Economics (2003), "ICT and GDP Growth in the United Kingdom: A Sectoral Analysis".
- Morrison, S. and Winston, C. (1995), *The Evolution of the Airline Industry*, Brookings Institution.
- Morrison, S. and Winston, C. (1997), "The Fares Skies", *Brookings Review*, Fall 1997.
- Motohashi, K. (2002), "IT Investment and Productivity Growth of the Japanese Economy and A Comparison with the United States", *Research Institute of Economy, Trade and Industry (RIETI) Discussion Papers*, 02-J-018.
- OECD (2003), *ICT and Economic Growth: Evidence from OECD Countries, Industry and Firms*.
- Oliner, S. and Sichel, D. (2002), "Information Technology and Productivity: Where Are We Now and Where Are We Going?", *Federal Reserve Bank of Atlanta Economic Review*, Third Quarter 2002, Atlanta, GA.
- Oulton, N. (2001), "ICT and Productivity Growth in the United Kingdom", *Bank of England Working Paper No. 140*, London.
- Pakko, M. (2002), "The High-Tech Investment Boom and Economic Growth in the 1990s: Accounting for Quality", *Federal Reserve Bank of St.Louis Economic Review*, March/April 2002, St.Louis, MO.
- Parham, D. (2002), "Productivity Gains from Policy Reforms, ICTs and Structural Transformation", *IAOS Conference on the New Economy*, London.
- Pilat, D. (2000), "No Longer Services as Usual", *OECD Observer*, November 2000.
- Roller, L-H. and Waverman, L. (2001), "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach", *The American Economic Review*, Vol. 91, No. 4.
- RWI and Gordon, R. (2002), "New Economy – An Assessment from a German View Point", Research from a project commissioned by the Ministry of Economics and Technology, Berlin.
- Simon, J. and Wardrop, S. (2002), "Australian Use of Information Technology and Its Contribution to Growth", *Reserve Bank of Australia*, Research Discussion Paper RDP2002-02, Sydney.
- Tapscott, D. (1996), *The Digital Economy*, McGraw-Hill, New York, NY.
- Urwin, R. (2000), "Pioneering Privatized Transmission: National Grid's Perspective", *The Utilities Project Volume I*, National Grid Company.
- van Ark, B., Inklaar, R. and McGuckin R. (2003), "The Contribution of ICT-Producing and ICT-Using Industries to Productivity Growth: A Comparison of Canada, Europe and the United States", *International Productivity Monitor*, spring 2003.

List of Abbreviations

CLEC	Competitive Local Exchange Carrier
CRTC	Canadian Radio-television and Telecommunications Commission
GDP	Gross Domestic Product
ICT	Information and Communications Technology
IP	Internet Protocol
NIPA	National Income and Product Accounts
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
TFP	Total Factor Productivity
UK	United Kingdom
VoIP	Voice over Internet