Boom and Bust of Information and Communication Technology and Thereafter

by Laila Gulzar

An Honours essay submitted to
Carleton University in fulfillment
of the requirements for the course
ECON 4908, as credit toward
the degree of Bachelor of Arts with
Honours in Economics.

Department of Economics
Carleton University

Ottawa, Ontario

April 7, 2006

Acknowledgement

Many people have guided me in writing this essay. First of all, I would like to thank my supervisor Professor Hashmat Khan, without whose continuous guidance and numerous suggestions for improvement, it would have been impossible for me to complete this essay. I would also like to thank Professor Kenneth Xi, the second reader of this essay. Professor Armstrong has also helped me in preparing a schedule, which greatly helped me in producing this essay in a timely manner. I would also like to thank Nan Zhou, who guided me in using Shazam for forecasting. I would like to thank my friends who have supported and helped me through out the last year. Last but not the least, I would like to thank my loving husband Rehan without whose constant help, support, trust and motivation I could not have completed this essay in time.

TABLE OF CONTENTS

FIGURES

TABLES

Executive Summary

This paper follows the ICT sector during its boom in the late 1990s to its bust in early 2000s, and also examines data from more recent years. It examines the impact of the boom and bust of this sector on some key economic indicators, like employment, GDP, revenues and expenditures of the sector. By looking at more recent data, it tries to determine if the bust of the industry seems a temporary or a persistent phenomenon. Finally, the study forecasts the rate of growth of the ICT sector by employing econometric methods.

The paper draws information from a variety of sources, but I have acquired most of the data from Statistics Canada and Industry Canada.

By observing the trends in various economic indicators like employment and output during the boom and bust of the ICT sector, I find that the ICT manufacturing sub-sector was more deeply affected by the bust than the services sub-sector. By observing the trends in the ICT manufacturing sub-sector, I find that during the bust, companies generated more revenue from ICT services than manufacturing. The ICT services sub-sector appears to have returned to steady growth since the bust, and is on its way to recovery. I can, therefore, assert that the bust in the ICT sector was not persistent but rather a temporary phenomenon.

1. Introduction

In this paper I will portray the picture of the boom and bust of the ICT (Information and Communication Technology) sector in past few years, and its impact on the Canadian economy. Several studies have examined this issue of boom and bust of the ICT sector, but most of them were done either immediately or shortly after the bust. Therefore, in this paper I will look at more recent employment and output statistics to examine how the effects of the bust in the ICT sector have evolved over time. Specifically I will examine whether the bust has caused a persistent downturn in the performance of the ICT sector. Lastly, I will forecast the future of the ICT sector. For the purpose of this study, I have classified the data into three time periods, the boom (1997 – 2000), the bust (2001 – 2003), and thereafter (2004 – 2005).

As a result of deep reliance on ICT in businesses, fluctuations in the ICT sector have had a significant affect on the Canadian economy.[1] But its affect on the economies of major cities of Canada has been much more profound as compared to rural areas. For that reason, I have included the affect of ICT sector fluctuations on some of the major cities like Toronto, Montreal, Ottawa and Vancouver.

Most research on this topic was done shortly after the bust, in the year 2001 and 2002, but now the data for years 2003 to 2005 is also available, which can help to determine whether the bust of ICT sector has caused a persistent reduction in the employment and output of the sector or not. I have drawn information from a variety of sources including Statistics Canada and Industry Canada.

I report three main findings. First, my sectoral analysis reveals that during the period of the bust, ICT manufacturing sector was severely affected, while ICT services industries continued to grow. Second, although the rate of growth of ICT sector is currently slower relative to that at the time of the boom; it is in a phase of recovery. This finding suggests that the bust in the ICT

[1] Source Statistic Canada, "Information and Technology Communication, a statistical profile of the ICT sector," Catalogue No. 56-506.

sector was temporary. Third, using historical data I conduct a forecasting exercise for the ICT sector. My result indicates that the ICT sector is expected to grow at a steady rate.

The next of the essay is structured as follows: Section 2 presents a brief literature review. Section 3 defines the ICT sector. I have used quarterly data from 1997 Q1 to 2005 Q3 for the next sections. Section 4 lists the contribution of the ICT sector to the Canadian economy. Section 5 discusses the employment in the ICT sector. Section 6 describes the change in production of the ICT sector. Section 7 explains the ICT sectors revenue. Section 8 discusses the overview of the ICT expenditure. Section 9 explains the role of International Trade in the ICT sector. Section 10 presents forecast of the ICT sector's performance from the year 2005 up to 2015 and total ICT investments for major industries of Canada from the year 2005 up to 2008. Section 11 concludes my findings.

2. Literature Reviewed

In this section I provide a brief review of some of the literature I have read as background to my research. I draw upon the ideas presented in the three articles discussed below to support my arguments.

Bowlby and Langlois (2002) provide an overview of the boom and bust of ICT sector of Canada between the years 1996 and 2001. The authors describe how the ICT sector experienced amazing growth between the years 1997 and 2000, and how the sector declined dramatically at the end of 2001 especially in the manufacturing sub-sector. Due to the downfall, many companies had to resort to layoffs and hiring freezes in order to keep their accounts in black. The authors claim that due to this decline, women and low-skilled workers were more severally affected then others. The authors also look at the affect of ICT downturn on employment in major urban centers of Canada and show that Ottawa–Gatineau and Toronto were the two centres most affected by the downturn.

Beckstead and Brown (2005) focus on employment growth and decline within the ICT sector in Canada from 1997 – 2003. The authors found that the decline in the ICT sector was first felt in

terms of output, and then employment, which is typical of most industries experiencing a downturn. The question they have tried to address in their paper is "whether the recent pattern of growth and decline within the ICT sector is simply a short-run phenomenon or does the downturn represents a structural break, with the ICT firms entering a more mature, slower growth stage." They examines the number of companies entering and exiting the ICT sector in the light of the Product Life Cycle theory to answer this question. They claim that since the ICT sector continues to attract a relatively large number of new entrants, the slowdown is temporary and not a structural shift. To further support their assertion, the authors also show that there has not been a large shift in employment from larger to smaller and presumably cheaper, centres. According to them, this is another proof that the slowdown in the ICT sector is temporary.

In both the articles the authors claimed that due to limitations of labour surveys done by Statistics Canada, it is not possible to accurately measure the full extent of the change in ICT employment, and, therefore, these articles use employment data from a core sub-sector of ICT: computer and telecommunications. Beckstead and Brown (2005) claim that Computer and Telecommunication sub-sector account for over 90% of the employment in the ICT sector.

Inklaar and McGuckin (2003) used 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. Due to a lack of ICT investment data, the study focuses on labour productivity rather than total factor productivity. This study breaks down 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 authors claim that the growth experience of Canada is somewhere in between that of Europe and the United States. They also assert that while labour productivity growth accelerated during the second half of the 1990 decade, it remained slower in Canada than in the United States.

The literature reviewed here covers the period immediately following the bust in the ICT sector. More recent data is now available which may shed light on whether the economic consequences described in their studies have been temporary or more persistent. Based on the historical data another interesting issue which I examine in this essay is the outlook of the ICT sector.

3. Defining the Information and Communication Technology sector

Statistics Canada defines the ICT sector as the "manufacture and service-based provision of advanced information technologies that rely on programming or other automated control mechanisms." For the purpose of this study, I use the same definition in this essay.

The manufacturing industry includes: computer and peripheral equipment, commercial and service industry machinery, communication and audio video equipment, and semiconductor and other electronic component manufacturing. The service industry includes: ISPs, web search portals, data processing services, communication services including wired and wireless communication, and computer system design and related services.

I have not examined industries like biotech, pharmaceutical, and oil and gas in this study. These industries have a knowledge-intensive production process, which is reflected in an advanced skill base and extensive R&D investments; however, they tend to play a much smaller role than overall ICT sector in the local economy. [2] Also, the demand and innovation cycle of these industries is independent of those directly related to the ICT sector as these industries did not directly share the recent boom and bust cycle of the ICT sector.

4. ICT sector's contribution to the Canadian Economy

To establish the importance of the ICT sector in the Canadian economy, it is useful to look at its contribution to the economy. I list some key indicators of the ICT sector:[3]

- During the 1997 – 2004 periods, the ICT sector's GDP grew at a compound annual growth rate (CAGR) of 8.4% compared to 3.6% for the Canadian economy.

2 According to the Statistic Canada report Catalogue No. 81-004 titled Information and Communication technology.
3 The numbers taken from Industry Canada report titled "Canadian ICT Statistical Overview (ICTSO) last updated October 2005.

Consequently, the share of ICT sector to the Canadian GDP increased from 4.0% to 5.5%. In dollar terms, the ICT sector's contribution to the Canadian GDP reached $57.5 billion in 2004. This is the first time since 2000 when the growth of the ICT sector outperformed the growth of overall economy.

- During the 1997 – 2004 periods, the employment in the ICT sector grew at CAGR of 3.7% as compared to the 2.2% growth rate in the Canadian economy.

- During the 1997 – 2004 periods, the revenues of the ICT sector grew at a CAGR of 4.9%.

- The ICT sector's export gained a momentum during the 1997 – 2000 periods; however, it slowed down during the 2001 – 2004 period and accounted for a total of 6.3% of the Canadian exports in 2004 compared to 10.0% in 2000.

- Employment in the ICT sector in 2004 kept growing at a slower rate of 0.8% as compared to 2003's growth rate of 5.3%, resulting in 570 thousand people.[4]

- In 2004, the ICT sector revenues were expected to reach $136 billion, which represented a recovery of 4.4% from 2003.

- The total private sector R&D expenditures were expected to be $13.8 billion in 2005, an increase of about 1.6% from 2004. The ICT sector remains the largest R&D player in Canada, with investments reaching about $ 5.2 billion.

- Imports of ICT sector also recovered in 2004 and increased about 9.3% from 2003, which translates to $47.4 billion (12.1% of all Canadian imports)

The statistics establish the importance of the ICT sector for the Canadian economy. I now examine how employment, GDP, International Trade, ICT Revenue and Expenditures of the sector were affected by the ups and downs of the sector.

[4] The numbers collected from Statistic Canada report No. 56-506 XIE.

5. ICT Sector And Employment[5]

ICT sector is considered to be a major source of jobs in the Canadian job market. Statistics Canada collects employment statistics for the ICT sector in to two categories: manufacturing and services. In this section I describe the employment in ICT sector as a whole, and then consider the employment trends in the manufacturing and services sub-sectors.

From boom to bust:

After a recession in 1990, the ICT sector was severally affected. It took this sector about 5 years to recover while other sectors recovered a year earlier[6]. In the few years after the recovery of the ICT sector, its growth outperformed the growth of the Canadian economy, but the sector saw a decline in 2002. Employment within the sector followed the same cycle of growth and decline. Between 1990 and 2000, ICT industry employment increased by 66.0% – four times that of the rest of the economy (16.4%). But this did not last long. Employment in this sector reached its peak in 2000 and then started to decline, while other industries continued to grow into 2002.

The growth in ICT industry employment slowed down in 2001 and 2002, though employment still increased in both industry groups. In 2002, however, there was a marked decrease in ICT industry employment. The substantial drops in employment in 2001 and 2002 in the manufacturing industries resulted in a structural shift of the ICT sector from manufacturing to services.

After the bust

The year 2003 proved to be the year of recovery for the ICT sector. By 2004, the ICT sector employed about 3.6% of all Canadian workers. The software and computer services industries

[5] All the data collected from Industry Canada: The Information and Communications Technologies Statistical Overview (ICTSO).
[6] Statistics Canada Report - Catalogue No. 56F0004MIE.

within the sector experienced the most gain, where the number of employees increased by 64% in 2004 as compared to 1997.

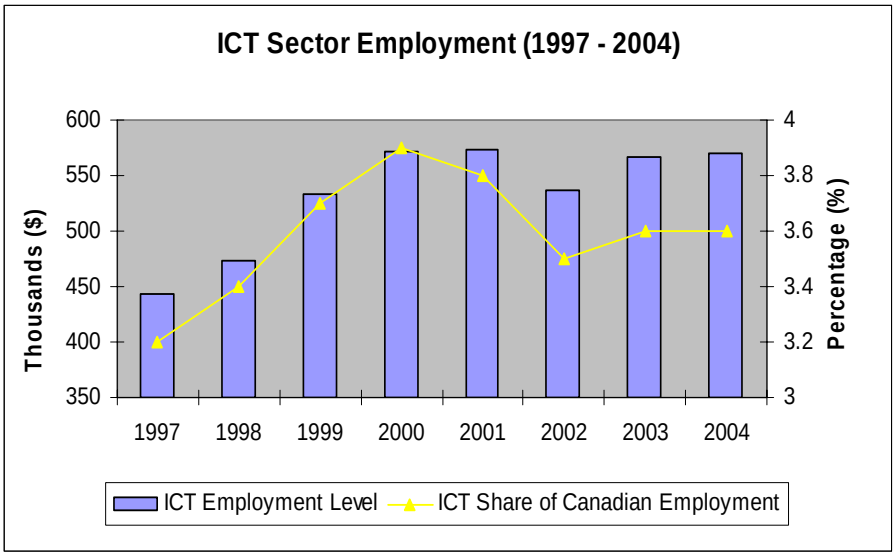

Figure 1: ICT Sector Employment (1997 – 2004) [7]

Figure 1 shows the trend in employment in the ICT sector from 1997-2004. It is evident that the boom was fast and so was the bust. But the sector appears to have recouped most of the employment it lost during the bust. However, as I discuss later when I look at employment distribution within the sector, not all sub-sectors faired equally in this comeback. The aggregate picture, therefore, masks the sectoral differences.

Figure 2 shows the ICT employment from 1997-2005. As a general trend, the employment has increased since the bust. However, the same figure shows that the situation changed in the third quarter of 2005 when the ICT sector experienced a drop in the employment rate by 1.8%, which brought the ICT employment to its lowest level since the second quarter of 2003. Also, the overall Canadian employment was up by 0.4% for this quarter. Figure 2 compares the growth in employment within the ICT sector to that of the Canadian economy. The drop in growth is clearly noticed during the third quarter of 2005, but another important observation is that the indexed growth in employment of ICT sector has continuously outperformed the indexed growth in the Canadian economy, even during the bust period.

[7] Data was collected from the Statistic Canada, only available up to 2004.

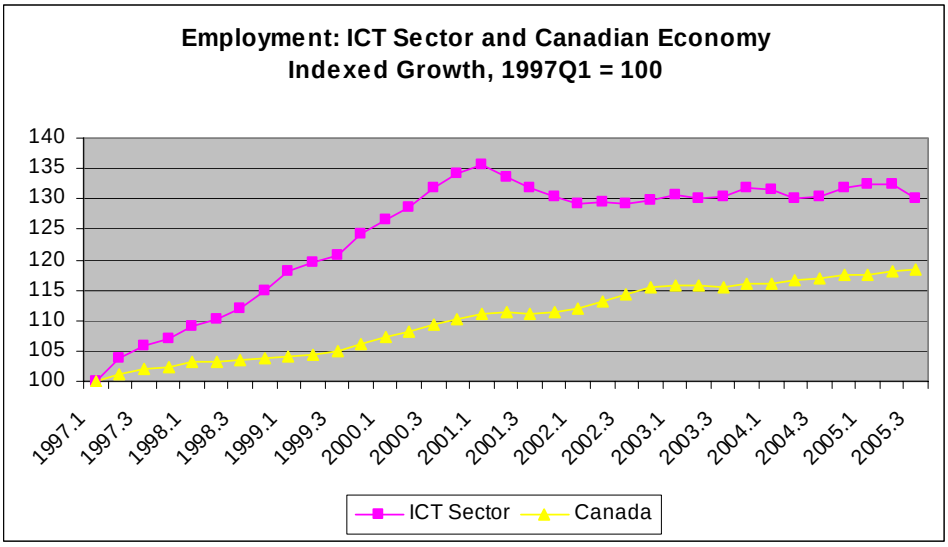

Figure 2: Employment: ICT Sector and Canadian Economy [8]

I have described the general trends in ICT employment from 1997 – 2005. I will now discuss how the boom and bust affected employment within the major sub-sectors of ICT: manufacturing and services.

5.1 ICT Manufacturing

5.1.1 Before and during the bust

During the boom of ICT, hype and speculation caused many equipment makers to significantly increase their output. Due to this, they had to hire as many people as possible. Most of the jobs were low paying and employees had low skills, but that did not matter at that time. Orders were flowing in, and equipment had to be produced. When the bubble burst, there suddenly did not remain a need for these jobs. Growth in the services sector during the boom may have been comparable, but the workforce had overall higher skills and were able to re-align themselves to newer areas of growth. Cuts in ICT manufacturing were more drastic than services. Also, ICT manufacturing industries have been experiencing a continual decline in jobs since 2002. It is, however, now declining at a much slower rate as compared to 2002, when it experienced a

[8] Data was collected from Statistic Canada.

sudden fall. Bowlby and Langlois (2002) have also claimed that low-skilled workers were affected more than high skilled ones during the bust.

5.1.2 After the bust

Employment in ICT manufacturing has been continuously declining since 2002. Employment levels in Canadian manufacturing industry dropped by 0.6%, and the ICT manufacturing employment also took a dip by 1.2% in the third quarter of 2005 compared to 2004. Currently (2005, Q3) it is 4.5% below from the second quarter of 2002 whereas the overall Canadian manufacturing employment has fallen about 4.8% for the same period.

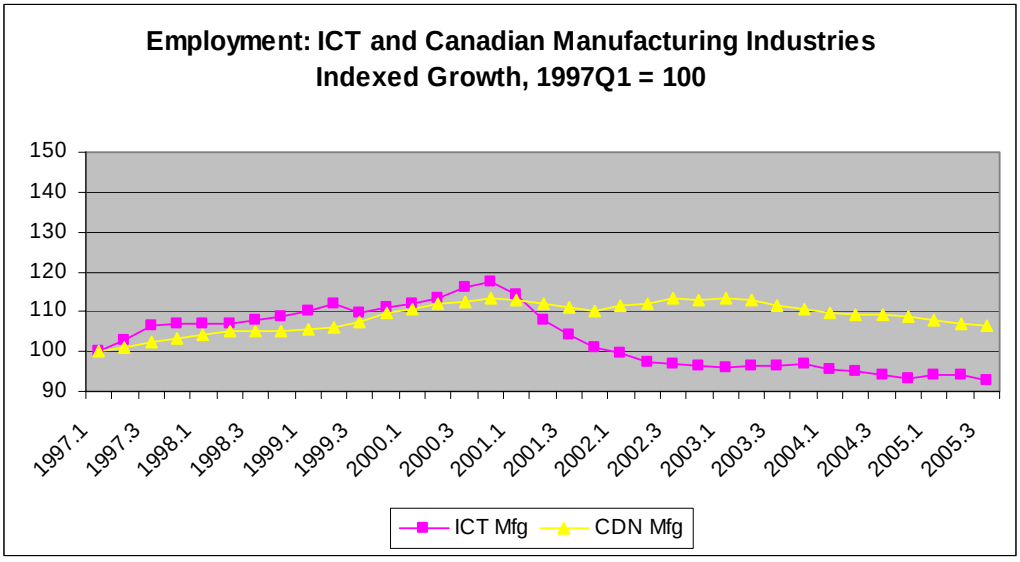

Figure 3: Employment: ICT and Canadian Manufacturing Industry [9]

Figure 3 compares employment in ICT manufacturing with employment in Canadian manufacturing. Whereas overall indexed growth in the ICT sector has outperformed indexed growth in the Canadian economy, decline in employment in ICT manufacturing is significantly higher than that of Canadian manufacturing since the bust.

[9]Data was collected from Statistic Canada Annual Survey of Manufactures (ASM) (no 2103), Catalogue no. 31-203, CANSIM Table 301-0003,

Within the manufacturing sub-sector, the computer and peripheral equipment industries, commercial and service machinery industries and instruments industries experienced the most employment losses. The third quarter of 2005 is the fifth consecutive quarter in which the computer and peripheral equipment industries witnessed loss in employment, and employment level is 45% below to the 1997 level. Employment in communication equipment industries and electronic component industries were stable in this quarter.

Figure 4 shows employment trends in various sub-sectors of ICT manufacturing from 1997 Q1–2005 Q3.

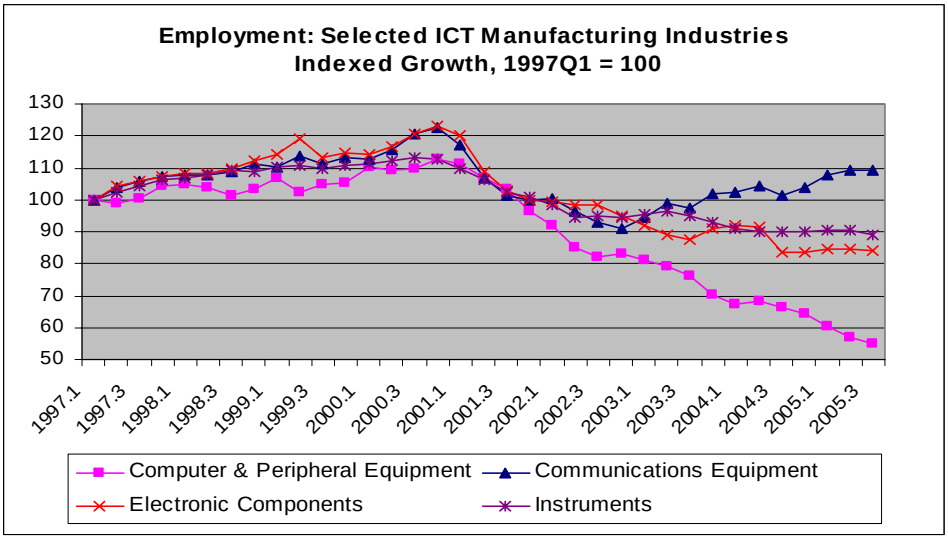

Figure 4: Employment: Selected ICT Manufacturing Industries [10]

5.2 ICT Services

5.2.1 Before and during the boom

Like ICT manufacturing, growth in ICT services during the boom was spectacular. New graduates were being hired before they graduated. The atmosphere of hype and speculation had tainted judgement of those in authority. All they could see was that if they could not grow fast enough, someone else would happily take the pie. When the industry crashed, cuts to the services

[10] Source: Industry Canada Quarterly Monitor of the Canadian ICT Sector, Third Quarter 2005 Annual Survey of Manufactures (ASM) (no 2103),Catalogue no. 31-203, CANSIM Table 301-0003.

sector were harsh. However, due to the nature of the jobs in this sector, many employees that were let go were highly skilled, and were able to realign their careers. Nevertheless, many had to change their fields and re-train themselves to make a living. I consider the educational distribution of the ICT sector workforce in the next section.

5.2.2 After the bust

After the bust, employment in ICT services started growing back as early as the second quarter of 2002. This growth, however, was much slower than what was experienced during the boom. According to the latest data (2005 Q3), employment in the sub-sector is about 1.7% higher than 2002. The sector, however, experienced a significant job loss of 1.9% in 2005 Q3. Figure 5 compares employment in ICT services with employment in the Canadian services industry. Whereas overall growth in the ICT services sector since the bust has been very small, it is worth noting that the employment in ICT services has been significantly higher than that of Canadian services industry even during the bust.

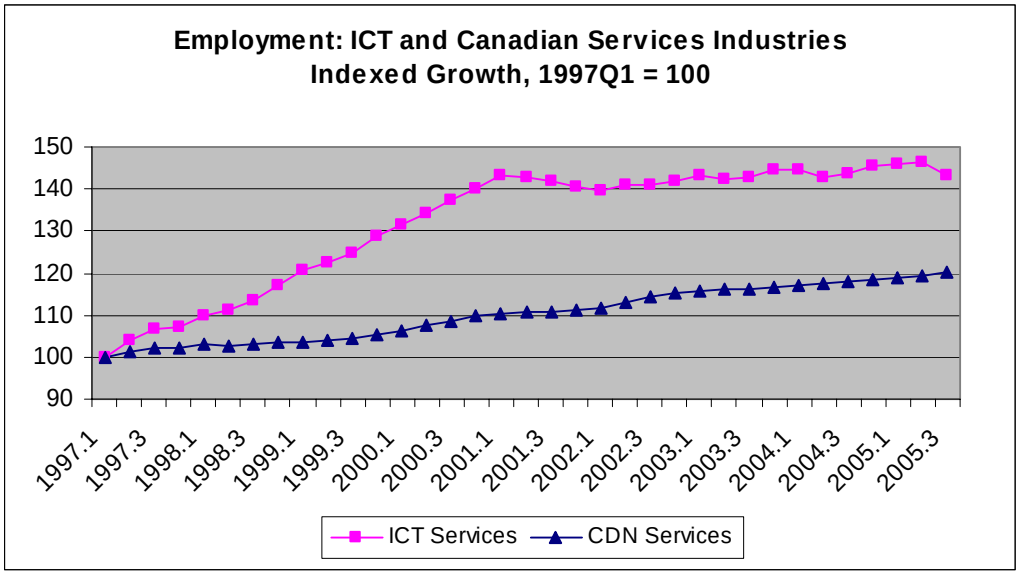

Figure 5: Employment: ICT and Canadian Service Industries [11]

Within the ICT services sub-sector, the telecommunication services saw the most job loss, falling by 4.1% in this quarter after four consecutive quarters of growth. Data processing services

[11] Source: Industry Canada Quarterly Monitor of the Canadian ICT Sector, Third Quarter 2005.

industry also fell down by 2.8% but the computer system design industry remained stable. On the other hand, the software services industry showed an improvement of 3.3% in this quarter, following an upward trend since the last quarter of 2003 and showed a rise of 17 % since then.

Figure 6 shows employment trends in various sub-sectors of ICT services from 1997 – 2005Q3.

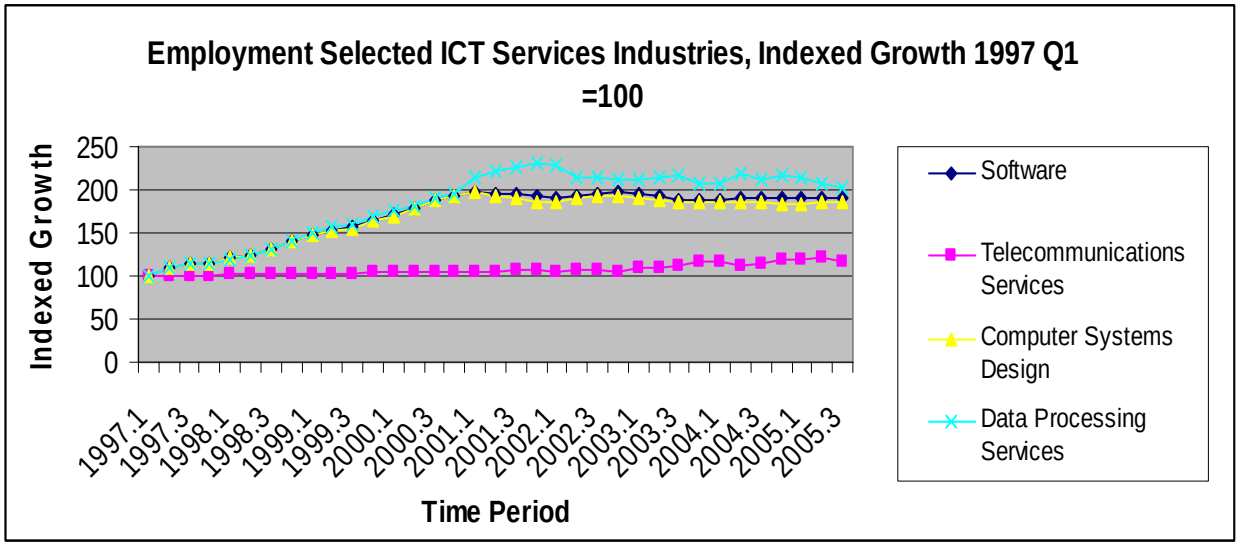

Figure 6: Employment: Selected ICT Services Industries [12]

5.3 Educational Distribution of the ICT Sector workforce

The ICT sector has a knowledge-intensive workforce as compared to the other sectors. According to a survey in 2004, 38% of all workers have a college degree, which is significantly higher than the national average of 21% (of all other sectors).

Within the ICT sector, the communication equipment manufacturing industries have the most educated workforce of 51%, followed by the computer and software services industries which come close to 46%. The telecommunication services industry has the lowest level of educated

[12] Source: Annual Survey of Software Development and Computer Services (no 2410), Catalogue no. 63-222, CANSIM Table 354-0005.

workforce (26%), which is still higher than the national average of 21%. Figure 7 breaks down the percentage of workers with a university degree by industries in the ICT sector.

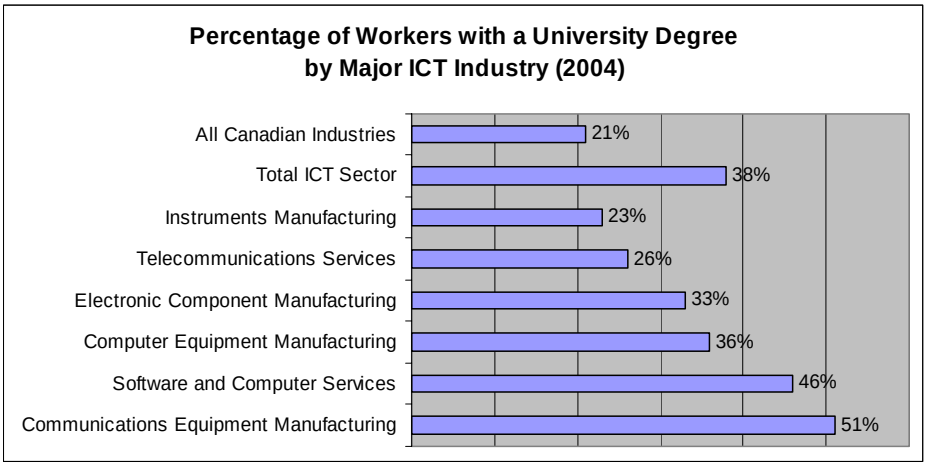

Figure 7: Percentage of Workers with a University Degree [13]

The ICT sector is not just limited in creating high number of jobs and having the most skilled workforce; the earnings in this sector also out perform the average wages in the overall Canadian job market. The earnings in this sector are about 45% more than the economy-wide average, which is $36,695 as compared $53,335 in the ICT sector.

The most highly paid industries among the ICT sector are the computer and software services industries in which the earnings were about $58,069 on average, followed by the communications and instruments equipment manufacturing industries that earned 46% more than the economy-wide average.

[13]Data was collected form the Statistic Canada.

6. Change in Production for ICT Sector

Like employment, output of the ICT sector contributes significantly to the Canadian economy. It is, therefore, interesting to see how the output of the sector changed from 1997 to 2002 and beyond. As in the previous section, I first described the trends in the output of the ICT sector as a whole, and then consider the output trends in the manufacturing and services sub-sectors. For the sake of understanding the effects of bust on the output of the sector, I divide our study of the output as a whole into two periods: from boom to bust; and after the bust.

From Boom to Bust (1997 – 2002) [14]

According to the report "Canada's Journey to an Information Society" by Statistic Canada, the ICT sector continued to make its contribution to the Canadian economy in 2002 despite of slight decline in 2001. In 2002 the ICT sector contributed $58.7 billion to Canada's GDP, which represents 7.1% of business sector GDP and 6.0% of total economy GDP (in 1997 chained dollars). This amount was about 2.5% more than 2001 GDP of $57.2 billion (1997 chained dollars).

The ICT sector's average annual compounded growth was 12.4% for the 1997 – 2002 segments. For the same period, the economy-wide growth was 3.7% and business sector growth was 4.1%. The total growth for the ICT sector for 1997 – 2002 periods was 79.3%, about four times the growth of total economy, which was 9.7% and considerably higher than business sector growth which was 22.0% for the 1997 – 2002 period. The ICT manufacturing output dropped nearly 30% between 2000 and 2001; however, the situation improved a bit in 2002 when the drop was about 17%. The ICT services sector output grew 8.1% between 2001 and 2000.

ICT manufacturing, at its peak in 2000 contributed about 31.2% to the total ICT sector GDP and started declining after that, reaching 18.1% in 2002. This downfall was mainly caused by the slow demand in communication and telephonic devices industry causing many businesses to shutdown their operations. On the other hand, the ICT services industry's share to GDP

[14] Data from Statistic Canada Catalogue no. 56-508-XIE titled Canada's Journey to the Information Society.

decreased continually from 1997 to 2000; however, it picked up some pace when the ICT manufacturing slowed down. This illustrates that the GDP shares of ICT manufacturing and services sector were inconsistent between 1997 and 2002. Within the ICT services sector, the telecommunication services industry made the largest contribution to ICT GDP reaching at 81.9% of all ICT services in 2002.

Table 1 presents a breakdown of ICT sector output and percentage contribution of each sub-sector to the overall output of the ICT sector from 1997-2002.

ICT Sector GDP (1997 – 2002) [15]

Year	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*02/97*	*CAGR (02/97)*
	Billions of 1997 chained dollars						*%*	
Manufacturing	*8.2*	*9.7*	*13.2*	*18.1*	*12.8*	*10.6*	*28.9*	*5.2*
% of ICT	*25.2*	*25.8*	*27.7*	*31.2*	*22.3*	*18.1*	*----*	*----*
Services	*24.5*	*28.0*	*34.3*	*39.9*	*44.5*	*48.1*	*96.3*	*14.4*
% of ICT	*74.8*	*74.3*	*72.3*	*68.9*	*77.7*	*81.9*	*----*	*----*
Total ICT Sector	*32.7*	*37.7*	*47.5*	*57.9*	*57.2*	*58.7*	*79.3*	*12.4*
Business sector	*679.6*	*710.2*	*752.2*	*791.3*	*801.9*	*828.8*	*22.0*	*4.1*
ICT as a %	*4.8*	*5.3*	*6.3*	*7.3*	*7.1*	*7.1*	*----*	*----*
Total economy	*816.8*	*848.4*	*892.9*	*933.7*	*947.0*	*977.3*	*19.7*	*3.7*
ICT as a %	*4.0*	*4.4*	*5.3*	*6.2*	*6.0*	*6.0*	*----*	*----*

Table 1: ICT sector GDP from Boom to Bust

After the Bust (including 2003-2005):

While in the bust era, ICT sector's downturn was clear, more recently, the sector has shown some steady growth. According to Industry Canada's quarterly report, Canada's ICT sector output (GDP) expanded by 1.1% in the third quarter of 2005, keeping pace with growth in the Canadian economy as a whole. According to the same report "economic activity in the ICT sector has grown almost continuously since the last quarter of 2001, and the ICT sector's output

[15] Statistic Canada Catalogue no. 56-508-XIE titled Canada's Journey to the Information Society.

was 18% higher in the third quarter of 2005 than it was at the end of 2001. As a whole, over this period according to Industry Canada it adds up to the growth of 12.7% for the Canadian economy." Overall, the performance of the ICT sector has been impressive as it has grown by 96% since the first quarter of 1997, almost three times as much as the Canadian economy (+37%).

Figure 8 shows the trend in output of the ICT sector from 1997 Q1 to 2005 Q3. The affect of the boom and the bust can be clearly seen on the graph. It may also be noted from the Figure 8 that the sector's output in 2005 Q3 is higher than what it used to be just before the bust. However, it is also worth noting that rate of growth since the bust has been much slower.

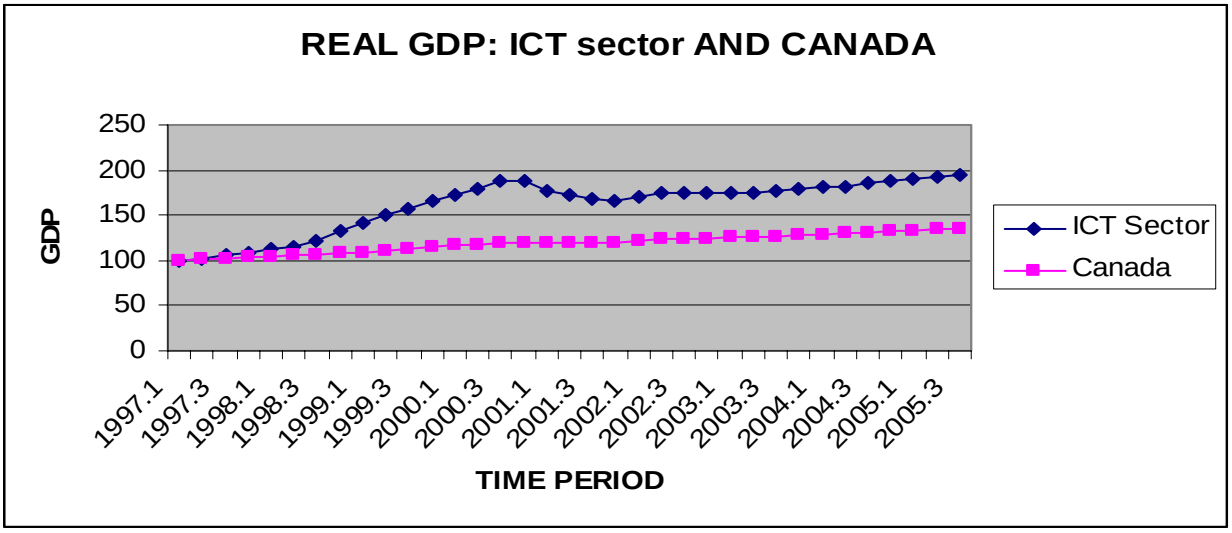

Figure 8: Real GDP: ICT sector and Canada [16]

Figure 9 compares the output of ICT manufacturing and services to the output of the overall services and manufacturing industries. As for employment, the decline in the ICT manufacturing output is much more dramatic than the decline in ICT services output. An interesting point to note here is that although the ICT manufacturing output fell significantly, it was only slightly below the overall manufacturing output, and since then, has surpassed it. Another interesting

[16] Source: Catalogue no. 15-001, CANSIM Tables 379-0017 and 379-0020, Industry Measures and Analysis Division, Statistics Canada.

observation is that the output of ICT services never showed a significant decline even during the bust period.

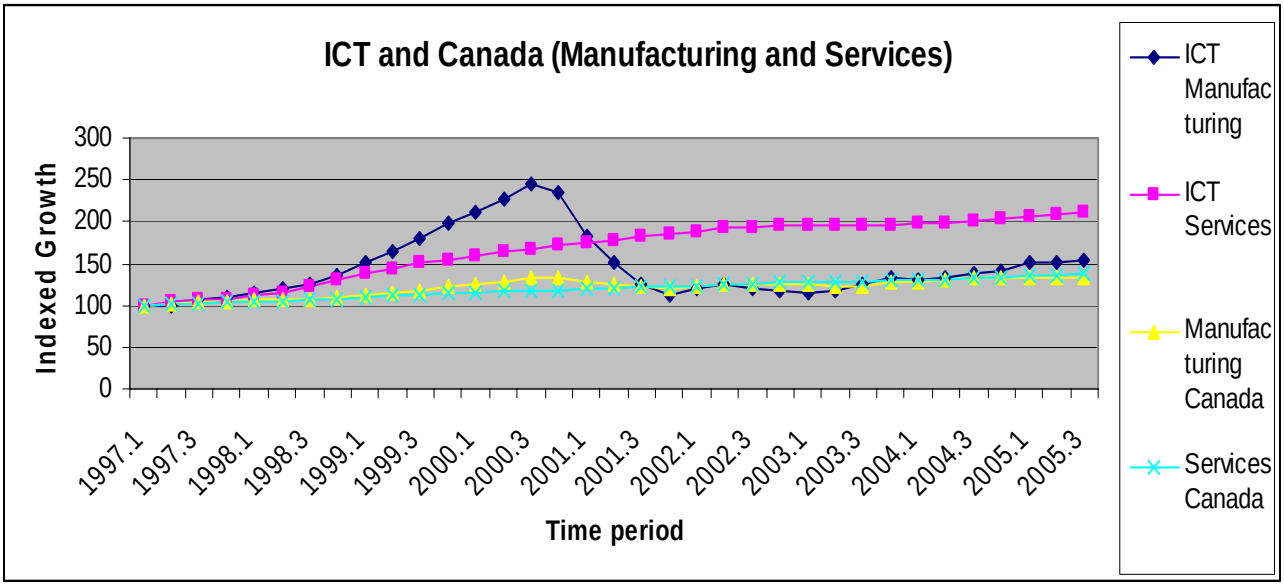

Figure 9: ICT and Canada Real GDP (Manufacturing and Services) [17]

6.1 Real GDP: ICT sector compared with Canada

I have seen the general trends in ICT output from 1997 – 2005. I shall now examine in depth how the boom and bust affected major sub-sectors of ICT: manufacturing and services.

6.1.1 ICT Manufacturing Real GDP:

6.1.1.1 Before and during the bust

As expected, the growth in the output of ICT manufacturing followed a trend similar to that shown by employment in the sector. The growth rate was extremely high during the boom, thus bringing a major decline during the bust. A sudden growth in demand for ICT related equipment left suppliers with no other choice than to grow their operations out of control. The crash,

[17] Source: Data from Industry Canada Quarterly Monitor of the Canadian ICT Sector, Third Quarter 2005.

therefore, left the suppliers with a lot of unwanted inventory. The trends in ICT manufacturing sub-sector employment and output paint a very similar picture: both show a period of extremely high growth just before the bust, followed by a significant decline.

6.1.1.2 After the bust

According to Industry Canada, ICT manufacturing industries grew by a modest 0.3% in the third quarter of 2005, while Canadian manufacturing as a whole grew by 0.7%. After a decline in the first quarter of 2004, ICT manufacturing output has expanded for six consecutive quarters. Since the end of 2001, the ICT manufacturing industries have grown by 36%, driven by sharp increases of 98% and 60% in the production of electronic components and communications equipment, respectively. Since the beginning of 1997, output in the ICT manufacturing sub-sector has grown by 53%, compared to 34% growth in the entire Canadian manufacturing sector. A comparison in the trends of ICT manufacturing sub-sector employment and output shows a remarkable discrepancy. Comparing figure 5 and figure 10, I note that while the ICT manufacturing employment has continued to decline since the 2001 Q1, ICT manufacturing output has shown growth since 2001 Q4.

Figure 10 shows a breakdown of output of ICT manufacturing by its sub-sectors. The computer and peripheral sub-sector of ICT manufacturing has had a rollercoaster ride, whereas the instruments sub-sector has shown remarkable stability in its output, even during the bust. Some of this can be attributed to the steep rise in demand for computer equipment with the boom of dot-coms and 1 person companies with no real business models. I discuss this point in more detail to understand the reasons for the bust.

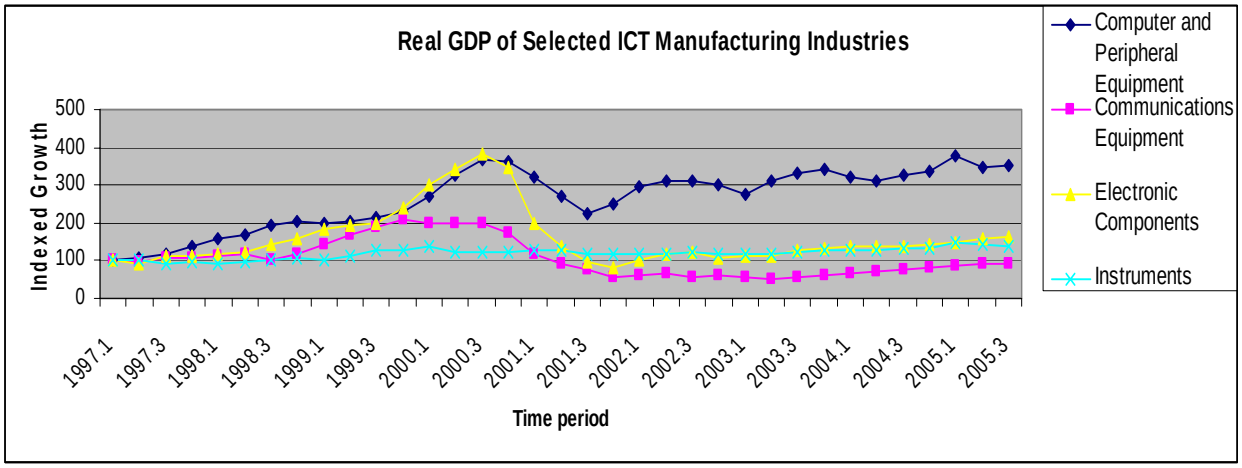

Figure 10: Real GDP of Selected ICT Manufacturing Industries [18]

6.1.2 ICT Services Real GDP

6.1.2.1 Before and during the bust

ICT services seem to be growing continuously since 1997. While it is surprising that ICT services was not affected by the bust, a sneak peek into the breakdown of sub-sectors of ICT services paint an even interesting picture. A quick comparison of the Figure 10 and Figure 11 above shows that most sub-sectors of ICT manufacturing were having a free fall from the beginning of 2001 to the first quarter of 2002. At the same time, ICT services were growing (Figure 9). Only at the beginning of 2002 did ICT services show some signs of weakness. This is an interesting observation because it shows that during 2001, there was a structural shift from ICT manufacturing to ICT services. To further elaborate this point, I discuss what happened after the bust.

[18] Source: Data from Industry Canada Quarterly Monitor of the Canadian ICT Sector, Third Quarter 2005.

6.1.2.2 After the bust

According to the reports from Statistic Canada, ICT service industries have experienced almost uninterrupted growth since the first quarter of 1997, and output in the third quarter of 2005 was more than double the first quarter 1997 level (110% growth), far outperforming overall Canadian services, which were up 37% over their 1997 level. I compare this to ICT manufacturing. Since the bust, the only sub-sector of ICT manufacturing that has shown any sign of growth, and decline, is the computer and peripheral sub-sector. Other than that, most sub-sectors have shown very limited signs of recovery. When I compare this with data for ICT services, it is clear that there was indeed a structural shift from ICT manufacturing to ICT services during the bust as the effect seems to be persistent.

Figure 11 shows a breakdown of output of ICT services by its sub-sectors. The software sub-sector of ICT services looks like the only sector really affected by the bust. Most other sectors continued their growth as if the bust never happened. This can also be attributed to the fact that although ICT services did loose some steam during and after the bust, it was compensated by the shift from ICT manufacturing.

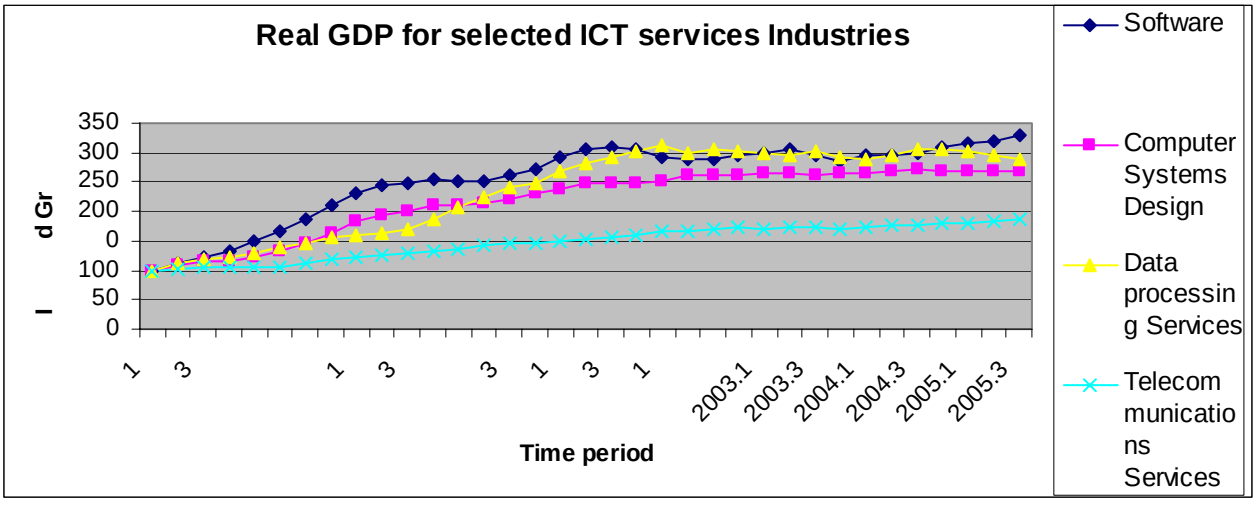

Figure 11: Real GDP for Selected ICT Services Industries[19]

[19] Source: Data from Industry Canada Quarterly Monitor of the Canadian ICT Sector, Third Quarter 2005.

7. ICT Revenue

Data for this section is only available from 1997 to 2004.

7.1 ICT revenue from boom to bust:[20]

After strong and steady growth throughout much of the 1990s, ICT sector revenues fell by 6.1% in 2001. The sector contributed about 5.7% of total industry revenue, down from its share of 6.3% in the previous year. Between 1998 and 2001, annual average revenue growth for the ICT sector was 6.8%, while total revenue growth over the reference period stood at 21.7%. Within the ICT services sector, ICT wholesaling generated the highest revenues ($36.9 billion), while telecommunications services followed closely with $32.8 billion. ICT sector services revenue increased steadily since 1998 – its share of total industry revenue reached 75.1% in 2001. Revenue for ICT manufacturing peaked in 2000 at $44.7 billion. This represented 30.7% of total ICT sector revenue, which has since dropped to 24.9% or $34 billion. Communications equipment manufacturing was responsible for most of the decline.

A look at revenues after the bust (2004)

In 2004, ICT manufacturing revenues recovered for the first time after 2000, reaching $26.4 billion. Wireless communication equipment was the largest contributor, making up 33% of the shipments, followed by electronic components accounting for 6.6% of the ICT manufacturing revenues. However, computer equipment shipments declined by 18.7%.

On the other hand, ICT services sector revenues increased by 3.8% in 2004 reaching $70 billion. Cable and other program distribution showed the most growth, which increased by 8.5%, followed by sales in ISP, data processing and software industries, which grew by 6.1%, 5.6% and 3.3% respectively.

The distribution of ICT sector revenues changed due to growth in the services sector and decline in the manufacturing sector since 2000. Share of services sector increased from 42% to 52%, and

[20] Statistics Canada - Catalogue No. 56-508-XIE.

share of manufacturing sector decreased from 31% to 19% from 2000 to 2004. However, share of ICT wholesaling, rental and leasing sector remained the same (29%).

Revenues of overall ICT sector grew at a CAGR of 4.9% from 1997 to 2004. The services sector grew at a CAGR of 9.0%, within which computer systems design and telecommunication services showed the most increase, accounting for 56% of this growth.

Figure 12 shows a breakdown of ICT revenues by industry.

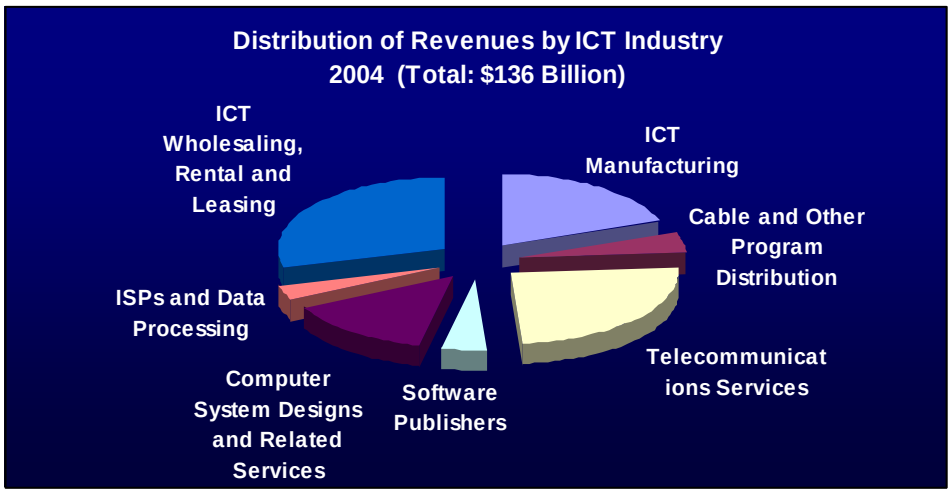

Figure 12: Distribution of Revenues by ICT Industry [21]

Table 2 shows a breakdown of ICT revenues by industry from 1997 – 2004. As noted in the ICT sectors output above, ICT services showed continuous growth through the bust. However, I take this observation with a pinch of salt. Considering that ICT services sub-sector revenues grew about 11.9% from 1998-1999, and about 10.5% from 1999-2000, growth did slow down in 2001 when the sub-sector revenues grew only about 6.5%. So it is not entirely true that the bust did not affect ICT services.

[21] Source: Statistic Canada.

ICT Sector Revenues (1997 – 2004)

ICT Sector ($'000,000)	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
Manufacturing	*26,786*	*29,326*	*33,707*	*44,830*	*34,147*	*26,552*	*25,523*	*26,360*
Services	*38,356*	*48,846*	*54,652*	*60,368*	*64,276*	*65,953*	*67,401*	*69,991*
ICT Wholesaling, Rental & Leasing	*32,131*	*34,059*	*38,716*	*40,165*	*38,614*	*38,249*	*37,276*	*39,600*
Total ICT Sector	*97,273*	*112,232*	*127,075*	*145,363*	*137,037*	*130,754*	*130,200*	*135,951*

Table 2 : ICT Sector Revenues[22]

Table 3 shows percentage change in ICT revenues and compound annual growth rate by industry. Although all industries with the ICT sector slowed down during the bust, growth has been positive for all of them between 2003 and 2004.

Growth in ICT Sector Revenues (1997 – 2004)

Industry	% Change 2003-2004	% Change 1997-2004	CAGR 1997-2004
ICT Manufacturing	3.3%	-1.6%	-0,2%
ICT Services	3.8%	82.5%	9.0%
ICT Wholesaling, Rental and Leasing	6.2%	23.2%	3.0%
Total ICT Sector	4.4%	39.8%	4.9%

Table 3: Growth in ICT Sector Revenue[23]

Figure 13 shows a breakdown of ICT sector revenues by main sub-sectors from 1997-2004, and compares that to overall ICT revenues. As for output, ICT services seems to be unaffected by the bust.

[22] Source: Statistic Canada.
[23] Source: Statistic Canada.

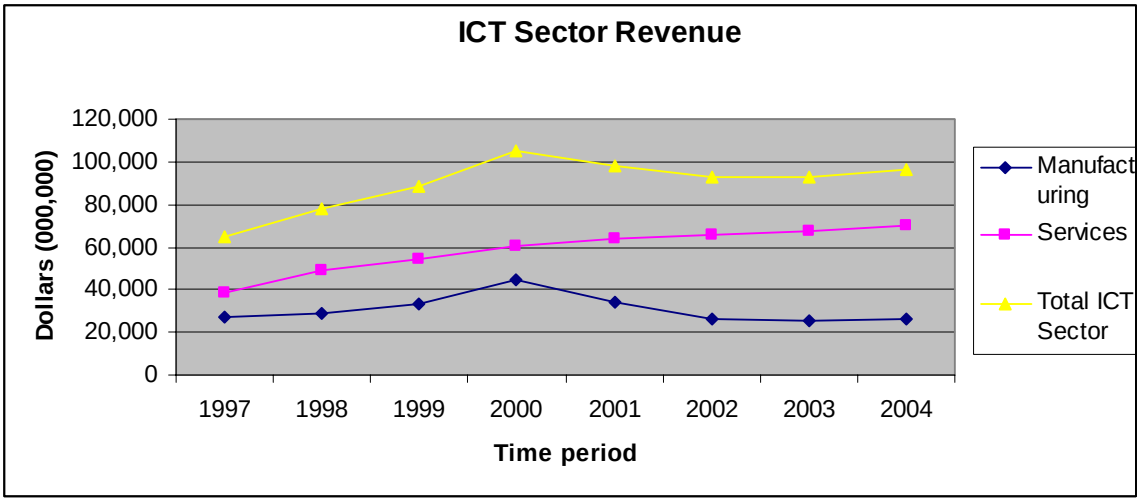

Figure 13: ICT Sector Revenue [24]

7.2 ICT Sector Revenues by Region (2003)

It is important to look at different regions of Canada and see which region has contributed heavily in the revenues of ICT sector. Unfortunately for this analysis, data is only available until 2003.

After reaching its peak in 2000, the revenues for ICT sector experienced a downfall. But the sector somewhat stabilized in 2003 with growth in the ICT services sector. Ontario and Quebec generated most of the revenue, contributing 48% and 24% respectively, followed by British Columbia and Alberta contributing 10.4% and 9.5% respectively, while Atlantic Canada and the Prairies (excluding Alberta) shared 4.3% and 3.7% of the total revenues.

Between 1997 – 2003, Atlantic Canada showed the fastest growth in the ICT sector revenues, reaching 8.1% per annum, followed by British Columbia and Ontario having 6.6% and 6.1% growth in revenues per annum.

Figure 14 shows a breakdown ICT revenue growth by regions from 1997 to 2003.

[24] Source: Statistic Canada Catalogue no. 31-203, CANSIM Table 301-0003.

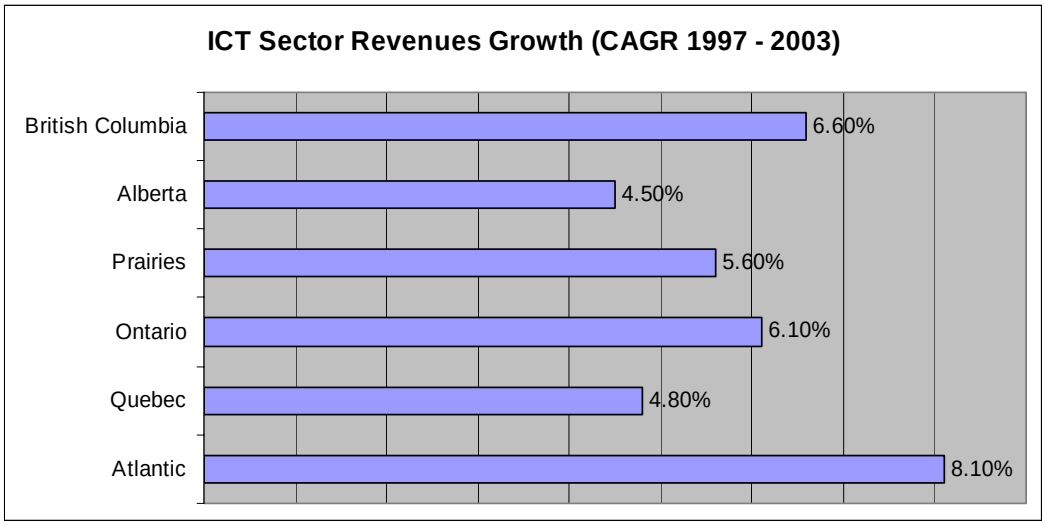

Figure 14: ICT Sector Revenues Growth [25]

My analysis of ICT sector revenues would not be complete without looking at the revenues generated by ICT's main sub-sectors: manufacturing and services.

7.3 ICT Manufacturing Revenues (2003)

ICT manufacturing revenues (for computer and electronic product manufacturing) were $39.6 billion in 2000 but reduced to $22.9 billion in 2003. This was mainly due to the dot-com crash with which the whole ICT manufacturing came down. However, the decrease in revenues was much small in 2003 (3.6%) as compared to 2002 (18%) and nearly 30% in 2001.

Among the provinces, Ontario and Quebec contributed over 80% of the ICT manufacturing revenues with Alberta and British Columbia at 8.0% and 6.0% respectively, followed by Atlantic Canada and the Prairies (excluding Alberta) with 1.1% and 1.2% of the total generated revenue.

Figure 15 shows a breakdown ICT manufacturing revenues by regions in 2003. With the recent rise in oil prices and a resulting boom in oil rich Alberta, there is a big chance that this distribution has changed in 2003. Unfortunately, I do not have statistics to substantiate this claim.

[25] Source: Statistic Canada.

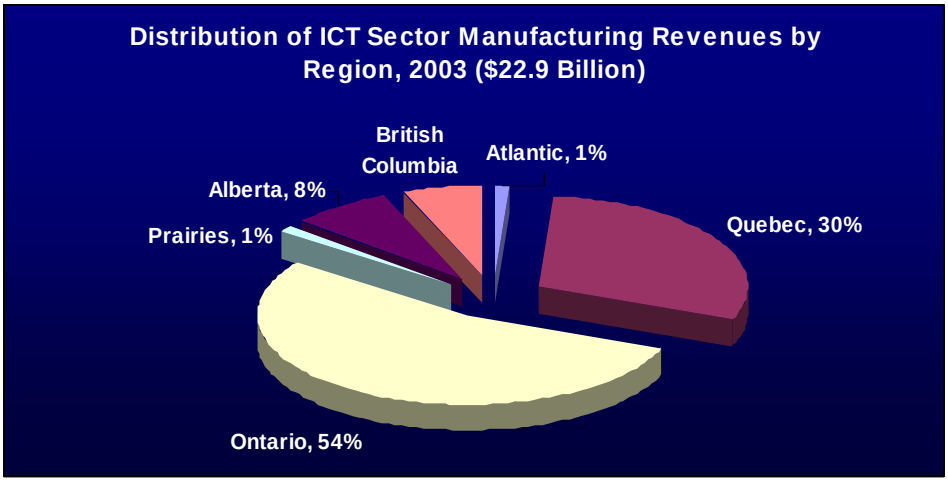

Figure 15 : Distribution of ICT Sector Manufacturing Revenues by Region [26]

Figure 16 shows a breakdown of CAGR of ICT manufacturing by regions.

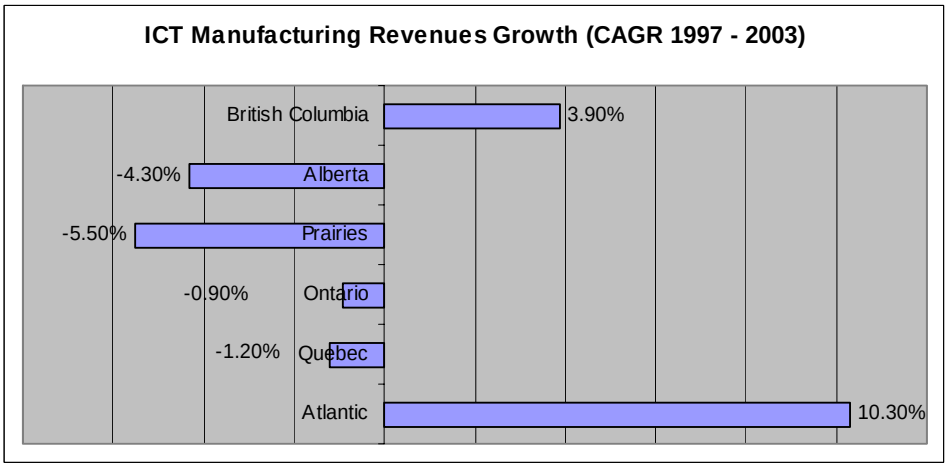

Figure 16: ICT Manufacturing Revenues Growth [27]

In 2003, British Columbia experienced the most growth in revenues, showing an increase of 13.2%, followed by Atlantic Canada and the Prairies with 11.8% and 7.7% growth in the revenues but still making a very small proportion of the national revenues. On the other hand,

[26] Source: Statistic Canada.

[27] Source: Statistic Canada.

Alberta, Ontario and Quebec experienced a decline of 9.6%, 4.3% and 4.5% respectively in their ICT manufacturing revenues. Once again, more recent data may be significantly different.

7.4 ICT Services Revenues (2004)

ICT services revenues have showed a totally different picture then the ICT manufacturing revenues. Looking at Figure 13, I observe that the ICT services revenues have been steady through out the boom and bust of ICT, and beyond. This is a different result compared to the ICT manufacturing sub-sector. “Software and Computer” and “Communication” industries are the highest contributor of revenues in the ICT services sub-sector. As such, I now examine the affect of boom and bust on these specific industries to determine the affect of boom and bust on the ICT services revenues.

7.4.1 Software and Computer Services Revenues (2003)

The software and computer services industries experienced a continuous rise in revenues since 1997. In 2003, its revenues increased by 4.3%, reaching $27.3 billion..

About 53% of the total revenues for this sub-sector came from Ontario. Quebec came second with 21% share of the total revenues, followed by Alberta with 9.4% and British Columbia with 10.2% share of the national revenues. Figure 17 shows a breakdown of Software and Computer Services revenues by regions.

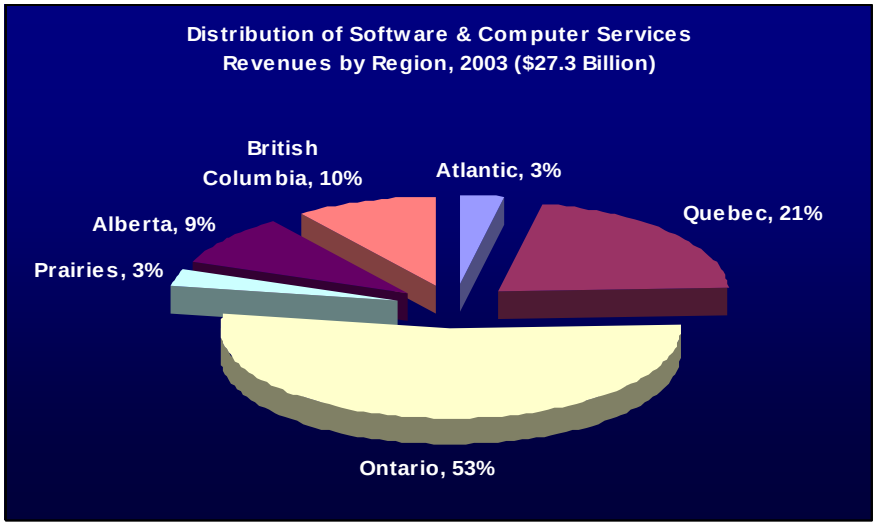

Figure 17: Distribution of Software and Computer Services Revenue [28]

The Figure 18 shows a breakdown of Software and Computer Services CAGR by region from 1997 – 2003.

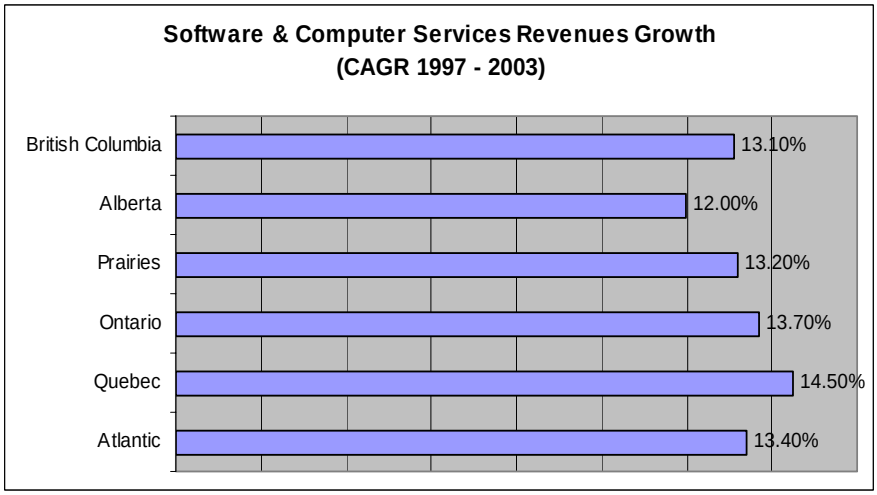

Figure 18: Software & Computer Services Revenues Growth [29]

Between 1997 and 2003, Quebec experienced the most growth in the software and computer services sub-sector with CAGR of 14.5%, followed by Ontario, Atlantic Canada and The Prairies with a CAGR of 13.7%, 13.4% and 13.2% respectively.

[28] Source: Statistic Canada.

[29] Source: Statistic Canada.

7.4.2 Communication Services Revenues (2003)

Telecommunication and cable television services are classified as communication services; however, this does not include wireless distribution services like satellite television etc. Figure 19 shows a breakdown of Communication Services revenues by region.

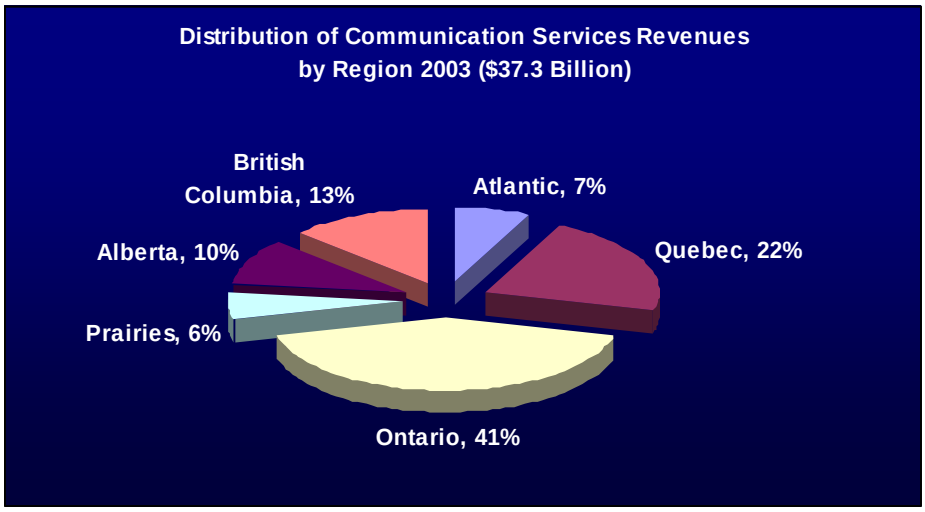

Figure 19: Distribution of Communication Services Revenues [30]

Figure 20 shows a breakdown of Communication Services Revenues CAGR by provinces from 1997 – 2003.

[30] Source: Statistic Canada.

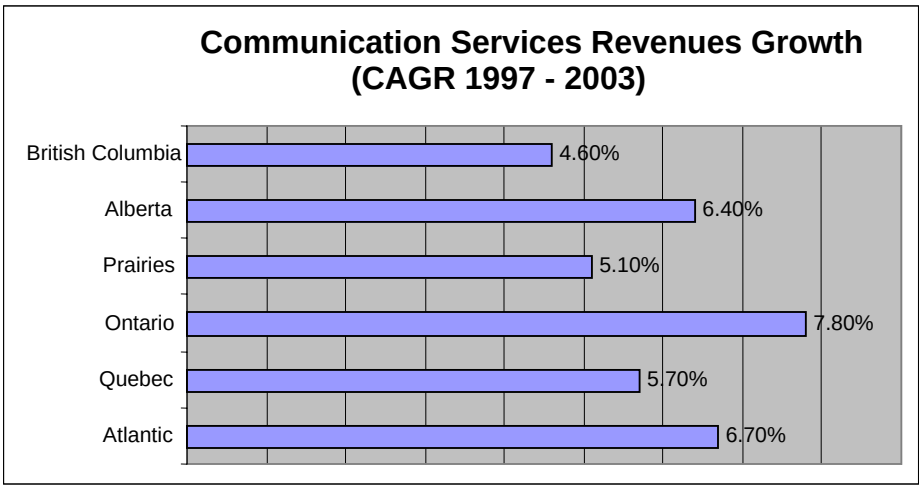

Figure 20: Communication Services Revenues Growth [31]

Distribution of these services closely matches the demographic dispersion of local population as these services are mainly for individual and household customers. Between 1997 and 2003, revenues for these industries grew by 6.5%. However, the growth was slow in recent few years mainly due to contractions in the Ontario and Quebec region.

Communication services revenues were $37.3 billion in 2003, out of which Ontario's share was 41% and Quebec contributed another 22%. British Columbia, Alberta, Atlantic Canada and The Prairies contributed 13.3%, 10.4%, 7.4% and 5.6%, respectively.

8. Overview of ICT Expenditures

Expenditure within a sector is not only a good indication of its present health, but also its future. Expenditures in ICT can be divided in to two sections: R&D expenditure and Capital expenditure.

[31] Source: Statistic Canada.

8.1 Contribution of Research and Development to ICT

Telecommunications sub-sector of ICT has been the top R&D performing industry for many years in Canada. It would be interesting to look at how R&D expenditure changed during and after the bust.

From Boom to Bust[32]:

Over the period of 1994 up to 2000 the ICT sector has spent about $26.9 billion on research and development. ICT sector's R&D expenditures grew at an annual average rate of about 8.6% between these years which is about 2% more then that of annual average of private sector's R&D expenditure.

Taking a look at how R&D expenditure was distributed between the manufacturing and services industries, notice that it grew at an annual average rate of 11% and at an overall rate of 86.6% between 1994 and 2000 in the manufacturing domain; where as, for the service industries, it increased little over this period at an annual average rate of 2.3% contributing to a slower growth. In 2001, there was some amount of increase in R&D expenditure as well. But the picture changed after that. I discuss this further in the next section.

A look at the distribution of R&D expenditure by provinces and regions reveal that before and during the bust, Ontario was the highest contributor to R&D spending in all of Canada. Ontario's share to R&D in 2002 was 69% of the total Canadian R&D expenditures. With other provinces not even making half of it. Figure 21 shows the distribution of R&D expenditure by provinces and regions as of 2002.

[32] Statistic Canada Catalogue No. 56-506-XIE titled Information and Communication in Canada, a statistical profile of the ICT sector.

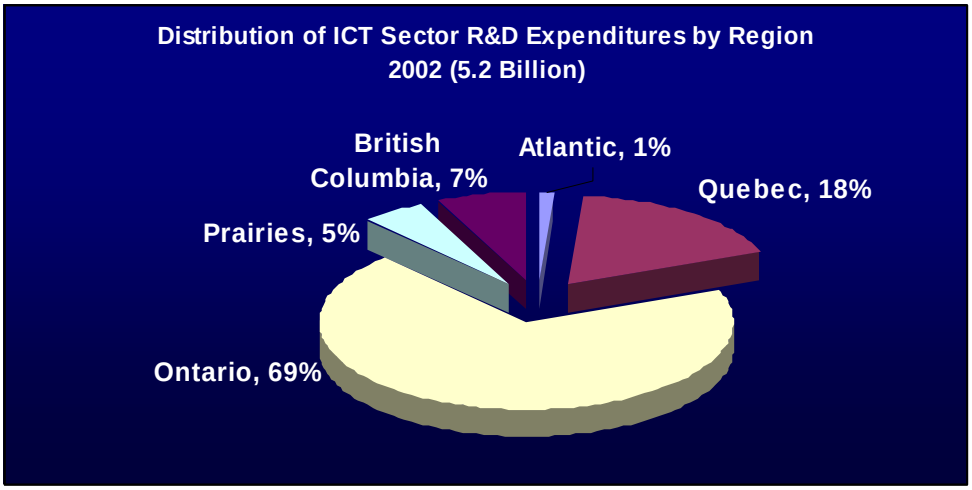

Figure 21: Distribution of ICT Sector R&D Expenditures by Region[33]

In 2002, all the provinces saw a decrease in the R&D spending. Ontario experienced the steepest decline of almost 25%, from $4.7 billion to $3.5 billion. British Columbia, Atlantic Canada, and Quebec also experienced a drop of 23%, 22%, and 19% respectively. The Prairies (including Alberta) showed some stability in their R&D spending.

Considering the period leading up to the bust (1997 – 2003), the highest growth in the ICT sector's R&D was observed in British Columbia with a CAGR of 13.8%, while Atlantic Canada was the only province that showed a decline in their R&D spending from 1997 to 2002.

[33] Source: Statistic Canada.

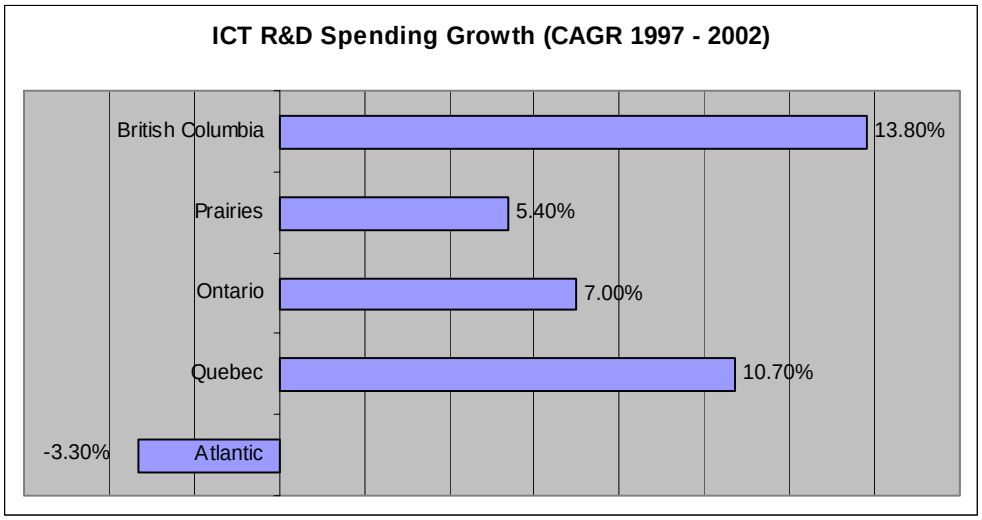

Figure 22: ICT R&D Spending Growth[34]

Looking at what percentage of total R&D expenditure each province puts towards ICT, Ontario still leads all other provinces and regions. Figure 23 shows percentage of total R&D expenditures devoted to ICT by region and provinces. It also compares that to the portion of R&D expenditure dedicated to ICT in Canada.

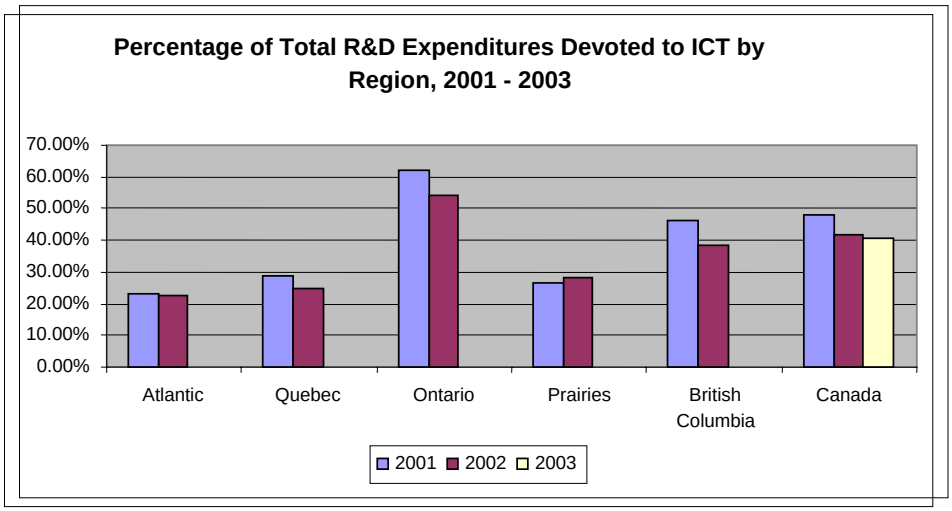

Figure 23: Percentage of Total R&D Expenditures Devoted to ICT by Region[35]

[34] Source: Statistic Canada.

[35] Source: Statistic Canada.

The ICT sector saw significant decline in the R&D spending in 2002; however, it still remained a major contributor to the overall provincial R&D spending. ICT's R&D accounted for more than 50% of the total R&D spending for Ontario, followed by 39% in British Columbia (including Territories) and 28% for the Prairies (including Alberta). Quebec and Atlantic Canada's spending on ICT R&D were 25% and 22% respectively (of their total R&D spending).

Note: Regional data for the year 2003 is not available yet. However, based on the 2003 national data, I can predict that the reduction in the importance of ICT R&D spending may have stabilized.

After the Bust

For the year 2005, overall Canadian R&D expenditures (private sector) are expected to reach $13.8 billion, which is an increment of 1.6% from previous year. R&D expenditures for ICT are expected to recover by 2.0% ($103 million) in 2005 with total expenditures of $5.2 billion. The ICT sector experienced a decline in R&D investments for three years but still remains the largest contributor to the national R&D investments. Figure 24 shows a breakdown of R&D expenditures by ICT industries as of 2005.

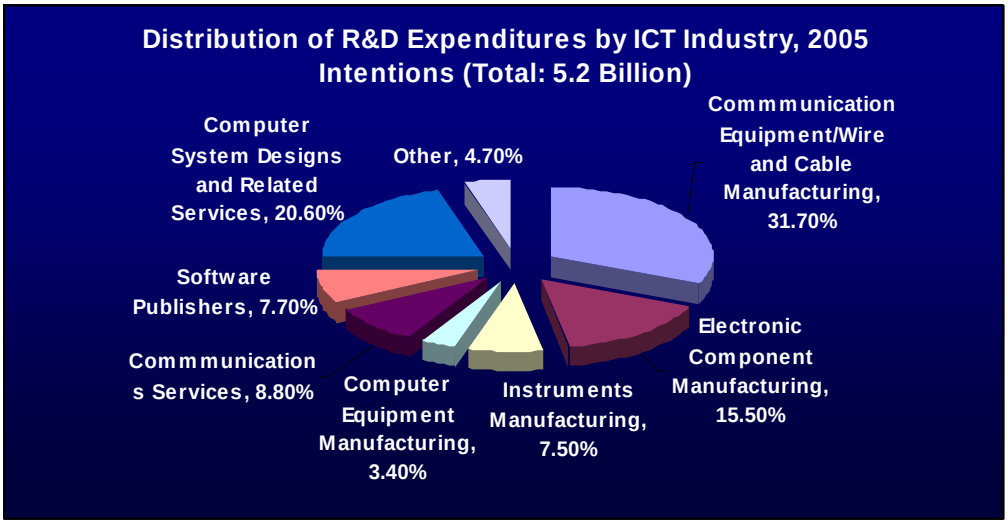

Figure 24: Distribution of R&D Expenditures by ICT Industry, 2005 [36]

[36] Source: Statistic Canada.

The ICT sector was hit hard in 2002 and experienced major declines in the R&D expenditures of communication equipment manufacturing, which went down by nearly 40% ($1.3 billion) and kept decreasing till 2004. However, the situation changed in 2005 when it experienced a slight increase in spending, totalling 32% of ICT sector's R&D and 12% of overall Canadian R&D spending.

Communication equipment and electronic component manufacturing industries are expected to be the key players for the 2005 expenditures. The projected increments for these industries are $33 million and $27 million respectively. Software industry is expected to increase its R&D spending by 3.7%.

Figure 25 shows indexed growth in R&D expenditures for the ICT sector and the Canadian private sector from 1997 – 2005. The trend depicted by both sectors is similar to a great extent, but as with most ICT indicators, the rise and decline of R&D expenditure are much more profound than that of the private sector. A ray of hope can be seen for the ICT sector as it inches back to growth between 2004 and 2005.

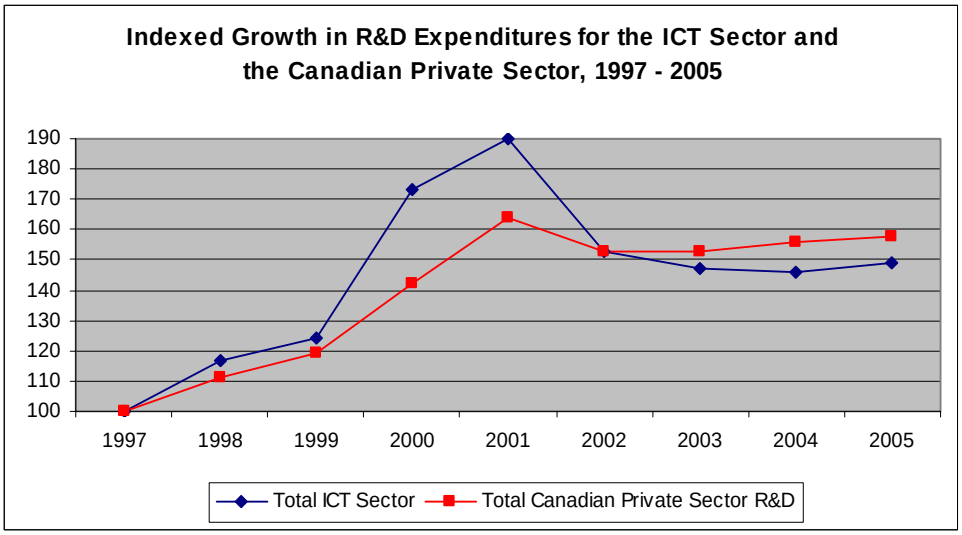

Figure 25: R&D Expenditures for the ICT sector and The Canadian Private Sector[37]

[37] Source: Survey on Research and Development in Canadian Industry (no 4201), Catalogue no. 88-202 and/or 88-001, CANSIM Table 358-0001, Science, Innovation and Electronic Information Division, Statistics Canada.

R&D expenditures have grown at a CAGR of 5.1% during 1997 – 2005 periods, whereas the overall Canadian R&D spending grew at 5.9% for the same period. This was mainly due to reduction in R&D spending in 2002, which made the ICT sector's share of R&D to overall Canadian R&D drop from 49% in 2000 to 38% in 2005.

Table 4 presents a breakdown of ICT expenditure by industries from 1997 – 2005. It is interesting to note that while R&D expenditure in manufacturing suffered continuously from 2001 to 2004, investment in R&D services, although more tamed since 2001, continued to grow. The table also shows that the growth in the manufacturing R&D expenditure was highest between 1999 and 2000, when it grew by 36%. Growth in ICT services R&D expenditures was most profound between 2000 and 2001, when it grew by a whopping 52%

ICT Sector Intramural R&D Expenditures (1997 – 2005)
(Manufacturing and Services)

Industry ($'000,000)	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***
ICT Manufacturing	*2,702*	*3,238*	*3,472*	*4,729*	*4,859*	*3,482*	*3,079*	*3,035*	*3,112*
ICT Services	*739*	*814*	*854*	*1,087*	*1,659*	*1,773*	*1,943*	*1,951*	*1,975*
ICT Wholesaling, Rental & Leasing	*85*	*70*	*59*	*296*	*170*	*136*	*159*	*160*	*161*
Total ICT Sector	*3,526*	*4,123*	*4,385*	*6,112*	*6,687*	*5,390*	*5,181*	*5,146*	*5,249*
Total Canadian Private Sector R&D	*8,739*	*9,682*	*10,400*	*12,450*	*14,320*	*13,367*	*13,391*	*13,630*	*13,848*
ICT R&D as a Percentage of Canadian Private Sector R&D	*40.3%*	*42.6%*	*42.2%*	*49.1%*	*46.7%*	*40.3%*	*38.7%*	*37.8%*	*37.9%*

Table 4: ICT Sector R&D Expenditures[38]

[38] Source: Statistic Canada CANSIM Table 358-0001.

One does not get a complete appreciation of how quickly and profoundly expenditures in ICT manufacturing grew by looking at the percentage change in expenditure between 1997 and 2005. Expenditure in the sector rose and fell sharply, making the overall change just 15.2% between 1997 and 2005. In comparison, percentage change in ICT services expenditures present a more remarkable sight. This is consistent to our observation for output of ICT services. Table 5 shows growth in ICT sectors R&D expenditures from 1997 to 2005

Growth in ICT Sector Intramural R&D Expenditures (1997 – 2005)
(Manufacturing and Services)

Industry	*% Change 2004-2005*	*% Change 1997-2005*	*CAGR 1997-2005*
ICT Manufacturing	*2.5%*	*15.2%*	*1.8%*
ICT Services	*1.2%*	*167.2%*	*13.1%*
ICT Wholesaling, Rental & Leasing	*1.0%*	*89.3%*	*8.3%*
Total ICT Sector	*2.0%*	*48.8%*	*5.1%*
Total Canadian Private Sector R&D	*1.6%*	*58.5%*	*5.9%*

Table 5: Growth in ICT sector Intramural R&D Expenditures(1997 – 2005)[39]

8.2 Current Picture of Capital Expenditure

While companies need to continually invest in R&D to maintain their competitive advantage, they also need, from time to time, to buy or upgrade physical assets or equipment. This expenditure is usually called capital expenditure as it increases the capital assets of a company. In 2005, the capital expenditures of the ICT sector are expected to increase (for a second

[39] Source: Survey on Capital and Repair Expenditures (no 2803), Catalogue no. 61-205, Investment and Capital Stock Division, Statistics Canada.

consecutive year), totalling to $11.5 billion, an increase of 4.9% from 2004, whereas the overall Canadian capital expenditures are expected to grow by 8.4%.[40] Let us take a look at how capital expenditures fared before and during the bust, and beyond.

Before and during the bust

By nature, capital expenditures are long term investments. Before the bust, when expectations of growth were high, it was easy to justify long term growth plans, and thus, huge capital expenses. As the orders sagged, so did capital investment in the sector. Figure 26 compares indexed growth in capital expenditures of the ICT sector and the Canadian economy from 2000 – 2005. It is evident that huge capital investments were being made in ICT even up to 2001. It nose-dived between 2001 and 2003, but has since picked up a bit.

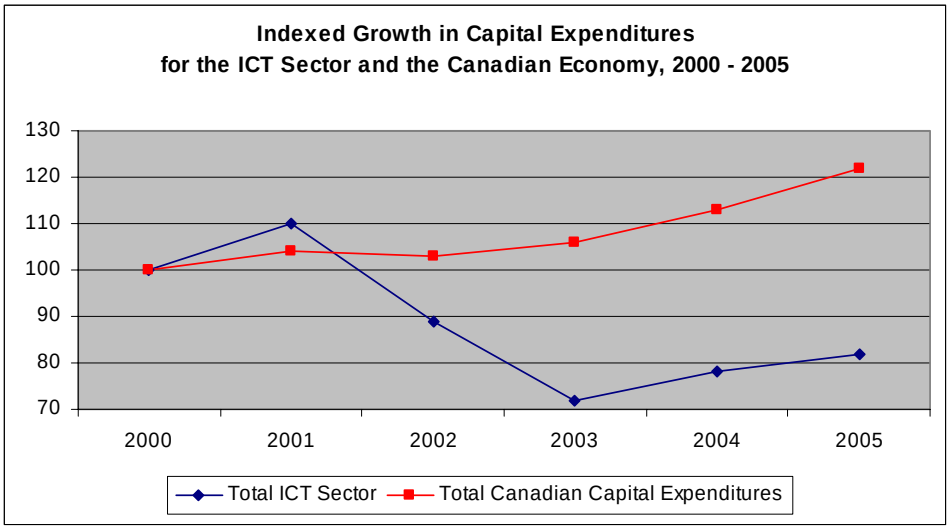

Figure 26: Indexed Growth in Capital Expenditure for the ICT sector and Canadian economy[41]

As expected, capital expenditures are made in both the manufacturing and services industry. Let us take a look the state of capital expenditures in these two industries. The distribution of capital expenditures is highly unequal between manufacturing and services industries. Figure 27 shows

[40] Information and Communications Technologies Statistical Overview by Industry Canada.

[41] Source: Statistic Canada.

an estimate of the distribution of capital expenditures in ICT by segment. There is no comparison between the investments in ICT services and ICT manufacturing.

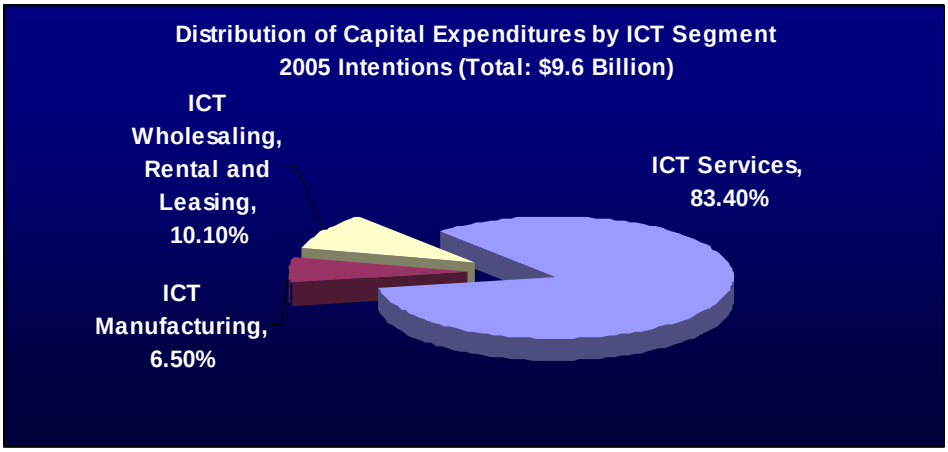

Figure 27: Distribution of Capital Expenditures by ICT Segment 2005[42]

8.2.1 Manufacturing

Although in ICT manufacturing, capital investments is much lower than capital investments in ICT services, investments are estimated to increase in manufacturing by 22.2% in 2005, making $752 million for the sector. Instruments, electric components and communication equipment industries are expected to have the largest increases, accounting for 30.7%, 29.3% and 26.5%, respectively. However, ICT wholesaling, rental and leasing industries are expected to remain stable at $1.16 billion after declines experienced in 2003 and 2004.

8.2.2 Services:

The ICT services sector is set to increase its investments in 2005 by 4.4% to $9.6 billion. This is mainly due to increase in spending by communication services industries, which includes telecommunication and cable program distribution. Also, data processing services, ISPs and web

[42] Source: Statistic Canada.

search portals industries intend to spend more in 2005; however, according to Statistics Canada, the computer systems design industry intend to reduce its capital investments.

I have already highlighted that the difference in capital expenditures in ICT services and manufacturing is large. But a look at the trends followed by both before and during the bust reveals that they both behaved remarkably similar to each other. Capital expenditures in both ICT services and manufacturing started to decline in 2001 and continued the downward trend until 2003. Figure 28 compares ICT capital expenditures in services and manufacturing industries.

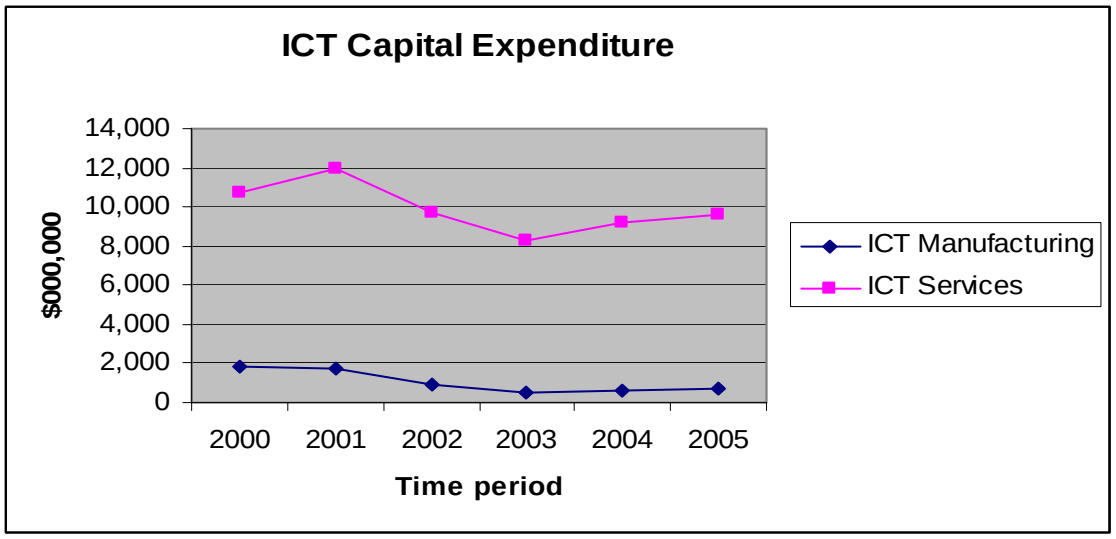

Figure 28: ICT Capital Expenditure 2000 - 2005[43]

While capital expenditures in both ICT services and manufacturing declined significantly between 2001 and 2003, the decline was more prominent in ICT manufacturing. This may come as a surprise because in Figure 28, the rate of decline of capital expenditures in ICT services seems to be higher than that of ICT manufacturing. However, the Figure 28 may be a bit deceiving in the sense that although capital expenditures in ICT services have declined more sharply in dollars, the percentage change has been less than that of ICT manufacturing. Between 2001 and 2002, capital expenditures in ICT services declined by 19% and between 2002 and

[43] Source: Statistic Canada.

2003 by about 15%; capital expenditures in ICT manufacturing declined by 46% and 40.5% during the same time periods.

Table 6 presents a breakdown of capital expenditures by industries from 2000 – 2005. It also shows ICT sector's share of overall Canadian capital expenditures.

ICT Sector Capital Expenditures (2000 – 2005)

Industry ($'000,000)	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***
ICT Manufacturing	*1,844*	*1,755*	*933*	*555*	*615*	*752*
ICT Services	*10,736*	*11,984*	*9,707*	*8,252*	*9,213*	*9,617*
ICT Wholesaling, Rental & Leasing	*1,525*	*1,734*	*1,890*	*1,401*	*1,160*	*1,159*
Total ICT Sector	*14,106*	*15,473*	*12,530*	*10,208*	*10,988*	*11,527*
Total Canadian Capital Exp.	*153,702*	*160,307*	*158,611*	*163,242*	*173,661*	*188,257*
ICT Capital Exp. as a % of Canadian Capital Exp.	*9.2%*	*9.7%*	*7.9%*	*6.3%*	*6.3%*	*6.1%*

Table 6 : ICT sector Capital Expenditure

ICT sector's share of overall Canadian capital expenditures is expected to decline to 6.1% in 2005 because of major cut backs in 2002 and 2003. Within the ICT services industries, the communication services industries remains the largest capital investor with investments reaching $7.5 billion in 2005 accounting for 65% of the total ICT sector's capital expenditures.

The table below shows the growth, or rather the decline, in ICT sector capital expenditures from 2000 – 2005. Consistent with other data I have looked at, the decline in capital expenditure in ICT manufacturing is much higher than other industries within the sector.

Growth in ICT Sector Capital Expenditures (2000 – 2005)

Industry	*% Change 2004 – 2005*	*%Change 2000 – 2005*	*CAGR 2000 – 2005*
ICT Manufacturing	*22.2%*	*-59.2%*	*-16.4%*
ICT Services	*4.4%*	*-10.4%*	*-2.2%*
ICT Wholesaling, Rental & Leasing	*-0.1%*	*-24.0%*	*-5.3%*
Total ICT Sector	*4.9%*	*-18.3%*	*-4.0%*
Total Canadian Capital Expenditures	*8.4%*	*22.5%*	*4.1%*

Table 7: Growth in ICT Sector Capital Expenditure[44]

9. International Trade and ICT

Canada has leveraged growth in the ICT sector to increase its exports of ICT goods, especially to the US. United States was, and still is, the biggest importer of ICT goods from Canada. Before I start a discussion on the impact of ICT sector fluctuations on International trade, it is worth noting that International Trade data for ICT is only available from 1997 to 2004.

Exports of ICT Goods by Destination, Value and Share at the time of Bust

Canada was not the only country to suffer significant decline in ICT goods and services. The same trend was observed in the US, which is the biggest market for Canadian ICT products and services. At the time of the bust, the shipments to the United States dropped by 32.1% in 2001. In 2001, exports to the U.S. accounted for 81.5% of all exports of ICT goods, compared to 80.0% in 1995. Canada's next biggest importer was Asia-Pacific region, whose imports for Canadian goods also went down by 8.3% in 2001 to a value of $1.7 billion. Despite a slight

[44] Source: Statistic Canada.

increase in 2001, the proportion of shipments to this region fell from 8.4% to 6.4% between 1995 and 2001.

Table 8 shows geographical markets for Canadian ICT goods by their value and percentage in 2001

Country	*USA*	*Latin America*	*Asia-Pacific*	*EU*	*Others*
Value ($)	*$21.2 B*	*$0.5 B*	*$1.7 B*	*$2.3 B*	*$0.4 B*
Share (%)	*81.5%*	*1.8%*	*6.4%*	*8.9%*	*1.4%*

Table 8: Geographical markets of Canadian ICT goods as of 2001[45]

Trade of ICT Goods as of 2004:[46]

According to the ITAC (Information Technology Association of Canada), "ICT companies are robust global traders, 70% of ICT products manufactured in Canada are exported." After three years of continual decline, ICT exports grew by 10% from 2003 to 2004 according to Statistic Canada. The United States remains the ICT industry's most important market, accounting for 72% of exports, but new markets are growing in importance. The Asia Pacific region accounted for 5% of ICT exports from Canada in 2000; today, it accounts for 12%.

Looking in to more detail about these trades, I notice that the exports of ICT goods accounted for 5.0% of all Canadian goods exports in 2004, which translates to $20.7 billion. Imports of ICT goods also experienced a fall for three years till 2004 when it increased by 9.5%, reaching $42.5 billion. For the same time, the imports of overall Canadian goods increased by 5.8%. ICT's share of overall Canadian imports was 11.5% in 2004.

In 2004, both exports and imports of ICT products increased except for the imports of wired communication equipment. Wired and wireless communication equipment and instruments showed the most increase in exports, reaching 14.2% and 13.3% respectively. Electronic components imports showed the most increase reaching 25.4%.

[45] Source: Statistic Canada.

[46] All the Data are collected from Statistic Canada researches.

Trade deficit of Canada for ICT goods increased by 8.6% in 2004 accounting for $21.7 billion. Most of trade deficit was caused by loss in exports of Computer equipment, which accounted for 41% of this deficit. The audio/video equipment and instruments also contributed largely to this deficit, accounting to 23% and 20% respectively.

The only ICT product group showing a positive balance for more than ten years was the wired communication equipment group, which showed a trade surplus of $2.5 billion in 2004 regardless of the loss in exports in 2000.

The Export Development Canada (EDC) expects that the export of telecommunication equipment will grow by 8% in 2005 and by 5% in 2006. Also exports of computers and peripheral devices, semiconductor instruments, satellites and electrical equipment are expected to grow by 3% for the year 2005 and 2006.

Table 9 shows the growth in imports and exports of ICT goods from 1997 – 2004 as well as the compound annual growth rates for trade for the same period. This is not a pretty picture for Canada as it seems that even though exports of ICT goods increased by 10.5% between 2003 and 2004, the overall change from 1997 to 2004 remains negative. Even the CAGR for exports of ICT goods remain negative.

Growth in Trade of ICT Goods (1997 – 2004)

ICT Goods	% Change 2003-2004	% Change 1997-2004	CAGR 1997-2004
Exports	10.5%	-6.3%	-0.9%
Imports	9.5%	8.0%	1.1%

Table 9: Growth in Trade of ICT Goods[47]

[47] Source: Industry Canada

Trade of ICT Services as of 2004

After more than ten years, exports of ICT services declined in 2004, decreasing by 7.7% and reaching close to $7.1 billion. During this year, exports of almost all groups of ICT services decreased; however, ICT services still accounted for 21.8% of total exports of commercial services.

On the other hand, imports of ICT services increased in 2004 by almost 7.4%. The ICT services imports accounted for $5.0 billion, which is 12.0% of overall Canadian commercial services imports.

The largest portion of trade of ICT services comes from computer and software services group, which makes up 75% of exports and 54% of imports of the ICT services sector.

Canada had a trade surplus of $2.1 billion for the ICT services sector in 2004; however, it is down by nearly 30% from the previous year. The computer and software services industry had a surplus of 42.6 billion, and telecommunication services had a surplus of $37 million, but there was a trade deficit of $535 million in information services sub-sector, which reduced the overall surplus to $2.1 billion.

Table 10 shows the growth in trade of ICT services from 1997 – 2004. Like trade of ICT goods, exports of ICT services declined from 2003 to 2004. It should be noted, however, that the percentage change in export of ICT services is not only positive between 1997 and 2004; it is also significantly higher than ICT services imports. Also, the CAGR of ICT services exports is also positive and higher than that of ICT services imports.

Growth in Trade of ICT Services (1997 – 2004)

ICT Services	% Change 2003-2004	% Change 1997-2004	CAGR 1997-2004
Exports (Receipts)	-7.7%	70.2%	7.9%
Imports (Payments)	7.4%	38.5%	4.8%

Table 10: Growth in Trade of ICT services[48]

Table 11 shows a combined view of ICT goods and services trade between 1997 and 2004. An analysis of the data shows that the trade balance of ICT goods and services has remained negative before, during and after the bust. One of my observations is that the balance has remained more or less constant from 1997 to 2004.

Trade of ICT Goods and Services (1997 – 2004)

ICT Goods & Services ($'000,000)	1997	1998	1999	2000	2001	2002	2003	2004
Exports	26,312	28,784	32,110	44,220	33,225	28,315	26,473	27,855
Imports	42,892	46,726	51,253	61,371	51,434	46,903	43,409	47,438
Trade Balance	-16,580	-17,942	-19,142	-17,151	-18,209	-18,588	-16,936	-19,583

Table 11: Trade of ICT Goods and Services[49]

Figure 29 shows the same information graphically. It is remarkable that both the imports and exports of ICT good and services have followed the same trend. They look like almost parallel lines on the Figure 29, with both of them peaking in 2001, declining till 2003 and then beginning to return to growth in 2004. Rate of growth of ICT goods and services exports, however, seem to be lagging behind slightly as compared to imports.

[48] Source: Industry Canada.

[49] Source: Industry Canada.

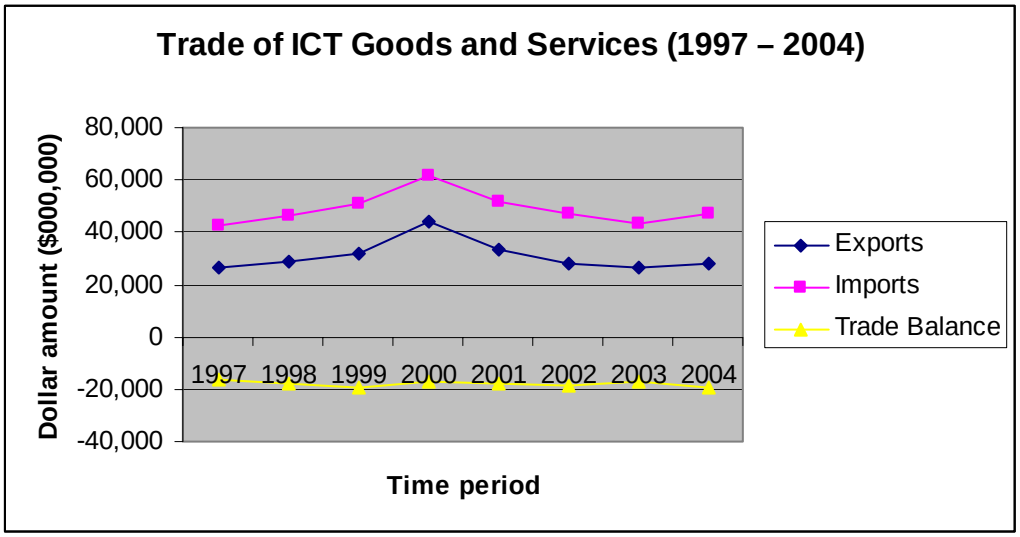

Figure 29: Trade of ICT Goods and Services[50]

I have assessed the ICT sector's performance before, during, and after the bust. I have also discussed how the manufacturing and services sectors and various industries in them fared between 1997 and 2005. Next, I conduct a forecasting experience to determine, how the ICT sector would grow from 2005 to 2015.

10. Forecast

10.1 Methodology and Results to forecast ICT's Performance (2005 – 2015)

Telecommunication industry is a major contributor to ICT sector's performance. As such, I will take a look at the past performance of this industry and try to predict ICT's performance based on that. One of the reasons for choosing only telecommunication from the entire ICT sector is that on the 23 February 2005, in the 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 recognized "the critical importance of the

[50] Data Source: Cat. no. 67-203, CANSIM Table 376-0033, Balance of Payments Division, Statistics Canada.

telecommunications sector to Canada's future well being." In announcing this review panel the government recognized that telecommunications policy is to benefit consumers and industry.

The panel was formed in an announcement of 11 April 2005 by then Industry Minster 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."

As presented in earlier section and the evidence suggests that the telecommunications sector is a strong driver of overall economic performance (which is a similar conclusion as that of a report presented by IAC).[51]

Trethewa (2005) discusses the concept of evaluating and forecasting the performance of a sector. The main entity I would use to evaluate performance in this paper is the estimated NPV of economic gains contributed by the telecommunications sector between 2005 and 2015. I will achieve this by calculating growth projections including and excluding the telecom sub-sector. Including telecom and 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 2006 and 2025.

The baseline growth was computed by:

Forecasted economic growth – annual contribution of ICT to economic growth (1981 -2004)

Which comes to 2.1 (2.6 - 0.5)

[51] Report from International Association of Canada .

To calculate GDP growth (with telecom) involves adding telecommunication's share of ICT contribution to GDP growth to the bottom line growth rate of 2.1%.

The lower and upper bound contribution of telecom to ICT is assumed to be 30% and 70% respectively. I then scaled the ICT contribution to GDP growth by these telecom percentages and added these values to the baseline growth rate of 2.1%. Below are the upper and lower bound GDP growth rates which include the telecom sub-sector:

- ***Upper bound 70%****: 2.1% + (0.3*(0.5%)) = 2.250%*
- ***Lower bound 30%****: 2.1% + (0.7 * (0.5%)) = 2.450%*

I then calculate the projected GDP for both the ICT sector and the whole economy.

- *With telecom:* $GDP_t = GDP_{2005} * (1 + r_{withtelecom})^{t-2005}$
- *Without telecom:* $GDP_t = GDP_{2005} * (1 + r_{withouttelecom})^{t-2005}$

Baseline growth rate	*2.10 %*	*Lower bound*	*2.450%*
10 year Benchmark bond yields	*4.12 %*	*Upper bound*	*2.250 %*

$NPV_t = GDP_{t,withtelecom} - GDP_{t,withouttelecom} \div (1 + r)$

Discount rate (r) = 4.12% which is 10 year benchmark bond yield.

Using the method described above, the following table forecasts projected GDP with and without the telecom sector and the NPV from 2005 to 2015.

Year	Projected GDP with telecom	Projected GDP without telecom	Difference b/w the two	Net Present Value (NPV)
2005	$1,083,916	$1,083,916	$0	$0.00
2006	$1,110,472	$1,106,678	$3,794	$3,643.59
2007	$1,137,679	$1,129,918	$7,760	$7,452.96
2008	$1,165,552	$1,153,647	$11,905	$11,433.79
2009	$1,194,108	$1,177,873	$16,234	$15,591.91
2010	$1,223,363	$1,202,609	$20,755	$19,933.34
2011	$1,253,336	$1,227,863	$25,472	$24,464.28
2012	$1,284,042	$1,253,649	$30,394	$29,191.13
2013	$1,315,501	$1,279,975	$35,526	$34,120.46
2014	$1,347,731	$1,306,855	$40,877	$39,259.05
2015	$1,380,751	$1,334,299	$46,452	$44,613.90
Total	$13,496,450	$13,257,282	$239,168	$229,704.40

Table 12: Projected GDP with and without Telecom

Figure 30 shows the base growth in GDP (1.9% per annum) without the historical contribution of ICT.

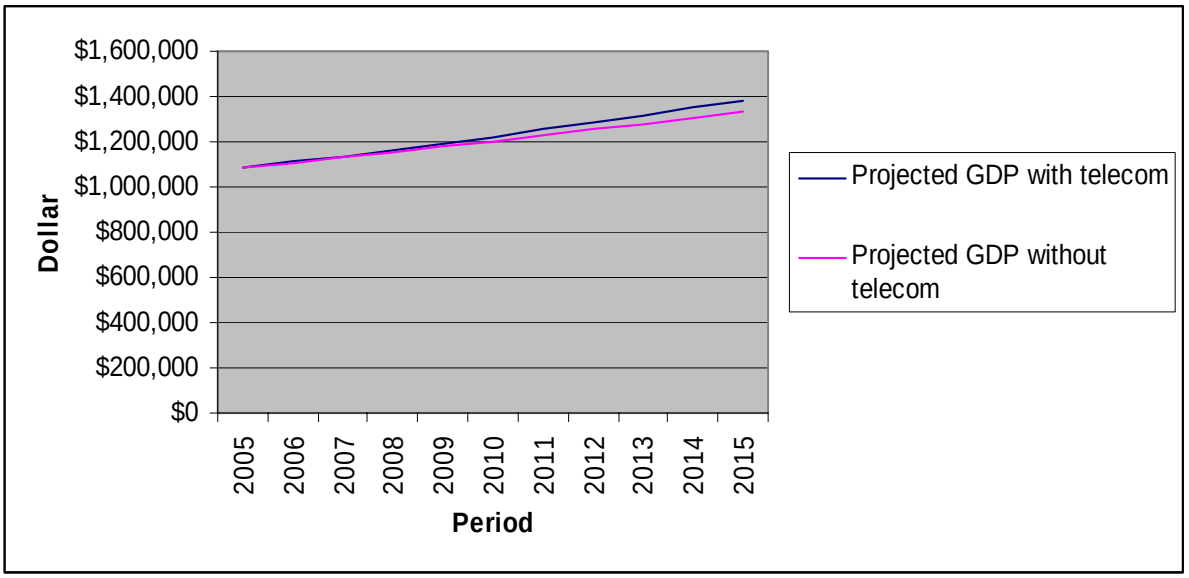

Figure 30: Projected GDP with and without Telecom 2005 - 2015

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 4.12% per annum, is roughly $*$239,168*, while the NPV of the telecommunications contribution is between *$3,643.59* and *$44,613.90*. Thus I conclude that if current telecommunications technology deployment were to be frozen as is today, over a course of ten years; Canada would forego an equivalent of 21.19% of annual GDP.

10.2 Forecasting of total ICT Investment

Analysis of ICT sector help us in understanding the evolution of the Canadian economy overall. While companies within the ICT sector invest in their own development, ICT products and services are used by many other industries too. Contributions from these industries also impact Canada's GDP. It is, therefore, necessary to look in to how much other industries invest in the ICT sector.

Data:

For this purpose the data was collected from the database of the "Information and Communication Technology (ICT) Investment and Capital Stocks Trends: Canada vs United States." This database is maintained by the Centre for the Study of Living Standards Centre (CSLS). CSLS is a non-profit, national, independent organization that seeks to contribute to a better understanding of trends in and determinants of productivity, living standards and economic and social well-being through research.[52]

The ICT investment comprises of the investment in ICT by some major industries like agriculture, forestry, fishing and hunting industry, mining and oil and gas extraction industry,

[52] http://www.csls.ca.

utilities industry, construction industry, manufacturing industry, retail trade industry, transportation and warehousing industry, scientific and culture industry and above all information and culture industry.

Methodology:

For the purpose of forecasting the impact of investments in ICT from outside the sector, I have chosen a few major industries of Canada that contributes heavily in the GDP of the country. By using historical data from these industries, I intend to determine the impact of ICT investments on the Canadian economy in the coming years (2006 – 2008). This forecasting will help the ICT sector manufacturing and service industries to make their growth projections.

For this purpose I have used "The Box-Jenkins (BJ) Methodology". There are 4 steps to this methodology.

Step1: Identification. The chief tools in identification process are the autocorrelation function (ACF), partial autocorrelation function (PACF), and the resulting correlograms which are simply the plots of ACFs and PACFs. I have used a lag length of 24.

For a time series where j = 1,2,…..24 the sample autocorrelations are:

$$r_j = c_j / c_0$$

$$c_j = 1/N \sum_{t=j+1}^{N} \left[\left(z_t - \bar{z} \right) \left(z_{t-j} - \bar{z} \right) \right]$$

PACF gives information about the order of an autoregressive process. The j^{th} partial autocorrelation coefficient is the estimated coefficient of z_{t-p} from a p^{th} order autoregressive model with p = j. I used the Shazam to compute the PACFs. Shazam computes the PACF using the Durbin's recursive method.

The data for which I use the correlogram function declined at higher lags, which confirms that the data follows the stationary time series.

Step 2: Estimation. With the help of the first step, I plotted ACF and PACF and identified the appropriate p and q values. BJ method models time series as autoregressive integrated moving average (ARIMA) processes. The term 'I' stands for "integrated" in ARIMA which refers to differencing. Once the data is stationarized, the next step is to estimate the parameters of the autoregressive (AR) and moving average (MA) terms. The AR can be defined by using the formula:

$$\left(Y_t - \delta\right) = \alpha_1\left(Y_{t-1} - \delta\right) + \alpha_2\left(Y_{t-2} - \delta\right) + \ldots\ldots\ldots + \alpha_p\left(Y_{t-p} - \delta\right) + u_t$$

Where Y_t is a p[th]-order autoregressive or AR (p)

An MA process is simply a linear combination of white noise error term. I calculated MA by using the following formula.

$$Y_t = \mu + \beta_0\mu_t + \beta_1\mu_{t-1} + \beta_2\mu_{t-2} + \ldots\ldots\ldots + \beta_q\mu_{t-q}$$

Step 3: Diagnostic Checking. After choosing a particular ARIMA model, and having estimated its parameters, I assess whether the chosen model fits the data reasonably well. For this purpose, I tried other p and q values in my Shazam code. After running the Shazam code for these p and q values, I observed that all of them resulted in a higher standard error, proving that the original p and q values were indeed the best fit.

Step 4: Forecasting. Forecasting is the final step. The reason behind ARIMA's popularity is its success in forecasting. In many cases, the forecasts obtained by this method are more reliable than those obtained from the traditional econometrics modelling.

10.2.1 Results

I have attached the Shazam code and output in the Appendix. The result of the forecasting is shown in Figure 31.

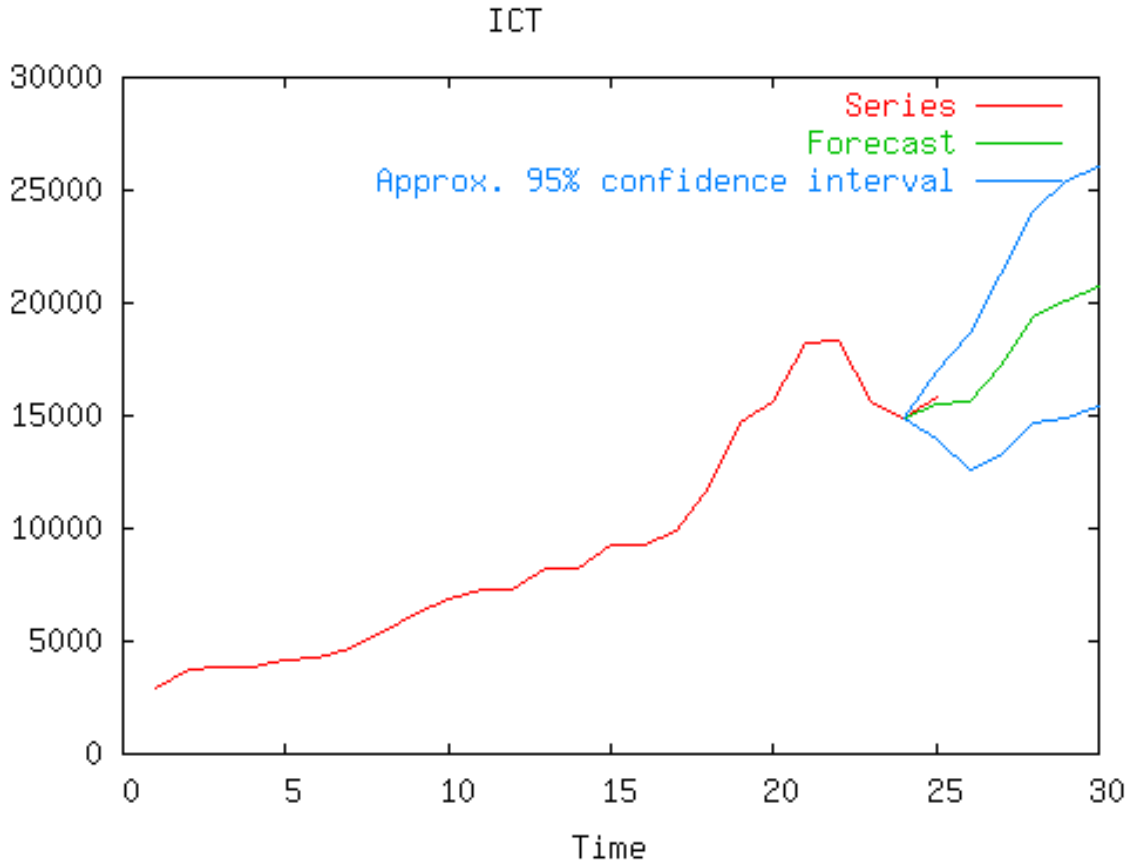

Figure 31: Projection of ICT Investment in Canada

The red line is the historical ICT investment from 1980 to 2004. The time period 1 – 30 represents 1980 – 2010. The green line represents the forecasting which was done using Box Jenkins ARIMA methodology. My forecast starts from the year 2003 and Figure 31 shows that the forecast was almost same as the actual. This adds to my confidence in the forecasted figures. For the coming years, my forecast shows that the ICT investment is recovering from the bust and soon the ICT sector will regain from the loss.

11. Conclusion

The question which I tired to answer through this essay was that whether the bust in the ICT sector was the temporary phenomena or a persistent one. From the trends in the economic indicators of the ICT sector, I conclude that from the mid to late nineties, the ICT sector was booming. This boom drew huge amount of investments into the industry which expanded exponentially until mid of 2000. My analysis of the data suggests that during the bust of the ICT sector ICT manufacturing was severely affected. ICT services, on the other hand, continued to grow at a slower rate. During this time, many companies moved from the manufacturing sector to services.

My analysis of the data suggests that since the bust, the ICT sector has recovered and has shown a steady growth in the past couple of years. I, therefore, conclude that the decline in the ICT sector was a temporary phenomenon. Beckstead and Brown (2005) have also reached the same conclusion using a different methodology.

In predicting the future of the ICT sector investments by using the Box-Jenkins methodology, I showed that investments in the sector would continue to grow at a steady rate, and would eventually surpass the level attained during the boom. The pace of technological advances may slow down for some period, but they cannot be stopped completely. With the advent of new technologies comes the requirement to manage and enhance the new services. In good time, the Canadian ICT sector has faced tough challenges from US companies offering services at lower rates. In bad times, it is faced with declining demands. But it has shown that it can live up to the challenges.

Appendix

Employment: Selected ICT Manufacturing Industries,
(Indexed Growth, 1997Q1 = 100)

Year.Q	Computer and Peripheral Equipment	Communications Equipment	Electronic Components	Instruments
1997.1	100.0	100.0	100.0	100.0
1997.2	98.9	103.9	104.3	102.1
1997.3	100.2	105.9	105.9	104.4
1997.4	104.3	107.4	107.2	106.5
1998.1	104.8	108.0	108.2	106.6
1998.2	103.7	107.7	108.5	108.0
1998.3	101.3	108.9	110.0	109.3
1998.4	103.2	111.0	112.3	109.0
1999.1	106.6	110.1	114.4	110.2
1999.2	102.3	113.8	119.2	110.7
1999.3	104.7	111.3	113.2	109.9
1999.4	105.5	113.1	114.8	110.5
2000.1	110.2	112.9	114.0	111.4
2000.2	109.2	115.8	116.5	112.2
2000.3	110.0	120.5	120.7	113.1
2000.4	112.6	122.4	122.9	112.7
2001.1	111.0	117.3	120.1	109.6
2001.2	106.7	106.9	108.6	106.1
2001.3	103.4	101.5	102.8	102.3
2001.4	96.4	100.0	99.7	100.7
2002.1	91.8	100.4	99.5	98.5
2002.2	85.0	96.6	98.5	94.6
2002.3	81.9	92.8	98.3	94.9
2002.4	83.0	91.2	94.7	94.2
2003.1	81.2	94.2	91.9	95.3
2003.2	79.2	98.9	88.9	96.3
2003.3	76.2	97.4	87.5	94.7
2003.4	70.4	101.9	90.8	92.9
2004.1	67.5	102.5	91.8	91.1
2004.2	68.2	104.2	91.6	90.2
2004.3	66.1	101.5	83.6	90.2
2004.4	64.1	103.6	83.7	90.2
2005.1	60.4	107.8	84.4	90.4
2005.2	57.1	109.4	84.4	90.3
2005.3	54.9	109.4	84.0	89.2

Table 13: Data for Figure 5[53]

[53] Source: Industry Canada Quarterly Monitor of the Canadian ICT Sector, Third Quarter 2005.

Employment: Selected ICT Services Industries,
(Indexed Growth, 1997Q1 = 100)

Year.Q	Software	Telecommunications Services	Computer Systems Design	Data Processing Services
1997.1	100.0	100.0	100.0	100.0
1997.2	108.6	101.0	108.7	109.1
1997.3	113.9	101.1	113.9	114.6
1997.4	114.8	100.5	114.8	115.0
1998.1	120.4	102.2	120.6	118.8
1998.2	124.7	102.3	125.0	123.5
1998.3	131.1	102.6	131.4	130.7
1998.4	139.9	102.7	140.0	141.4
1999.1	148.3	102.6	148.4	150.5
1999.2	152.6	102.0	152.5	157.1
1999.3	156.1	102.8	155.9	160.2
1999.4	164.4	103.8	164.0	170.1
2000.1	170.7	103.9	170.2	176.5
2000.2	178.6	104.3	178.5	181.9
2000.3	187.6	105.2	187.4	190.0
2000.4	193.3	105.4	193.2	195.6
2001.1	198.7	104.6	197.5	213.5
2001.2	195.9	105.2	192.7	221.9
2001.3	194.1	106.2	189.5	227.2
2001.4	191.7	106.7	185.7	231.0
2002.1	191.4	105.5	185.5	229.3
2002.2	194.0	106.4	189.7	214.0
2002.3	195.7	106.0	191.8	213.6
2002.4	197.3	105.9	193.8	213.0
2003.1	194.3	109.3	190.7	211.7
2003.2	191.7	109.2	187.4	213.4
2003.3	189.0	112.2	184.8	215.6
2003.4	187.6	116.4	184.8	208.3
2004.1	188.5	117.3	184.8	206.6
2004.2	190.0	112.3	186.0	219.1
2004.3	189.5	115.2	185.1	211.2
2004.4	190.6	118.2	184.3	217.3
2005.1	191.2	119.0	184.2	213.9
2005.2	190.8	120.8	185.1	207.8
2005.3	191.2	115.8	185.0	202.2

Table 14: Data for Figure 8[54]

[54]Source: Industry Canada Quarterly Monitor of the Canadian ICT Sector, Third Quarter 2005.

Table 15 shows a comparison of ICT sector output to the overall output

Table 15: Data for Figure 10 [55]

Period	ICT Sector	Canada
1997.1	100	100
1997.2	102.5	101.2
1997.3	106.7	102.7
1997.4	108.8	103.6
1998.1	112.1	104.7
1998.2	116.1	105.2
1998.3	122.5	106
1998.4	131.7	107.7
1999.1	141.5	109.4
1999.2	149.8	110.7
1999.3	157.3	112.6
1999.4	165.2	114.6
2000.1	171.9	116.2
2000.2	179.6	117.4
2000.3	187.2	118.8
2000.4	187.4	119.6
2001.1	177.1	119.7
2001.2	171.9	119.8
2001.3	167.5	119.7
2001.4	166.5	120.1
2002.1	171.4	121.7
2002.2	174.8	123.2
2002.3	175	124.1
2002.4	175.4	124.7
2003.1	174.8	125.5
2003.2	175.8	125.6
2003.3	177.3	126.3
2003.4	179.4	127.9
2004.1	180.7	128.6
2004.2	182.3	129.9
2004.3	185.1	131.3
2004.4	187.1	132
2005.1	191.4	132.9
2005.2	193.7	134
2005.3	195.7	135.3

[55] Source: Industry Canada Quarterly Monitor of the Canadian ICT Sector, Third Quarter 2005.

Shazam Output:

```
Welcome to SHAZAM - Version 10.0 -  JUL 2004 SYSTEM=WIN-XP   PAR=  4000

CURRENT WORKING DIRECTORY IS: C:\SHAZAM
 |_sample 1 25
 |_read ICT ff oil utili cons manu reta ware cult scient
   10 VARIABLES AND       25 OBSERVATIONS STARTING AT OBS       1


 |_Arima ict/nlag=24 nlagp=24 plotac plotpac
     ARIMA MODEL
 NUMBER OF OBSERVATIONS =  25
 ...NOTE..SAMPLE RANGE SET TO:     1,    25

 REQUIRED MEMORY IS PAR=       8 CURRENT PAR=    4000
      IDENTIFICATION SECTION - VARIABLE=ICT
 NUMBER OF AUTOCORRELATIONS =  24
 NUMBER OF PARTIAL AUTOCORRELATIONS =  24

              0     0 0
 SERIES  (1-B) (1-B  )  ICT

   NET NUMBER OF OBSERVATIONS =   25
 MEAN=    9221.9       VARIANCE=   0.24769E+08   STANDARD DEV.=    4976.8

   LAGS                        AUTOCORRELATIONS                            STD ERR
   1 -12    0.90 0.80 0.68 0.52 0.36 0.24 0.12 0.03 -.04 -.10 -.16 -.22   0.20
  13 -24    -.28 -.33 -.37 -.41 -.43 -.43 -.39 -.34 -.26 -.18 -.12 -.07   0.49

  MODIFIED BOX-PIERCE (LJUNG-BOX-PIERCE) STATISTICS  (CHI-SQUARE)
     LAG    Q    DF  P-VALUE       LAG    Q    DF  P-VALUE
      1   22.86   1  .000          13   80.24  13  .000
      2   41.52   2  .000          14   87.09  14  .000
      3   55.65   3  .000          15   96.52  15  .000
      4   64.35   4  .000          16  109.03  16  .000
      5   68.81   5  .000          17  124.86  17  .000
      6   70.88   6  .000          18  142.85  18  .000
      7   71.42   7  .000          19  160.18  19  .000
      8   71.45   8  .000          20  176.09  20  .000
      9   71.51   9  .000          21  187.92  21  .000
     10   71.94  10  .000          22  195.09  22  .000
     11   73.21  11  .000          23  199.96  23  .000
     12   75.79  12  .000          24  203.26  24  .000

   LAGS                    PARTIAL AUTOCORRELATIONS                        STD ERR
   1 -12    0.90 -.08 -.14 -.28 -.10 0.11 -.05 0.04 -.03 -.08 -.16 -.12   0.20
  13 -24    -.04 -.01 0.01 -.08 -.08 0.01 0.15 0.02 0.09 -.02 -.19 -.09   0.20

                                              0     0 0
 AUTOCORRELATION FUNCTION OF THE SERIES    (1-B) (1-B  )  ICT

  1 0.90 .                   +             RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR  .
  2 0.80 .           +                     RRRRRRRRRRRRRRRRRRRRRRRRRRRR      .
  3 0.68 .      +                          RRRRRRRRRRRRRRRRRRRRRRR   +       .
  4 0.52 .   +                             RRRRRRRRRRRRRRRRRR           +    .
  5 0.36 .  +                              RRRRRRRRRRRR                  +   .
  6 0.24 . +                               RRRRRRRR                       + .
  7 0.12 .+                                RRRRR                            +.
```

```
 8 0.03 .+                                RR                                +.
 9 -.04 .+                               RR                                 +.
10 -.10 .+                              RRRR                                +.
11 -.16 .+                            RRRRRRR                               +.
12 -.22 .+                           RRRRRRRRR                              +.
13 -.28 .+                         RRRRRRRRRRR                              +.
14 -.33 +                         RRRRRRRRRRRR                               +
15 -.37 +                       RRRRRRRRRRRRRR                               +
16 -.41 .                      RRRRRRRRRRRRRRR                               .
17 -.43 .                     RRRRRRRRRRRRRRRR                               .
18 -.43 .                     RRRRRRRRRRRRRRRR                               .
19 -.39 .                       RRRRRRRRRRRRRR                               .
20 -.34 .                      RRRRRRRRRRRRRR                                .
21 -.26 .                         RRRRRRRRRR                                .
22 -.18 .                            RRRRRRR                                .
23 -.12 .                              RRRRR                                .
24 -.07 .                                RRR                                .

                                                    0     0 0
PARTIAL AUTOCORRELATION FUNCTION OF THE SERIES  (1-B) (1-B  )  ICT

 1 0.90 .                    +              RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR  .
 2 -.08 .                    +           RRRR               +                 .
 3 -.14 .                    +         RRRRRR               +                 .
 4 -.28 .                    +    RRRRRRRRRR              +                 .
 5 -.10 .                    +           RRRR               +                 .
 6 0.11 .                    +              RRRRR           +                 .
 7 -.05 .                    +            RRR               +                 .
 8 0.04 .                    +              RR              +                 .
 9 -.03 .                    +             RR               +                 .
10 -.08 .                    +           RRRR               +                 .
11 -.16 .                    +         RRRRRR               +                 .
12 -.12 .                    +         RRRRR                +                 .
13 -.04 .                    +            RR                +                 .
14 -.01 .                    +             R                +                 .
15 0.01 .                    +             R                +                 .
16 -.08 .                    +           RRRR               +                 .
17 -.08 .                    +           RRRR               +                 .
18 0.01 .                    +              R               +                 .
19 0.15 .                    +              RRRRRR          +                 .
20 0.02 .                    +              RR              +                 .
21 0.09 .                    +              RRRR            +                 .
22 -.02 .                    +             RR               +                 .
23 -.19 .                    +       RRRRRRRR               +                 .
24 -.09 .                    +           RRRR               +                 .

|_ARIMA ICT / NAR=1 NMA=6 ndiff=1 COEF=BETA
    ARIMA MODEL
NUMBER OF OBSERVATIONS =  25
...NOTE..SAMPLE RANGE SET TO:     1,    25
DEGREE OF DIFFERENCING =   1
NUMBER OF AR PARAMETERS =   1
NUMBER OF MA PARAMETERS =   6
REQUIRED MEMORY IS PAR=      16 CURRENT PAR=    4000

ESTIMATION PROCEDURE
STARTING VALUES OF PARAMETERS ARE:
 0.10000      0.10000      0.10000      0.10000      0.10000
 0.10000      0.10000       1.0000
```

```
MEAN OF SERIES =   537.4
VARIANCE OF SERIES =  0.1172E+07
STANDARD DEVIATION OF SERIES =   1083.

INITIAL SUM OF SQUARES =      48564050.

NET NUMBER OF OBS IS   24
DIFFERENCING: 1 CONSECUTIVE, 0 SEASONAL WITH SPAN  0
NO CONVERGENCE AFTER 50 ITERATIONS
INITIAL SUM OF SQS=     48564050.     FINAL SUM OF SQS=     9763560.1

 R-SQUARE =  0.6379     R-SQUARE ADJUSTED =  0.4795
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.59611E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA =   772.08
AKAIKE INFORMATION CRITERIA -AIC(K) =   13.965
SCHWARZ CRITERIA- SC(K) =   14.358

             PARAMETER ESTIMATES        STD ERROR     T-STAT
              AR( 1)   0.19274         0.9439         0.2042
              MA( 1)  -0.50856         0.9198        -0.5529
              MA( 2)   0.56374E-01     0.5321         0.1060
              MA( 3)   0.19443         0.1854          1.049
              MA( 4)   0.23532E-01     0.2997         0.7851E-01
              MA( 5)   0.97725         0.1665          5.870
              MA( 6)   0.75347E-01     0.9305         0.8098E-01
            CONSTANT    534.10          634.9         0.8412

                                RESIDUALS
  LAGS                        AUTOCORRELATIONS                              STD ERR
  1 -12    -.08 -.17 0.01 -.17 -.30 0.24 0.05 -.05 0.02 -.09 0.09 0.01   0.20
 13 -23    0.03 -.09 -.05 0.00 0.01 0.02 0.08 -.01 -.08 0.00 0.02        0.25

 MODIFIED BOX-PIERCE (LJUNG-BOX-PIERCE) STATISTICS  (CHI-SQUARE)
    LAG    Q    DF  P-VALUE       LAG    Q    DF  P-VALUE
     8    6.94   1  .008          16    8.40   9  .495
     9    6.95   2  .031          17    8.41  10  .589
    10    7.33   3  .062          18    8.45  11  .672
    11    7.67   4  .104          19    9.28  12  .679
    12    7.68   5  .175          20    9.28  13  .751
    13    7.73   6  .258          21   10.53  14  .722
    14    8.24   7  .312          22   10.53  15  .785
    15    8.40   8  .396          23   10.79  16  .822


CROSS-CORRELATIONS BETWEEN RESIDUALS AND (DIFFERENCED) SERIES

CROSS-CORRELATION AT ZERO LAG = 0.68
  LAGS                    CROSS CORRELATIONS Y(T),E(T-K)
  1-12    0.52 -.06 -.14 -.05 -.59 -.04 0.09 0.00 0.00 -.01 -.01 0.07
 13-23    0.05 -.04 -.02 -.06 0.03 0.01 0.09 0.07 -.05 -.04 0.01
 LEADS                   CROSS CORRELATIONS Y(T),E(T+K)
  1-12    -.22 -.09 -.08 -.20 -.02 0.12 0.02 -.01 0.04 0.05 0.05 -.01
 13-23    -.03 -.15 -.07 0.05 0.01 0.02 0.07 -.01 -.05 0.00 0.01

             ANALYSIS OF RESIDUALS

             VALUES RANGE FROM   -1336.1148 TO    1312.4233


   SAMPLE MOMENTS OF RESIDUALS (USING THE DIVISOR  24) :
```

```
   MEAN =               -114.7944
   VARIANCE =            384231.3
   SKEWNESS =          -0.1793836
   KURTOSIS =            2.991684
   STUDENTIZED RANGE =   4.272773
|_GEN1 S=SQRT($SIG2)
..NOTE..CURRENT VALUE OF $SIG2=  0.59611E+06

|_ARIMA ICT/ NAR=1 NMA=6 ndiff=1 COEF=BETA fBEG=24 fend=30 Sigma=S GRAPHFORC
    ARIMA MODEL
NUMBER OF OBSERVATIONS =  25
...NOTE..SAMPLE RANGE SET TO:     1,    25
DEGREE OF DIFFERENCING =   1
NUMBER OF AR PARAMETERS =   1
NUMBER OF MA PARAMETERS =   6

REQUIRED MEMORY IS PAR=      10 CURRENT PAR=    4000
    ARIMA FORECAST

          PARAMETER VALUES ARE:

               AR( 1)=   0.19274
               MA( 1)=  -0.50856
               MA( 2)=   0.56374E-01
               MA( 3)=   0.19443
               MA( 4)=   0.23532E-01
               MA( 5)=   0.97725
               MA( 6)=   0.75347E-01
               CONSTANT =    534.10

FROM ORIGIN DATE  24, FORECASTS ARE CALCULATED UP TO    6 STEPS AHEAD

FUTURE DATE   LOWER      FORECAST       UPPER       ACTUAL       ERROR
     25      13963.4      15476.7      16990.0      15805.2      328.545
     26      12646.9      15633.3      18619.6
     27      13192.9      17214.6      21236.4
     28      14709.2      19404.3      24099.3
     29      14878.1      20121.5      25365.0
     30      15457.8      20767.9      26078.0


     STEPS AHEAD    STD ERROR     PSI WT
           1         772.1        1.0000
           2         1524.        1.7013
           3         2052.        1.7801
           4         2395.        1.6008
           5         2675.        1.5428
           6         2709.        0.5543


VARIANCE OF ONE-STEP-AHEAD ERRORS-SIGMA**2 =  0.5961E+06
STD.DEV. OF ONE-STEP-AHEAD ERRORS-SIGMA    =   772.1
|_stop
```

Bibliography

Geoff Bowlby and Stephanie Langlois, “High tech boom and bust”,
Statistic Canada – Catalogue no. 75-001-XIE, April 2002

Desmond Beckstead and W. Mark Brown, “An Anatomy of Growth and Decline: High-tech Industries through the Boom and Bust Years, 1997 – 2003.”
Statistic Canada – Catalogue no. 11-624-MIE, March 2005.

Van Ark, Inklaar and McGuckin, “The Contribution of ICT-Producing and ICT-Using Industries to Productivity Growth: A Comparison of Canada, Europe and the United States.”
Spring Volume of 2003.

Heidi Ertl and Chantal Vaillancourt, “Information and Technology Information- A Statistical profile of ICT sector”
Statistic Canada - Catalogue No. 56-506-XIE, Published in 2001.

C. Vaillancourt, “ A Profile of Employment in Computer and Telecommunication Industry.”
Statistic Canada – Catalogue No. 56F0004 MIE, Published in 2003.

Industry Canada, “Canadian, ICT Statistical Overview (ICTSO).” last updated October 2005.

The Daily, Statistic Canada, “Study: The information and communication technology sector through the boom and the bust years,” March 2, 2005.

The Daily, Statistic Canada, “Study: High-tech boom and bust,” April 17, 2002.

Michael W. Trethewa, “Enabling Canada’s Economic Potential: ICT and National Economic Performance,” Published in Year 2005.

OECD Report, “The Software Sector: A statistical Profile for Selected OECD Countries,” January 1998.

Walter Enders, “Applied Econometric Time Series,” published in 1995.

Whistler, White, Wong, Bates, “Shazam Econometric Software, User’s Reference Manual, Version 10,” Published in 2004.

Damodar N. Gujarati, “Basic Econometrics”, fourth edition, published in 2003.

Other articles read

Gury Gellatly, “The Canadian Economy in Transition: A guide to research on the new economy”
Statistic Canada: Catalogue no. 11-622-MIE, May 2003.

Martin Fransman, “The Telecoms boom and bust, 1996 – 2003 puzzles, paradoxes, and processing,” published in year 2003.

Mark Doms, “The Boom and Bust in Information Technology Investment,” Federal Reserve Bank of San Francisco, Year 2004.

Revenues and Other Financial Data

ICT Manufacturing
Annual Survey of Manufactures (ASM) (no 2103),
Catalogue no. 31-203, CANSIM Table 301-0003,

Software Publishers
Computer Systems Design and Related Services
Data Processing, Hosting and Related Services
Annual Survey of Software Development and Computer Services (no 2410),
Catalogue no. 63-222, CANSIM Table 354-0005,
Service Industries Division, Statistics Canada.

Telecommunications Services
From 1997 to 2003:
Annual Survey of Telecommunications Services (no 2722),
Catalogue no. 56-203 and/or 56-001, not available in CANSIM (terminated tables only),
Science, Innovation and Electronic Information Division, Statistics Canada.

EMPLOYMENT
ICT Manufacturing
Annual Survey of Manufactures (ASM) (no 2103),
Catalogue no. 31-203, CANSIM Table 301-0003,
Manufacturing, Construction and Energy Division, Statistics Canada.

GROSS DOMESTIC PRODUCT (GDP)
Special tabulations for Industry Canada,
Gross Domestic Product by Industry (no 1301),
Catalogue no. 15-001, CANSIM Tables 379-0017 and 379-0020,
Industry Measures and Analysis Division, Statistics Canada.

INTRAMURAL RESEARCH AND DEVELOPMENT (R&D) EXPENDITURES
Special tabulations for Industry Canada,
Survey on Research and Development in Canadian Industry (no 4201),
Catalogue no. 88-202 and/or 88-001, CANSIM Table 358-0001,
Science, Innovation and Electronic Information Division, Statistics Canada.

CAPITAL EXPENDITURES
Special tabulations for Industry Canada,
Survey on Capital and Repair Expenditures (no 2803),
Catalogue no. 61-205
Investment and Capital Stock Division, Statistics Canada.

TRADE
ICT Services
Canada's International Transactions in Services (no 1536),
Cat. no. 67-203, CANSIM Table 376-0033,
Balance of Payments Division, Statistics Canada.

Data for Forecasting
Database of ICT Investment and Capital Stock Trends: Canada vs United State**s**