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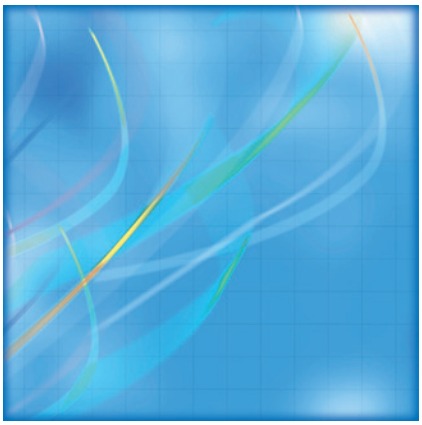
An Anatomy of Growth and Decline: High-tech Industries Through the Boom and Bust Years, 1997-2003



by Desmond Beckstead and W. Mark Brown

Micro-economic Analysis Division
18th floor, R.H. Coats Building, Ottawa, K1A 0T6

Telephone: 1 800 263-1136

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Ottawa, K1A 0T6
Statistics Canada

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How to obtain more information:
National inquiries line: 1-800-263-1136
E-mail inquiries: infostats@statcan.ca

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Abstract

This paper tracks the growth and decline of information and communications technology (ICT) industries that were synonymous with the so-called new economy boom of the late-1990s and its subsequent bust period in the early 2000s. The analysis focuses on the question of whether the ICT bust has been accompanied by a structural shift illustrated by less firm turnover. It shows that to date there is little evidence of a structural shift. Entry rates of new establishments within the ICT sector were above those of other sectors within the economy during both the ICT boom and bust. This is evidence that both firms and entrepreneurs continued to see opportunities to develop new products and markets even during a time of retrenchment. The location of the ICT sector also showed little evidence of a change.

Introduction

With dramatic increases in stock prices, output and employment, new economy industries in the 1990s established themselves as important drivers of economic growth. Seemingly as dramatic has been their decline, symbolized by the collapse of stock prices in 2000 on the high-tech laden NASDAQ exchange. It is now four years since the bursting of the high-tech bubble and we can begin to take stock of what has occurred.

This paper focuses on employment growth and decline within the information and communications technology (ICT) sector. This sector is composed of industries that analysts argue were at the epicentre of the so-called new economy boom of the 1990s and its post-2000 slump.[1]

The rapid growth of ICT industries through the 1990s is well documented[2] and increasingly so is their decline since 2000.[3] As we will describe in more detail below, the picture that emerges is that of a sector that has suffered significant losses of output and employment in 2001, most of which occurred in manufacturing. It is also evident that the downward trends in this sector's output and employment moderated in 2002 and 2003, even in manufacturing.

An important question that we now face is whether the decline in the ICT sector reflects a short-term downturn or a long-term structural shift. It may be that markets for ICT products and services have matured, implying the sector has undergone a structural shift towards a much slower pace of growth than that experienced through the 1990s. The significant issue then is whether or not there are telltale signs of a structural shift.

The role of the ICT sector as a source of employment growth in the 1990s cannot be underestimated. One out of every six new jobs over the decade was created in ICT industries. Moreover, in Canada's largest cities—Toronto, Montreal, Vancouver and Ottawa—ICT firms created four out of every ten new jobs gained during the 1990s.[4] Arguably, these large cities were attractive to ICT firms because their large diversified economies provided the needed variety of inputs that new industries require. If the ICT sector has begun to mature, it may have begun to turn away from these cities to find lower cost locations in Canada or abroad.

The objectives of this paper are, therefore, (1) to provide additional measures of the boom and bust in the ICT sector through the late 1990s and early 2000s, (2) to investigate whether its decline was merely a short-term restructuring or whether there has been a structural shift suggestive of longer-run changes, and (3) to determine how restructuring has affected employment in the cities that were at the centre of its growth in the 1990s.

The remainder of the paper is organized as follows. The next section outlines the data and methods used in the analysis. Following this, we outline the growth and decline of ICT through the late 1990s and early 2000s. This is followed by an analysis of the underlying dynamics of this period in order to provide some perspective on whether the decline in the ICT sector is merely a pause or a real structural shift. The last substantive section presents data on the growth and decline of the ICT sector across five urban and rural size classifications. The paper finishes with a brief conclusion.

Data

This analysis requires a database that is able to track ICT employment on an establishment by establishment basis through the late-1990s and into the early-2000s. In this section, we describe this database in detail, and provide a definition of the ICT sector.

The industrial classification that we use to define the ICT sector was developed by the Organization for Economic Co-operation and Development (OECD) and represents those industries that "electronically capture, transmit and display data and information."[5] This definition of the ICT sector is *output-based*; that is, it focuses on industries that are involved in the development, delivery and support of advanced technological products. In Canada, the ICT sector spans 19 individual industries—10 in manufacturing and 9 in services. The ICT manufacturing industries

> "… [m]ust be intended to fulfil [*sic*] the function of information processing and communication including transmission and display [and m]ust use electronic processing to detect, measure and/or record physical phenomena or to control a physical process."[6]

The ICT services industries

> "… must be intended to enable the function of information processing and communications by electronic means."[7]

Examples of ICT manufacturing include firms that operate in the electronic parts and components, and computing equipment industries. ICT services include, among other industries, firms in the computer services and telecommunications carriers industries.[8]

Our analysis requires establishment level data for the ICT sector, and the broader business sector. These data are obtained from Statistics Canada's Business Register (BR)—a comprehensive listing of all firms with employees in the Canadian economy.[9] The BR collects information from

businesses to derive a set of statistical entities for each firm, of which the statistical establishment is the most commonly used—it is a unit for which estimates of inputs and outputs (and hence, value added) can be measured. While large firms often maintain several establishments within their operating structure, the vast majority of firms, 91% of Canadian businesses, are organized as single-establishment firms.

The BR provides detailed information on the sales, employment, industry and geographic location of all establishments operating in Canada. Each establishment is assigned a 6-digit industry code.[10] This allows us to identify those establishments within a particular location that operate in ICT industries.[11] Because our analysis is based on a time series, we must ensure that the geographic treatment of different locations is consistent over time. Accordingly, we have applied Statistics Canada's 1996 Standard Geographical Classification to all establishments in all years.

An important part of our analysis is the measurement of ICT employment over time. A key concern is the ability of the BR to provide a timely, and therefore accurate, estimate of trends in ICT employment. The majority of business units that make up the BR are updated on a monthly basis, based on data from administrative sources. The largest and most complex businesses, however, are updated (profiled) less frequently. This means that our annual data are a weighted average of all firms, some of which have and have not been updated in a given year. However, as will become clear in the next section, there is evidence that the overall trend of industrial growth and decline is still captured by the aggregate numbers from the BR.

To ensure that the levels of employment from the BR are representative, we benchmarked its levels of employment to the total number of paid worker jobs in the total economy[12] for each year. This process also has the benefit of dampening what would otherwise be swings in the levels based on the periodic updating on the BR of large firms.

Comparing alternative measures of the growth and decline of ICT industries

This section seeks to provide a broad overview of trends within the ICT sector during the late 1990s and early 2000s and to place into context our estimates of ICT growth and decline derived from the Business Register. As we have noted above, the BR may tend to report a more muted ICT boom and bust than other non-administrative sources. Therefore, it is important to see how the BR estimates compare to other data sources.

We measure ICT growth and decline using output and two measures of employment (see Table 1). ICT output is measured using GDP in (1997) constant dollars. Employment is derived from the BR and the Labour Force Survey (LFS). Employment reported by the LFS is in Computers and Telecommunications or CT industries.[13] CT industries are a sub-component of the ICT sector that accounts for nearly 90% of ICT employment.[14]

All three measures of the ICT sector tell a similar story. The ICT sector experienced very strong output and employment growth through the late 1990s, but starting around the year 2000 it experienced a downturn that has resulted in employment levels that still remain below their peak. It is also evident, using employment or output, that the ICT sector's decline was concentrated in manufacturing. Services have only experienced a slowdown in output growth and, relative to manufacturing, more modest declines in employment (see Table 1).

Despite the broad similarities across the three measures evident in Table 1, there are differences that are worth noting. For example, the decline in the ICT sector was felt first in terms of output. Employment acted as a lagging indicator of the sector's decline, which is typical of most industries that experience a downturn. Since 2000, output growth has remained weak, reflecting a balance between generally declining ICT manufacturing output and growing ICT services output.

In terms of employment, there were similar levels and growth of employment during the 1990s for the BR-based ICT employment and LFS-based CT employment. Since 2000, the decline in CT employment was stronger than ICT employment, particularly for services. In part, this reflects the nature of the BR. The BR tends to lag other measures of employment, such as the LFS's CT measure, because of delays in reporting employment declines, particularly for larger business. Nevertheless, the BR appears to capture the essence of the ICT boom and its subsequent bust.

Table 1. ICT gross domestic product (GDP) and employment, 1997-2003

GDP and employment levels	1997	1998	1999	2000	2001	2002	2003
ICT GDP (millions)[a]	32,707	37,744	47,404	55,172	53,764	54,276	55,607
Manufacturing	8,233	9,788	13,681	18,158	13,454	11,419	11,476
Services	24,474	27,956	33,723	37,014	40,310	42,857	44,131
ICT Employment (,000)	411	433	476	532	546	536	529
Manufacturing	91	92	100	106	113	104	102
Services	320	341	376	426	433	432	427
CT Employment (,000)	416	463	487	533	552	511	484
Manufacturing	116	116	130	156	149	135	125
Services	301	347	357	377	403	376	359

GDP and employment change	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
ICT GDP (%)	15.4	25.6	16.4	-2.6	1.0	2.5
Manufacturing	18.9	39.8	32.7	-25.9	-15.1	0.5
Services	14.2	20.6	9.8	8.9	6.3	3.0
ICT Employment (%)	5.5	10.0	11.6	2.7	-1.8	-1.3
Manufacturing	1.0	9.0	5.6	6.4	-7.9	-2.3
Services	6.7	10.2	13.2	1.8	-0.3	-1.2
CT Employment (%)	11.4	5.2	9.3	3.6	-7.4	-5.4
Manufacturing	0.4	12.0	20.0	-4.5	-9.3	-7.4
Services	15.6	2.9	5.4	7.0	-6.7	-4.7

[a]GDP at basic prices (1997 constant dollars).
Source: Special tabulations of the Business Register, Labour Force Survey and CANSIM Table 379-0020

Dynamics of growth and decline

The question at hand is whether the recent pattern of growth and decline within the ICT sector is simply a short-run phenomenon or whether the downturn represents a structural break, with ICT firms entering a more mature, slower growth stage. To address this question we need to make reference to theory about how industries grow over time, specifically product life cycle theory.[15] In its more rudimentary form, product life cycle theory is based on the premise that new products follow a distinct growth or product life cycle. In the first stage, growth is slow as the product is first adopted. If the product becomes accepted, it will enter a second, high growth stage. In the third stage, the market matures and growth rates level off. Finally, in the fourth and final stage, sales decline as consumers switch to newer products.

Of course, the product life cycle is a broad generalization and there is no guarantee that all products will go through every stage of the process. Some may not make it past the first or second stages as they are eclipsed by new and better products, while others may not reach the fourth stage for a very long time if few alternatives emerge.

The ICT sector encompasses industries that are producing a wide variety of new products. During the 1990s, many of these products underwent a transition from the initial adoption phase of the product life cycle to the second high-growth stage.

If the ICT sector's recent decline represents a structural shift to a slower growth phase, the majority of its products would have entered the third, slower-growth stage of the product life cycle. Moreover, there would have to be relatively fewer new products under development that have the potential for strong growth in the future. If, on the other hand, the downturn in the sector is a short-run phenomenon and the sector is poised to return to a strong growth phase, then many of its products remain in the second stage of the product life cycle.

The actual behaviour of firms provides us with telltale signs of the stage in which an industry's products, on average, are found. If an industry's products are primarily in the first and second stage, considerable experimentation is taking place, with new and incumbent firms building new establishments at a rapid pace. Often, these new establishments fail, as unproven products and productions processes do not meet their initial promise. Therefore, during these two stages the industry should experience higher rates of establishment entry and exit than the average industrial sector. On the other hand, if the industry's products are maturing, then we would expect entry and exit rates to begin to match those of more mature sectors where there are fewer opportunities to develop new products or expand production. We turn therefore to examine entry and exit rates in the ICT sector.

In any year, a portion of establishments within an industry are new entries that were not present the year before. Similarly, a portion of establishments will exit by the next year. The proportion of employment found in exiting and entering establishments can, in part, be seen as a measure of how dynamic a sector is. A sector with a high degree of product experimentation will have relatively high rates of establishment entry and exit.

Figures 1 and 2 illustrate the rates of entry and exit[16] for the ICT sector relative to the non-ICT portion of the business sector (hereafter, the business sector), which is indexed to 100 for each year. Expressing entry and exit rates relative to the business sector serves two purposes. First, it allows us to eliminate the effect of cyclical fluctuation in the broader Canadian economy on entry and exit rates. Second, we have a frame of reference against which we can measure the rates of entry and exit in the ICT sector.

In both figures, we see evidence of the ICT sector's boom in the late 1990s and its post-2000 slump. During the years of rapid growth from 1998 to 2000, ICT entry rates increased from an index value of 125 to 144. As a consequence of the slowdown, entry rates fell during the post-2000 period to an index of 114 in 2002 (see Figure 1). Exit rates trended in the opposite direction to entry rates in response to the ICT sector's boom and bust. In the late 1990s, exit rates were relatively static, hovering at about 20% above the business sector's exit rates. After 1999, however, exit rates increased substantially (see Figure 2). By 2002, exit rates within the ICT sector were about 55% above those within the business sector.

Figure 1. Relative ICT entry rates, 1998-2003

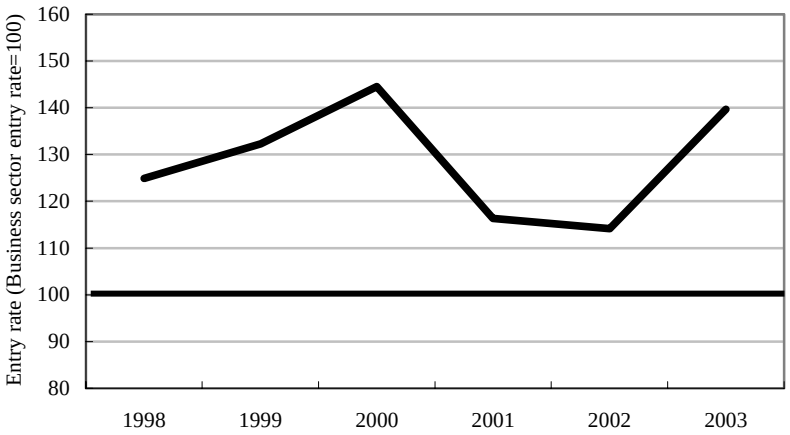
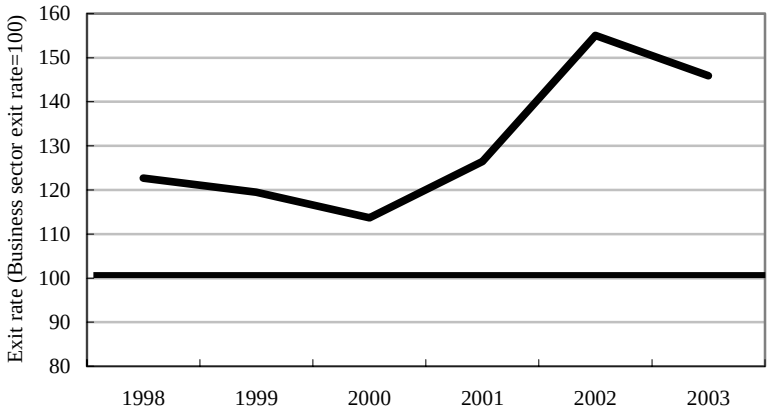


Figure 2. Relative ICT exit rates, 1998-2003



The most salient feature of Figures 1 and 2 is that entry and exit rates throughout the period remained well above that of the broader business sector. Exit rates in the ICT sector were much higher than in the business sector through the boom years of the late 1990s, possibly reflecting the high degree of experimentation taking place within this sector. Remarkably, entry rates remained relatively high through the depths of the ICT slump in 2001 and 2002. Therefore, even during a period of retrenchment, considerable investments were being made in new establishments by new and incumbent firms within the ICT sector.

As an aside, in addition to illustrating the ICT boom and bust, Figures 1 and 2 also give us signs of a potential ICT recovery. Entry rates in 2003 rebounded from their lows in 2001 and 2002. Exit rates, while remaining well above those experienced during the boom, fell for the first time since 2000.

As we noted in the last section, much of the ICT slump was driven by ICT manufacturing. ICT services were relatively unscathed. This means the relatively high post-2000 entry rates we report in Figure 1 may simply reflect the continued strength of the services part of the ICT sector, masking potentially very low relative rates of entry in ICT manufacturing. Furthermore, the high post-2000 exit rates may obscure even higher exit rates in ICT manufacturing.

To address these issues, we calculate entry and exit rates for ICT manufacturing and ICT services separately. As with aggregate ICT entry and exit rates, this requires a frame of reference against which entry and exit rates for ICT manufacturing and services can be compared. In this instance, entry and exit rates for ICT manufacturing and ICT services are indexed to their respective manufacturing and service sector aggregates[17] (see Table 2). This ensures that we are comparing entry and exit rates of firms within the same sector.

For both ICT manufacturing and ICT services, entry rates remained relatively high throughout the study period. For ICT manufacturing, this was true even in 2002 and 2003, years in which ICT manufacturing employment fell. Therefore, even though ICT manufacturing was harder hit than ICT services, it continued to experience rates of entry that were higher than the manufacturing sector as a whole.

The lesson to be taken from these results is that the ICT sector continues to attract a relatively large number of new entrants, even though it has undergone a considerable slowdown. This is inconsistent with a transition of the ICT sector from the early high growth phase into a slower growth stage.

Table 2. Relative entry and exit rates for ICT manufacturing and services

	1998	1999	2000	2001	2002	2003
	Index[a]=100					
Entry rates						
ICT manufacturing	104	186	116	168	121	187
ICT services	131	138	160	123	123	146
Exit rates						
ICT manufacturing	141	112	108	123	238	151
ICT services	122	128	121	139	151	155

[a]Entry/exit rates for manufacturing and services are indexed to 100 for each year.
Source: Special tabulation, Business Register

Growth and decline of the ICT sector across cities

During the 1990s, the ICT boom was primarily a big city phenomenon. ICT employment gains were concentrated in large urban centres—those over 1 million in population—and these gains accounted for 4 out of every 10 jobs created in these cities over the decade.[18]

Despite their higher costs, large cities provided attractive locations for ICT industries during the 1990s. Arguably, this was because large cities provide the diversity of labour, material and service inputs needed by ICT industries that were producing new types of products and employing new production techniques. In other words, these are places that are best suited to the development and production of products and services associated with the initial stages of their product cycle.[19] We ask here whether Canada's large cities are still as attractive a location for ICT employment.

One way to test this proposition is to see how ICT employment is shared across the rural-urban hierarchy and how these shares have changed over time. This requires us to define an exhaustive set of urban and rural classifications. We classify urban areas into two broad groups, census metropolitan areas (CMAs) and census agglomerations (CAs). The CMAs are divided further into three groups based on the size of their population: large CMAs with a population over 1 million (e.g., Toronto and Montreal); medium-sized CMAs with a population between 500,000 and 999,999 (e.g., Winnipeg and Edmonton); and small CMAs with a population between 100,000 and 499,999 (e.g., Halifax and Victoria). The remaining non-urban parts of Canada are classified simply as rural.

Consistent with our previous work,[20] the period running up to and including 2000 saw large CMAs increase their level and overall share of ICT employment (see Table 3). During this same period, medium-sized cities increased their level of ICT employment, but not their share. The levels and shares of ICT employment in smaller urban and rural classifications either declined or remained static. The effect of the post-2000 bust has been to halt the increasing share of ICT employment concentrated in large urban areas (see Table 3). There was a slight increase in the shares of ICT employment located in small CMAs, CAs and rural areas, but this was mainly the result of a declining share of employment in medium-sized CMAs.

In summary, although the increasing large-city share of ICT employment was arrested during the post-2000 period, we have not observed a general reversal of this trend. If there had been a change in the locational requirements of ICT industries towards lower cost Canadian locations over this period, we would have expected to have seen a more rapidly increasing share of ICT employment in smaller urban and rural areas.

Table 3. ICT employment across urban and rural size classes, 1997-2003

ICT employment (thousands)	1997	1998	1999	2000	2001	2002	2003
CMA-large	275	299	329	378	384	382	375
CMA-medium	56	58	67	69	73	66	62
CMA-small	46	40	44	47	49	48	50
CA	26	28	28	28	29	29	31
Rural	7	8	9	10	11	11	11
Total	411	433	476	532	546	536	529
ICT employment shares (%)	1997	1998	1999	2000	2001	2002	2003
CMA-large	67.0	69.0	69.1	71.0	70.4	71.2	71.0
CMA-medium	13.7	13.4	14.0	12.9	13.3	12.2	11.7
CMA-small	11.1	9.2	9.3	8.9	8.9	9.0	9.4
CA	6.4	6.5	5.8	5.2	5.4	5.4	5.8
Rural	1.8	2.0	1.9	1.9	2.0	2.1	2.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Special tabulation, Business Register

Conclusion

By almost all performance measures, the ICT sector during the 1990s 'punched above its weight'.[21] It was an important source of growth for the Canadian economy and especially the economies of Canada's largest cities. The essential question we have tried to answer is whether the decline of the ICT sector that began in 2000 is merely a pause or a structural shift to a much slower growth path.

We have relied on product life cycle theory to identify signs of a structural shift. If ICT firms have a larger than normal number of products and services in the early stages of their life cycle, we expect to see high rates of establishment entry and exit because of the considerable experimentation taking place during these stages. We also expect that during these early stages ICT firms will be attracted to large cities that provide the diversity of inputs that firms often require when developing new products.

During the late 1990s, we found evidence of a sector whose products were in the early stages of their product cycles. Entry and exit rates were above those of other industries in the business sector and employment was concentrating in Canada's largest cities.

The weight of the evidence in the post-2000 period suggests that, on average, the products of the ICT sector have not shifted towards the latter end of their life cycles. Despite the considerable retrenchment that took place over this period, entry rates remained well above average. Moreover, we have not observed a large shift in employment from larger to smaller, and presumably cheaper, urban and rural areas.

Appendix A: Defining the ICT sector

In the analysis, we define the ICT sector using industries that are part of the NAICS-1997 and NAICS-2002 industrial classifications. These are outlined in Table A1. NAICS-1997 is used for the years 1997 through 2001 and NAICS-2002 is used for the years 2002 and 2003.

Both industry-based definitions of the ICT sector have the same conceptual coverage. They differ only in the detail of the industry structure provided. Therefore, no bias is introduced by switching from the 1997 to the 2002 classification.

Table A1. ICT sector industries, NAICS-1997 and NAICS-2002

Manufacturing	***1997***	***2002***
Commercial and service industry machinery	333310	333310
Computer and peripheral equipment	334110	334110
Telephone apparatus	334210	334210
Radio and television broadcasting and wireless communications	334220	334220
Audio and video equipment	334310	334310
Semiconductor and other electronic components	334410	334410
Navigational and guidance instruments	334511	334511
Measuring, medical, and controlling devices	334512	334512
Communication and energy wire and cable	335920	335920
Services	***1997***	***2002***
Computer, computer peripheral and pre-packaged software	417310	417310
Electronic components, navigational and communications	417320	417320
Office and store machinery and equipment wholesaler-distributors	417910	417910
Software publishers	511210	511210
Cable and other program distribution	513220	517510
Wired telecommunications carriers	513310	517110
Wireless telecommunications carriers, except satellite	513320	517210
Telecommunications resellers	513330	517310
Satellite telecommunications	513340	517410
Other telecommunications	513390	517910
On-line information services	514191	
All other information services	514199	
Data processing services	514210	
Internet service providers		518111
Web search portals		518112
Data processing, hosting, and related services		518210
Office machinery and equipment rental and leasing	532420	532420
Computer systems design and related services	541510	541510
Electronic and precision equipment repair and maintenance	811210	811210

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Endnotes

1. For an overview of the impact of the ICT sector on productivity growth see Dachraoui, Harchaoui and Tarkhani (2003).
2. See Beckstead and Gellatly (2003). See also Ertl (2001) and Ertl and Vaillancourt (2001).
3. See Bowlby (2003). See also Statistics Canada (2003) and Vaillancourt (2003).
4. See Beckstead et al. (2003).
5. See Ertl (2001).
6. See OECD (2000).
7. See OECD (2000).
8. For a list of individual industries, see Appendix A.
9. It is this data source that allows accurate sample frames to be drawn for Statistics Canada's business survey program. While the agency has long had a centralized Business Register, this was traditionally supplemented with specialized lists that were used to support specific survey programs. Beginning in the late 1980s, many of these data sources were integrated into the central Business Register, thereby increasing its coverage of the business population. In support of this strategy, additional resources were devoted to maintaining the database. As a result, the Business Register now offers, in a single location, an extremely comprehensive picture of Canadian businesses (see Baldwin et al., 2000). Both employer businesses and non-employers are included in the file, but for this study, only employers were in scope, be they incorporated or unincorporated.
10. These industry codes are based on the 1997 North American Industrial Classification System (NAICS) for 1997 to 2001 and the 2002 NAICS for 2002 to 2003.
11. The specification for ICT industries exists for both the 1997 NAICS and the 2002 NAICS. The latter provides for some additional detail for some industries that are a part of ICT. This update has no effect on the measurement of the ICT aggregate or its components as identified in this study.
12. The data series for paid worker jobs are provided by Statistics Canada's Productivity Accounts, and can be found in CANSIM table 383-0009. For a more detailed description of the benchmarking procedure, see Beckstead et al. (2003).
13. For this study, data from the Labour Force Survey (LFS) excludes self-employed workers. This provides an estimate that corresponds as close as possible to that of the BR. The only distinction between the two sources is that the BR provides a job count while the LFS provides a count of individuals. The two estimates will differ only to the extent that individuals hold more than one job.
14. See Bowlby and Langlois (2002). Also see Vaillancourt (2003).
15. See Klepper (1996) for a theoretical discussion and Vernon (1966) for a discussion of the influence of the product cycle on international trade and the location of industry.
16. Entry and exit rates are measured in terms of the total employment in entering/exiting establishments.
17. The manufacturing and services reference sectors exclude ICT manufacturing and ICT services, respectively. This ensures that we are comparing the entry and exit rates of two mutually exclusive groups. Also note that public sector services (public administration, education and health care and social assistance) have been excluded from the service sector aggregate.
18. See Beckstead et al. (2003).
19. See Duranton and Puga (2001).
20. See Beckstead et al. (2003).
21. See Beckstead and Gellatly (2003).