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Life After the High-tech Downturn: Permanent Layoffs and Earnings Losses of Displaced Workers

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Abstract

The high-tech sector was a major driving force behind the Canadian economic recovery of the late 1990s. It is well known that the tide began to turn quite suddenly in 2001 when sector-wide employment and earnings halted this upward trend, despite continued gains in the rest of the economy. As informative as employment and earnings statistics may be, they do not paint a complete picture of the severity of the high-tech downturn. A decline in employment may result from reduced hiring and natural attrition, as opposed to layoffs, while a decline in earnings among high-tech workers says little about the fortunes of laid-off workers who did not regain employment in the high-tech sector. In this study, I use a unique administrative data source to address both of these gaps in our knowledge of the high-tech downturn. Specifically, the study explores permanent layoffs in the high-tech sector, as well as earnings losses of laid-off high-tech workers. The findings suggest that the high-tech downturn resulted in a sudden and dramatic increase in the probability of experiencing a permanent layoff, which quadrupled in the manufacturing sector from 2000 to 2001. Ottawa–Gatineau workers in the industry were hit particularly hard on this front, as the permanent layoff rate rose by a factor of 11 from 2000 to 2001. Moreover, laid-off manufacturing high-tech workers who found a new job saw a very steep decline in earnings. This decline in earnings was well above the declines registered among any other groups of laid-off workers, including workers who were laid off during the 'jobless recovery' of the 1990s. Among laid-off high-tech workers who found a new job, about four out of five did not locate employment in high-tech, and about one out of three moved to another city. In Ottawa–Gatineau, about two in five laid-off high-tech workers left the city.

Keywords: high-tech, permanent layoffs, earnings losses.

Executive summary

The high-tech sector was a major force behind the Canadian economic recovery of the late 1990s. The bubble burst in 2001, however, when sector-wide employment and earnings halted this upward trend, despite continued gains in the rest of the economy. As informative as employment and earnings statistics may be, they do not paint a complete picture of the severity of the high-tech downturn. A decline in employment may result from reduced hiring and natural attrition (as opposed to layoffs), while a decline in earnings among high-tech workers says little about the fortunes of laid-off workers who did not regain employment in the high-tech sector. In this study, I address both of these gaps in our knowledge of the high-tech downturn by examining permanent layoffs in the high-tech sector, as well as earnings losses of laid-off high-tech workers.

To do so, I use a unique administrative data source containing information on workers who were laid off from firms and their earnings following the layoff. The findings suggest that the high-tech downturn resulted in a sudden and dramatic increase in the probability of experiencing a permanent layoff, which quadrupled in the manufacturing sector (from 1.9% in 2000 to 7.7% in 2001). Ottawa–Gatineau workers in the industry were hit particularly hard on this front, as the permanent layoff rate rose from 1.5% in 2000 to 16.0% in 2001. In the services sector, the permanent layoff rate almost doubled nationally, from 2.2% in 2000 to 4.2% in 2001.

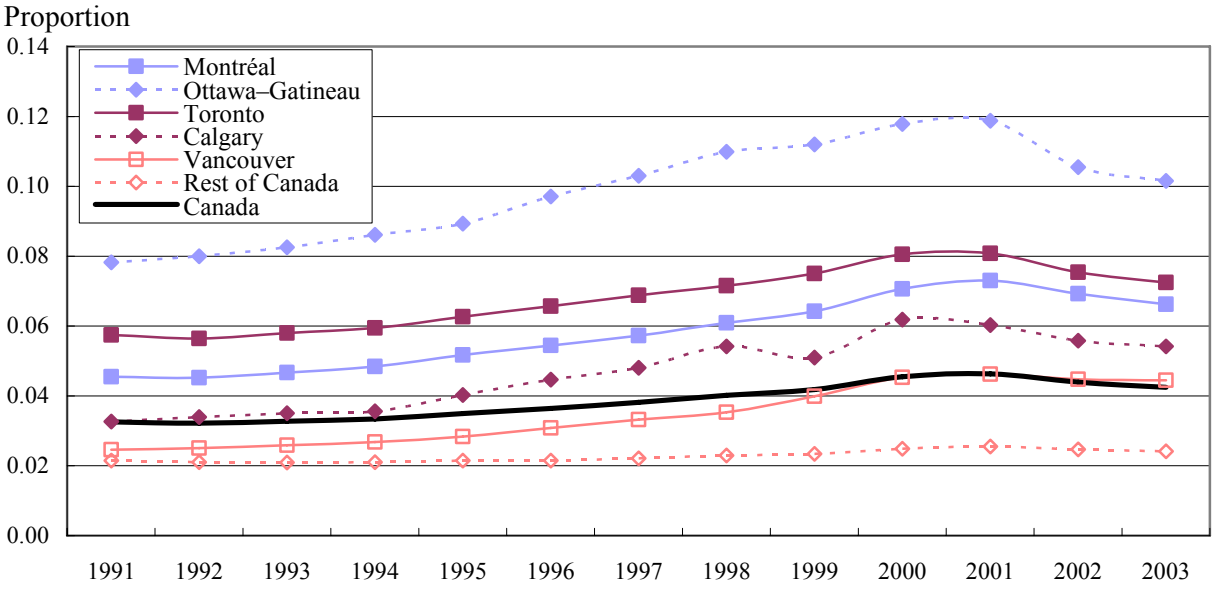
Moreover, laid-off manufacturing high-tech workers who found a new job saw a very steep decline in earnings. Specifically, workers who were laid off from their manufacturing high-tech jobs in 2001 saw a decline of $11,700 in earnings over the period from 2000 to 2003. By contrast, their co-workers who did not lose their jobs at this time saw an increase of $12,900 (a difference of $24,600). This decline in earnings was well above the declines registered among any other group of laid-off workers, including workers who were laid off during the 'jobless recovery' of the 1990s.

In addition to the economic consequences of experiencing a permanent layoff and suffering a loss of earnings, the high-tech downturn affected workers in other ways. Among laid-off high-tech workers, about four out of five did not locate employment in high-tech, and about one out of three moved to another city. In Ottawa–Gatineau, about two in five laid-off high-tech workers left the city. Mantler et al. (2005) conducted a survey of employed and unemployed high-tech workers during the downturn (in fall 2001 and winter 2002). Not surprisingly, they found that unemployed high-tech workers reported higher levels of stress than employed high-tech workers.

1. *Introduction*

It has been well documented that the high-tech sector was a leader in the Canadian economic recovery of the second half of the 1990s.[1] In 1991, the high-tech sector accounted for 3.3% of the Canadian paid workforce (Figure 1). The sector expanded at a faster pace than the rest of the economy during the 1990s, eventually representing 4.5% of the workforce in 2000. Much of this increase was fuelled by explosive growth in the Ottawa–Gatineau high-tech sector. Prior to the high-tech boom (in 1991), Ottawa–Gatineau led the country with 7.8% of its workforce employed in the high-tech sector. By 2000, the proportion jumped to 11.8%.

Figure 1
Proportion of workers in computer and telecommunications, by city

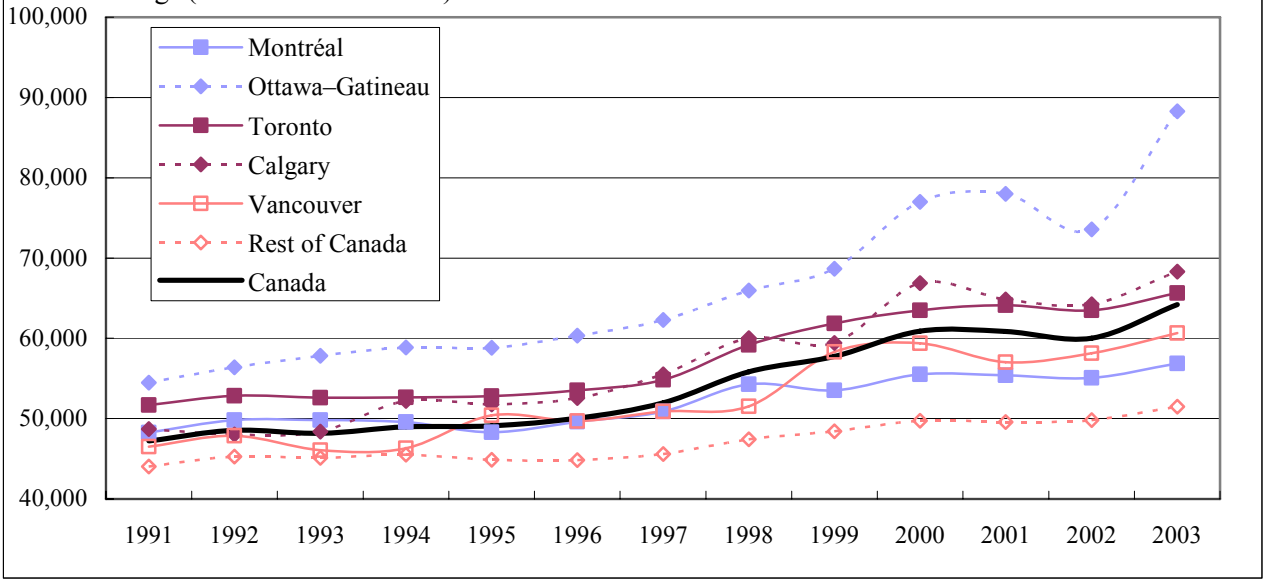


Source: Statistics Canada, Longitudinal Worker File.

As demand was increasing for high-tech workers, so too were real earnings in the industry. From 1991 to 2000, average high-tech earnings rose from $48,000 to $58,900, in 2003 constant dollars (Figure 2), while those in the rest of the economy grew at a much slower pace (numbers not shown below). In Ottawa–Gatineau, high-tech workers saw dramatic increases in real earnings, ranging from $54,500 in 1991 to $77,000 in 2000.

1. The high-tech sector is defined as computer and telecommunications (CT) industries in this study. See the Methodology section for more details.

Figure 2
Mean earnings of workers in computer and telecommunications, by city
Mean earnings (2003 constant dollars)



Source: Statistics Canada, Longitudinal Worker File.

The high-tech tide began to turn quite suddenly in 2001, when the sector experienced a downturn. Despite the fact that major news headlines periodically noted large-scale layoffs, the only statistical evidence of a downturn, from the workers' point of view, relates to overall employment numbers and average earnings in the sector.[2] In Figure 1, we see that the share of employment in the high-tech sector began to stabilize in 2001 and contracted shortly thereafter. Nationally, high-tech employment accounted for 4.2% of the overall workforce in 2003, compared with 4.6% in 2001. Once again, the Ottawa–Gatineau high-tech sector led the way with a sharp decline in its share of employment: from 11.9% in 2001 to 10.2% in 2003. In terms of earnings, no substantial declines were registered at the national level, which is still consistent with a downturn, given the downward rigidity of nominal wages and the modest inflation at the time. Despite these factors, high-tech workers in Ottawa–Gatineau still saw a substantial decline in average earnings from 2001 ($78,000) to 2002 ($73,600). Average earnings in the region's high-tech sector rebounded quickly, however, reaching $88,300 in 2003.

Although these numbers suggest an important reversal in the sector, they may leave the impression that the sector simply ceased to grow (with the exception of the Ottawa–Gatineau high-tech sector, which contracted at the time). In the aggregate, this may be true; however, little can be said about how many workers were actually affected by the downturn. For example, overall employment in a sector can decline as a result of reduced hiring and natural attrition. If there was a substantial number of layoffs (which is not apparent in the aggregate employment numbers), average earnings among high-tech workers say nothing about the fortunes of laid-off high-tech workers who had to find a new job, possibly in a different sector. The well-being of laid-off high-tech workers is of particular concern, given the rapid growth of 'technology clusters' (Jackson and Khan 2003). In a technology cluster, employment opportunities may be limited for workers outside of high-tech (i.e., those who are not engineers, computer scientists, consultants, etc.) In a downturn, however,

2. See Bowlby and Langlois (2002), Bowlby (2003) and Vaillancourt (2003) for some documented evidence.

technology clusters may not have the infrastructure in place to accommodate a sudden onset of laid-off high-tech workers who are seeking employment.

This study seeks to answer two questions related to the severity of the high-tech downturn from the workers' perspective. First, how likely were high-tech workers to face permanent layoffs during the downturn, relative to other industries and time periods (including the recession of the early 1990s)? Second, how substantial were the earnings losses of laid-off high-tech workers, again relative to other industries and time periods? To answer these questions, I use a unique administrative data source containing information on workers who were laid off from firms and their earnings following the layoff.

The findings suggest that the high-tech downturn resulted in a sudden and dramatic increase in the probability of experiencing a permanent layoff, quadrupling in the manufacturing sector in 2000 and 2001. Ottawa–Gatineau workers in the industry were hit particularly hard on this front, as the permanent layoff rate rose by a factor of 11 from 2000 to 2001. High-tech firms in the service industry saw a more moderate increase in permanent layoffs. The results also demonstrate that laid-off manufacturing high-tech workers who found a new job saw a very steep decline in earnings. The decline in earnings was well above the declines registered among any other group of laid-off workers, including workers who were laid off during the 'jobless recovery' of the 1990s. Among high-tech workers who were laid off during the high-tech downturn but who found a new job, about four out of five did not locate employment in high-tech, and about one out of three moved to another city. In Ottawa–Gatineau, about two in five laid-off high-tech workers left the city.

In the next section, I describe the unique administrative data source and methods that are used to track a large sample of laid-off high-tech workers. This is followed by a statistical description of laid-off and non-laid-off workers by industry. I then present descriptive and econometric evidence on permanent layoffs, as well as the earnings of laid-off workers in the following section. The study concludes in the final section.

2. Methodology

The data requirements for the study are quite substantial. First, one needs to be able to identify high-tech workers. Second, one needs to be able to identify workers who have been permanently laid off. Third, the sample of laid-off high-tech workers must be large enough for analysis. Fourth, the data need to be longitudinal in order to follow laid-off workers. Fifth, the data must have information on earnings of workers, as well as a sufficient amount of worker and firm characteristics.

Given that the high-tech sector makes up less than 10% of the Canadian economy, and that information on the reasons for separation is rarely available in large data sources, it should come as no surprise that virtually all Canadian data sources containing the appropriate information are much too small for the required level of detail. The one exception is the Longitudinal Worker File (LWF). The LWF is constructed from the following four administrative data sources:

- The Record of Employment (ROE) file: the *Employment Insurance Act* requires every employer to issue a ROE when an employee working in insurable employment has an interruption in earnings. For the purposes of this study, the ROE indicates whether or not a worker was laid off from a firm due to shortage of work (whether or not the firm closed).

- The T4 file: virtually all workers must receive a T4 slip from their employer to help them file their income-tax return. Included on this file are the earnings of workers in each job (defined as a firm in which the worker was employed during a given year), as well as the postal code of the worker. The postal code is used in this study to determine the city of residence—census metropolitan area (CMA)—with the help of the Postal Code Conversion File Plus (PCCF +). Throughout the study, the cities of residence (or cities) are Montréal, Ottawa–Gatineau, Toronto, Calgary and Vancouver; "rest of Canada" has been included as a residual category for comparison purposes.
- The T1 file: this includes information on age and sex of the worker.
- The Longitudinal Employment Analysis Program (LEAP): this file contains company-level data on industry and the number of workers in the firm (or firm size). The four-digit North American Industry Classification System (NAICS) for 2002 is available beginning in 1991 on the file, which allows us to identify the computer and telecommunications (CT) sector. Although the term 'high-tech' is generally associated with the information and communication technology (ICT) sector, one needs five-digit NAICS to fully identify the sector. Nevertheless, computer and telecommunications is an important sub-sector of the ICT sector, comprising approximately 88% of its workforce.[3] See Bowlby and Langlois (2002) for more details on the CT sector. Firm size must be approximated since the data are annual and not all workers spend the entire year within the same firm. The number of workers is estimated by dividing the total annual payroll of the firm by the average T4 earnings of all workers in the same industry and province of that firm.

The ROE, T4 and T1 files were linked by the Social Insurance Number (SIN) for each year from 1983 to 2003, inclusive. This file was then linked to LEAP by a company identifier (i.e., the payrolls deduction account number prior to 1997, and the business number from 1997 onwards), which is available on the ROE, the T4 and LEAP. The LWF is a 10% random sample of all employees in this linked file, based on the last digit of the SIN. In any given year, selected persons will appear more than once in the file if they have more than one job (i.e., they worked for more than one employer). Once persons are selected in the sample, they remain in it as long as they are in the paid workforce and the last digit of their SIN doesn't change.[4] If workers become self-employed without a paid job in a given year, they leave the sample.

The first set of results pertains to the probability of experiencing a permanent layoff in year t, which we shall call the year of a potential permanent layoff (i.e., the year when a permanent layoff, or lack thereof, is observed). The sample consists of workers aged 25 to 49 in the year prior to a potential permanent layoff (year $t - 1$). Older workers are excluded, since they may contemplate retirement following a permanent layoff. Younger workers are excluded, since they may simply return to

3. The North American Industry Classification System industries included in the computer and telecommunications sector are Commercial and service industry machinery (3333); Computer and peripheral equipment (3341); Communications equipment (3342); Audio and video equipment (3343); Semiconductor and other electronic components (3344); Navigational, measuring, medical and control instruments (3345); Computer and communications equipment and supplies wholesaler-distributors (4173); Software publishers (5112); Telecommunications (517); Internet service providers, web search portals, and data processing services (518); Computer systems design and related services (5415); and Electronic and precision equipment repair and maintenance (8112).

4. In most instances, a change in Social Insurance Number (SIN) occurs when a temporary resident wishes to work in Canada and is issued a temporary SIN, and subsequently becomes a permanent resident and is issued a permanent SIN.

school if they lose their jobs. Since workers may have more than one job in any given year, I only consider workers to be at risk of a permanent layoff from their main job. The main job is defined as the one which generated the highest T4 earnings in the year. In the event of a tie, one of the jobs is chosen at random. A permanent layoff occurs when a worker is laid off from his or her main job and does not return to the same employer in the same or following year. Since a layoff may occur early in the year, it is possible that, by construction, many workers could not get laid off from their main job in the current year (since earnings from that job would be relatively low). Therefore, I restrict permanent layoffs to occur only if they pertain to the worker's main job in the previous year. As a result of these criteria, this study is more focused on significant jobs than other studies that have reported permanent layoff rates. This results in lower permanent layoff rates than what is usually reported. For example, Morissette (2004) reports that the overall permanent layoff rate among all jobs generally varies between 6% and 7%. In the current study, the overall permanent layoff rate is usually around 3%.

I also report the change in earnings between year $t - 1$ and year $t + 2$ (i.e., before and after the year of the potential permanent layoff). Whether workers were permanently laid off in year t or not, I only select those with positive earnings in year $t + 2$. For workers who were not permanently laid off in year t, I also restrict the sample to those who kept the same main job in years $t - 1$ to $t + 2$ (inclusive). Although workers are only at risk of experiencing a permanent layoff in their main job, I report pre- and post-layoff earnings from all jobs held. The table below may help to better visualize the sample design.

Year	$t-1$	t	$t+2$
Sample selection	All workers aged 25 to 49 in their main job	Permanent layoff (from main job in $t-1$)	Positive earnings (from all jobs)
		No permanent layoff (from main job in $t-1$)	Positive earnings (from all jobs) and same main job from $t-1$ to $t+2$

For each cohort of workers at risk of losing their main job in year t, I estimate two types of models. The first is a probit model on the probability of experiencing a permanent layoff (*PLO*) in year t, expressed as a function of several characteristics from year $t - 1$: the industry of the main job (*IND*), firm size in the main job (*SIZE*), total earnings from all jobs (*EARN*), a female dummy variable (*FEM*), age and age squared (*AGE* and AGE^2), and the city of residence (*CITY*). Workers are divided into six industries, based on NAICS 2002: primary industries, construction, manufacturing (excluding CT), manufacturing (CT), services (excluding CT), and services (CT).

$$(1) \qquad \Pr(PLO_{i,t} = 1) = \Phi(\alpha_0 + \alpha_1 IND_{i,t-1} + \alpha_2 SIZE_{i,t-1} + \alpha_3 EARN_{i,t-1} + \alpha_4 FEM_i + \alpha_5 AGE_{i,t-1} + \alpha_6 AGE^2_{i,t-1} + \alpha_7 CITY_{i,t-1} + \varepsilon_i)$$

In the second model, which is estimated by ordinary least squares (OLS), the absolute change in earnings ($\Delta EARN$) is a function of similar variables, except that the industry variables are interacted with a dummy variable indicating a permanent layoff. The change in earnings is defined as earnings in period $t + 2$ minus earnings in period $t - 1$. Note that other than the permanent layoff variable, only characteristics in period $t - 1$ are included, since I am interested in the unconditional earnings

impact of a permanent layoff. In other words, if one of the consequences of a permanent layoff is a higher probability of landing a job in a low-paying industry, that consequence becomes part of the total earnings impact.

$$\Delta EARN_{i,t-1,t+2} = \beta_0 + \beta_1 IND_{i,t-1} + \beta_2 PLO_{i,t} + \beta_3 IND_{i,t-1} * PLO_{i,t} + \beta_4 SIZE_{i,t-1} + \beta_5 EARN_{i,t-1} + \beta_6 FEM_i + \beta_7 AGE_{i,t-1} + \beta_8 AGE^2_{i,t-1} + \beta_9 CITY_{i,t-1} + \mu_i \quad (2)$$

3. Sample description

Most of the analysis will focus on outcomes for workers who were potentially laid off in three distinct years: 1992 (at the end of the general recession and the beginning of the 'jobless recovery'), 1997 (at the beginning of a rapid growth period) and 2001 (at the beginning of the high-tech downturn, despite continued growth in the rest of the economy). In Table 1, I describe the sample by showing the means of the explanatory variables used in the econometric models and the sample size for all three periods combined and for each of the six industries. The numbers actually refer to the year prior to the potential permanent layoff.

I first compare all workers 'at risk of a permanent layoff' by industry. High-tech workers are generally employed in larger firms than other workers. Not surprisingly, high-tech workers have higher earnings than non-high-tech workers. High-tech is also male dominated, but this is true also in other industries except non-CT services. On average, high-tech workers are about one year younger than other workers. Finally, high-tech workers are far more likely to reside in major centres (especially Ottawa–Gatineau) than other workers.

Compared with high-tech workers who kept their job, laid-off high-tech workers are more likely to have been employed in small firms, although this is also the case in other industries. Laid-off high-tech workers also earned less than high-tech workers who were not laid off, although once again, this is true in other industries. Women in high tech were as likely to experience a permanent layoff as their male counterparts. Laid-off high-tech workers are slightly younger than high-tech workers who kept their job, but this holds true in all other industries. Finally, laid-off high-tech workers are far more likely to reside in Ottawa–Gatineau than non-laid-off high-tech workers, especially in manufacturing. This was generally not the case in other industries.

To the extent that these characteristics may have an influence on the probability of experiencing a permanent layoff, or on the earnings losses associated with that permanent layoff, it is important to account for these differences in comparing the experiences of workers in high-tech with those of other workers, and when comparing workers who were laid off with those who were not.

Table 1
Means of the explanatory variables

	Primary			Construction			Manufacturing (excluding CT)		
	At risk of permanent layoff	No permanent layoff and same main job	Permanent layoff	At risk of permanent layoff	No permanent layoff and same main job	Permanent layoff	At risk of permanent layoff	No permanent layoff and same main job	Permanent layoff
Firm size<20	0.399	0.284	0.534	0.510	0.469	0.466	0.110	0.069	0.207
20<=Firm size<100	0.177	0.155	0.216	0.279	0.311	0.293	0.202	0.170	0.281
100<=Firm size<500	0.132	0.125	0.128	0.115	0.124	0.127	0.210	0.210	0.211
Firm size>=500	0.292	0.436	0.122	0.097	0.096	0.114	0.479	0.551	0.301
Earnings<$50,000	0.691	0.528	0.873	0.802	0.695	0.833	0.711	0.629	0.879
$50,000<=Earnings<$100,000	0.261	0.400	0.120	0.185	0.284	0.161	0.266	0.344	0.114
Earnings>=$100,000	0.048	0.073	0.008	0.013	0.022	0.006	0.023	0.027	0.007
Male	0.776	0.799	0.777	0.884	0.870	0.921	0.710	0.737	0.677
Female	0.224	0.201	0.223	0.116	0.130	0.079	0.291	0.263	0.324
Age	36.40	37.53	35.60	35.98	36.71	35.98	36.69	37.44	35.92
Montréal	0.017	0.017	0.017	0.084	0.091	0.089	0.129	0.120	0.143
Ottawa–Gatineau	0.005	0.005	0.004	0.032	0.037	0.032	0.012	0.009	0.026
Toronto	0.040	0.039	0.020	0.114	0.128	0.099	0.178	0.169	0.171
Calgary	0.077	0.082	0.030	0.036	0.035	0.025	0.022	0.018	0.021
Vancouver	0.029	0.023	0.031	0.063	0.056	0.062	0.047	0.041	0.060
Rest of Canada	0.833	0.834	0.898	0.672	0.654	0.693	0.613	0.643	0.580
Sample size	74,792	32,653	4,645	123,289	41,484	11,940	421,384	249,112	13,562

	Manufacturing (CT)			Services (excluding CT)			Services (CT)		
	At risk of a permanent layoff	No permanent layoff and same main job	Permanent layoff	At risk of a permanent layoff	No permanent layoff and same main job	Permanent layoff	At risk of a permanent layoff	No permanent layoff and same main job	Permanent layoff
Firm size<20	0.074	0.052	0.093	0.209	0.133	0.402	0.142	0.088	0.303
20<=Firm size<100	0.128	0.116	0.129	0.157	0.124	0.205	0.170	0.122	0.305
100<=Firm size<500	0.172	0.165	0.151	0.131	0.124	0.122	0.153	0.119	0.202
Firm size>=500	0.627	0.667	0.627	0.502	0.619	0.271	0.535	0.671	0.189
Earnings<$50,000	0.547	0.459	0.662	0.791	0.711	0.934	0.559	0.488	0.724
$50,000<=Earnings<$100,000	0.369	0.443	0.260	0.193	0.270	0.061	0.372	0.445	0.229
Earnings>=$100,000	0.085	0.098	0.078	0.016	0.019	0.005	0.069	0.067	0.048
Male	0.668	0.678	0.602	0.443	0.445	0.488	0.594	0.573	0.606
Female	0.332	0.322	0.398	0.557	0.555	0.512	0.407	0.427	0.394
Age	35.86	36.40	35.30	36.60	37.71	35.58	35.75	36.52	34.72
Montréal	0.171	0.175	0.143	0.117	0.118	0.127	0.175	0.176	0.151
Ottawa–Gatineau	0.150	0.161	0.245	0.043	0.048	0.031	0.076	0.069	0.089
Toronto	0.279	0.279	0.209	0.153	0.147	0.120	0.280	0.269	0.282
Calgary	0.044	0.042	0.052	0.034	0.030	0.028	0.041	0.029	0.057
Vancouver	0.045	0.039	0.052	0.069	0.067	0.065	0.061	0.047	0.115
Rest of Canada	0.312	0.305	0.299	0.584	0.589	0.628	0.367	0.410	0.306
Sample size	31,301	17,962	1,424	1,851,482	1,013,920	43,308	67,079	32,254	1,943

Notes: The explanatory variables correspond to the year prior to the potential permanent layoff, for the years 1991, 1996, and 2000.
Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

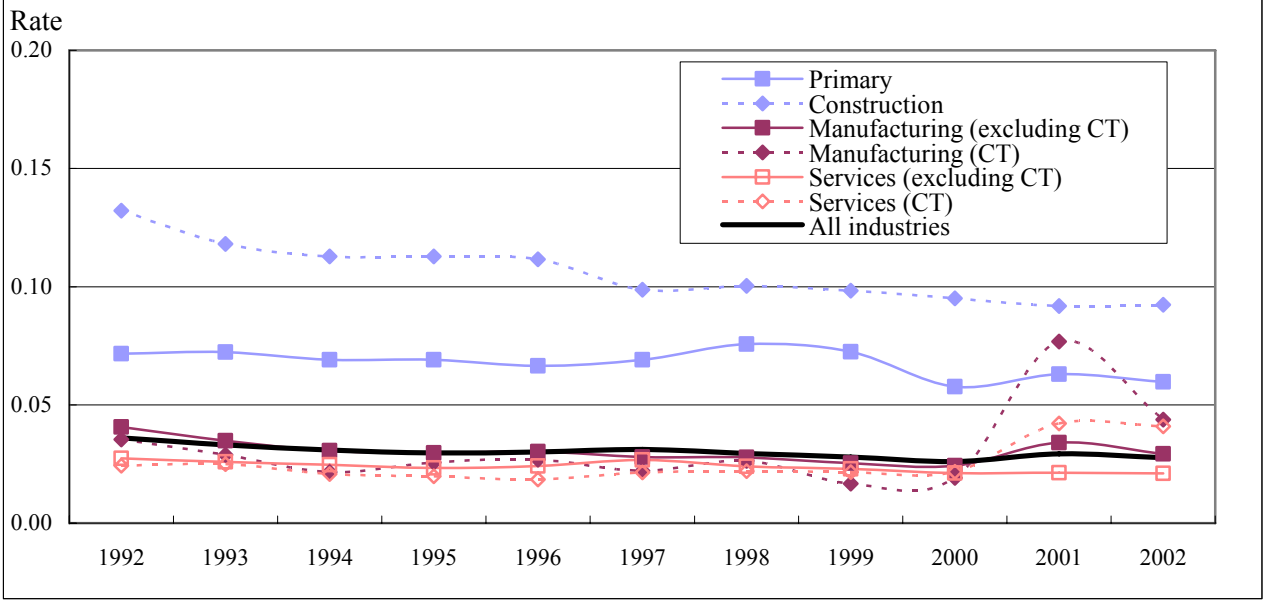
4. Results

4.1 Permanent layoff rates in the high-tech sector

4.1.1 Descriptive evidence

Focusing on a much less restrictive sample than is the case in this study, Morissette (2004) reports that the permanent layoff rate rose from about 6% during the peak of the economic cycle in the late 1980s to about 7% during the recession of the early 1990s.[5] Our data on permanent layoffs begin in 1992, which was at the tail end of the economic recession and at the beginning of the jobless recovery. Since the focus in this study is on significant jobs (see the Methodology section), the permanent layoff rate was only about 4% in the entire economy in 1992 (Figure 3). Workers in computer and telecommunications (CT) faced a similar probability of experiencing a permanent layoff at this time. Layoff rates were highest in construction, followed by primary industries. Over the remainder of the decade, permanent layoff rates declined slowly in most industries as the economy picked up steam.

Figure 3
Permanent layoff rate, by industry, Canada, 1992 to 2002



Notes: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

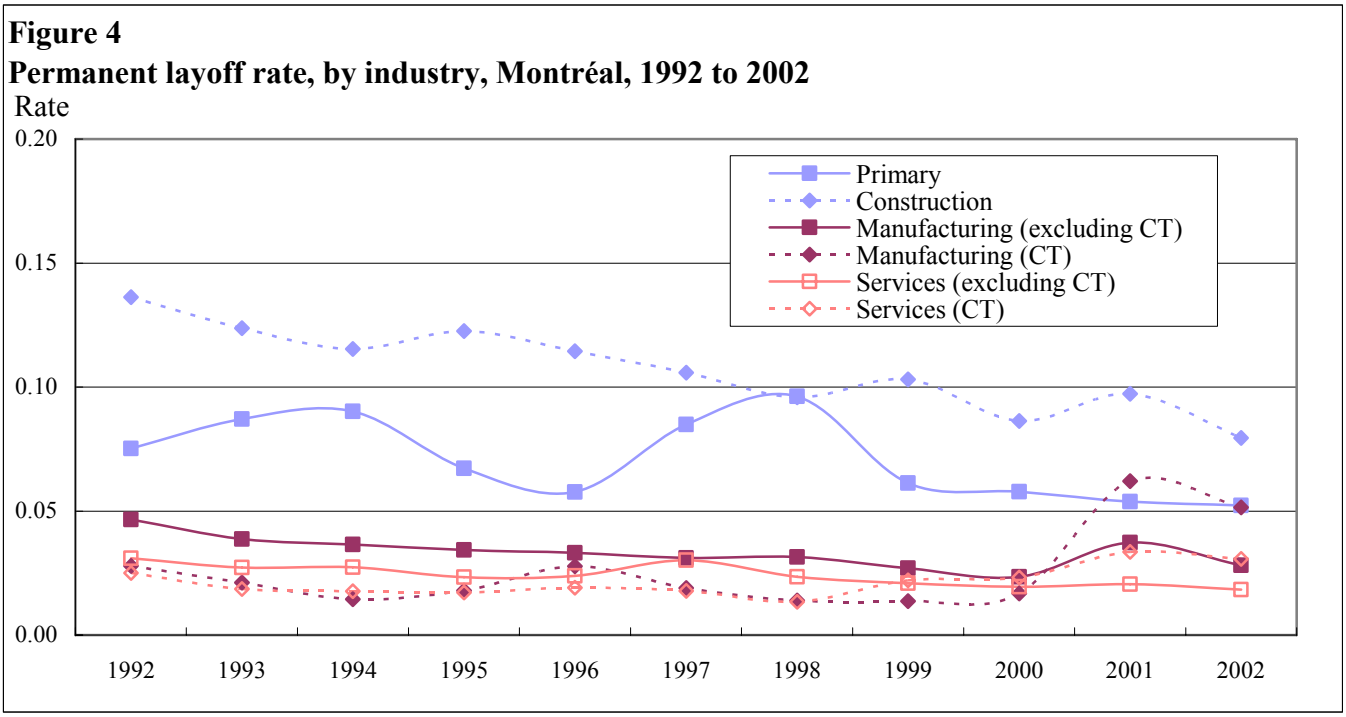
The relative stability of permanent layoff rates came to an abrupt end in 2001. First, non-CT manufacturing saw a sudden jump in its permanent layoff rate from 2.4% in 2000 to 3.4% in 2001.

5. The permanent layoff rate tends to be relatively stable over the business cycle, since firms often invest considerable amounts of time and money into recruiting and training new workers, thus raising the costs of replacing laid-off workers once the economy recovers. Moreover, training is often firm specific, making workers more productive from their current firms' perspective relative to other firms. This allows firms to recover part of their training costs by offering wages below the marginal product of workers who were trained (but above their own marginal product) in other firms, thus leaving some room for productivity to fall during a downturn before issuing layoff notices.

As abrupt a reversal as this may have been, its magnitude was dwarfed by the increase registered in the CT sector. The permanent layoff rate in the high-tech manufacturing sector more than quadrupled in the span of one year, going from 1.9% in 2000 to 7.7% in 2001. In 2002, high-tech manufacturing workers still faced a relatively high probability of experiencing a permanent layoff (4.4%). In high-tech services, the permanent layoff rate almost doubled, going from 2.2% in 2000 to 4.2% in 2001. Historically, the increases in the permanent layoff rates associated with the high-tech downturn were unprecedented in the 6 industries and 11 years examined here. Furthermore, Morissette (2004) looks at the period from 1983 to 1999 for the economy as a whole, and does not find any instance where the permanent layoff rate rose in such a dramatic manner.

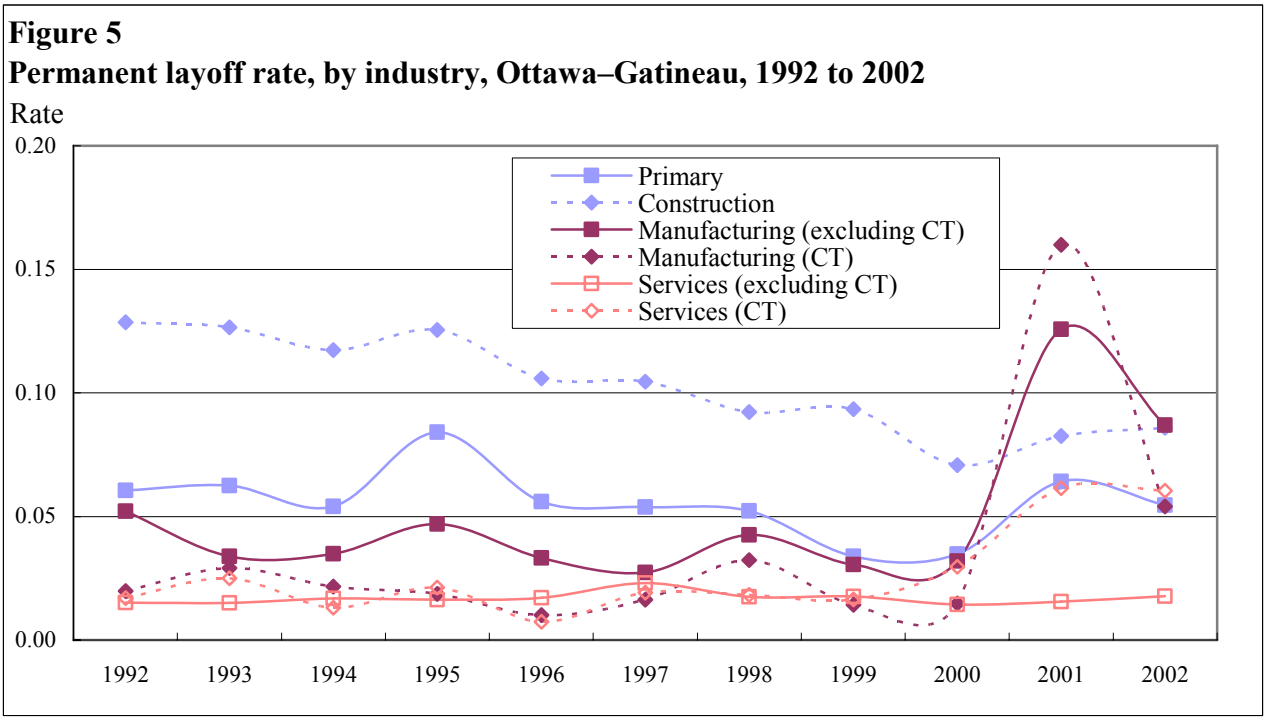
High-tech workers in all the major technology 'clusters' appear to have faced a greater risk of experiencing a permanent layoff at the onset of the downturn (Figures 4 to 9). In no city was this more apparent than in Ottawa–Gatineau, where the permanent layoff rate in the high-tech manufacturing sector catapulted from 1.5% in 2000 to 16% in 2001, corresponding to an elevenfold increase. Interestingly, a fourfold increase was registered in the non-CT manufacturing sector; however, all of this increase can be attributed to one particular North American Industry Classification System (NAICS) code (3359), which includes the communication and energy wire and cable manufacturing sector (NAICS 33592). Communication and energy wire and cable manufacturing is part of the broader concept of the high-tech sector (information and communication technology, or ICT), but since it is only defined at the five digit level in NAICS, it cannot be separately identified with the Longitudinal Worker File. Interestingly, Ottawa–Gatineau was the only city that saw a substantial increase in the permanent layoff rate among non-CT manufacturing workers. Manufacturing high-tech workers in Calgary and Vancouver were also hit hard, registering a sevenfold and a ninefold increase in their permanent layoff rates, respectively.

Figure 4
Permanent layoff rate, by industry, Montréal, 1992 to 2002



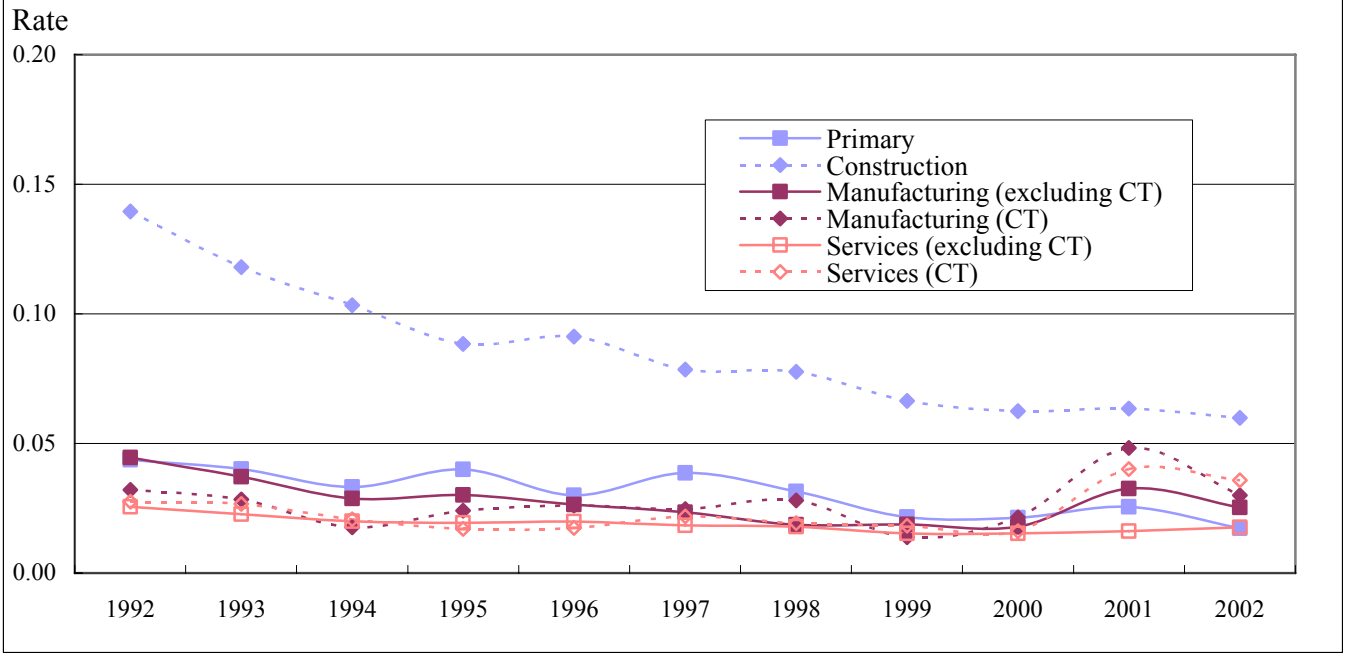
Notes: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

Figure 5
Permanent layoff rate, by industry, Ottawa–Gatineau, 1992 to 2002



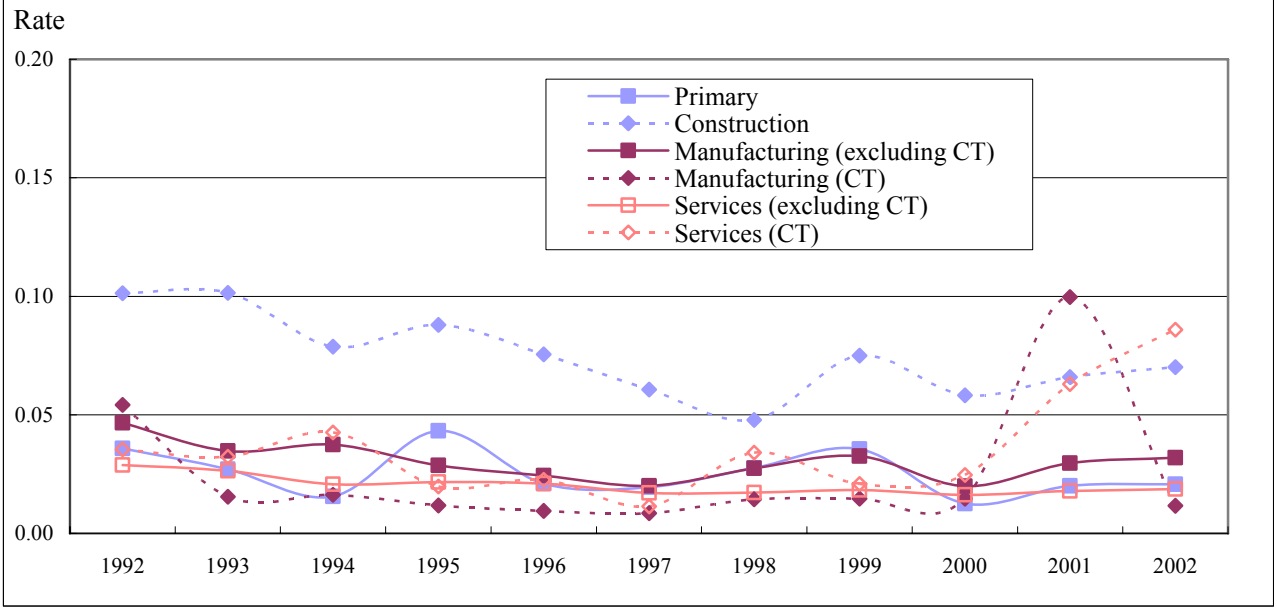
Notes: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

Figure 6
Permanent layoff rate, by industry, Toronto, 1992 to 2002



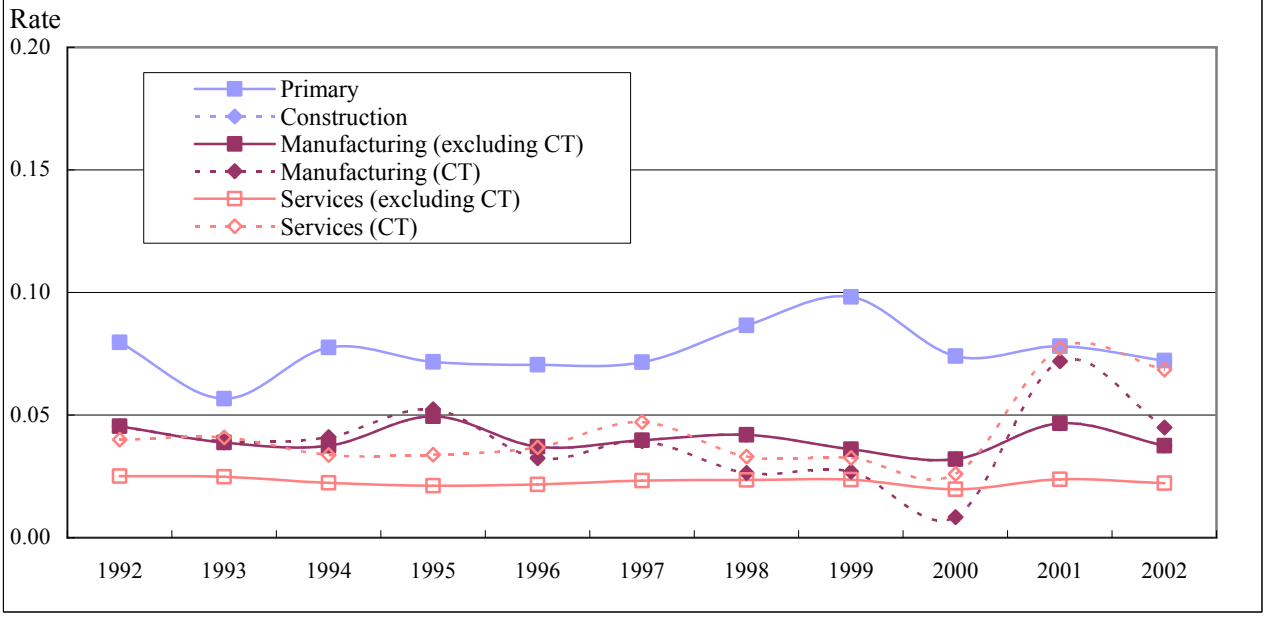
Notes: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

Figure 7
Permanent layoff rate, by industry, Calgary, 1992 to 2002



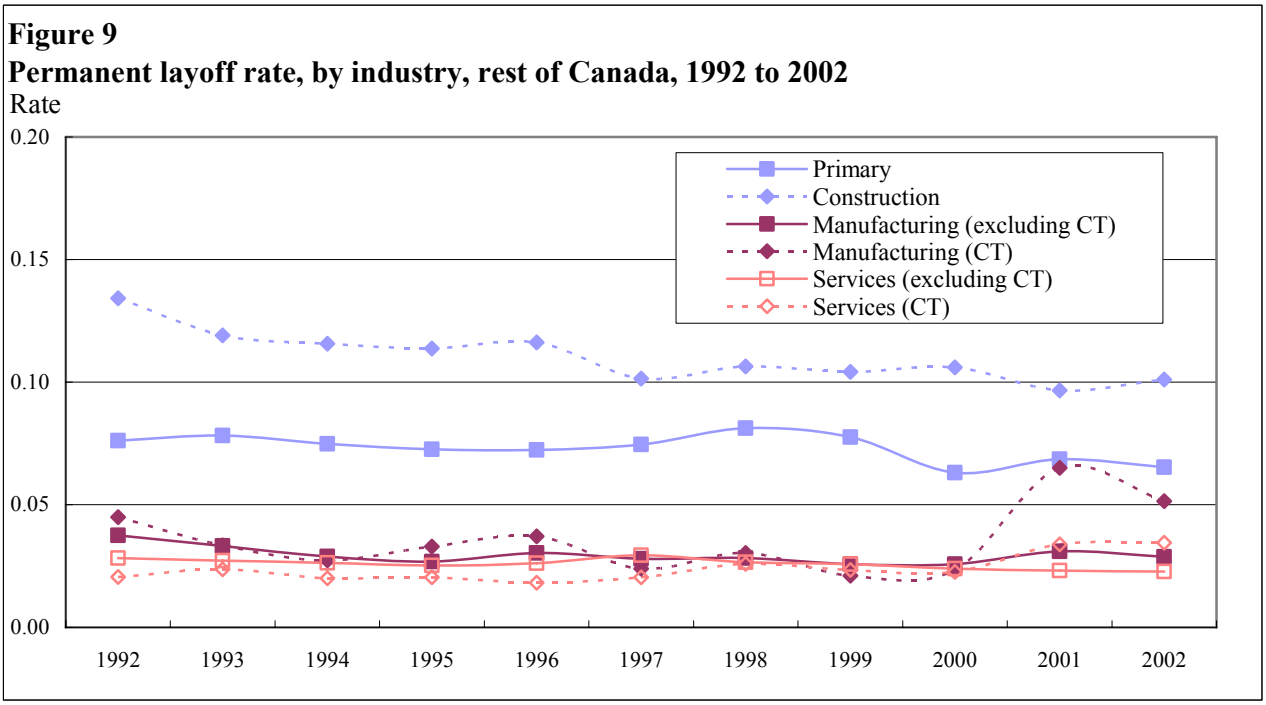
Notes: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

Figure 8
Permanent layoff rate, by industry, Vancouver, 1992 to 2002



Notes: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

Figure 9
Permanent layoff rate, by industry, rest of Canada, 1992 to 2002



Notes: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

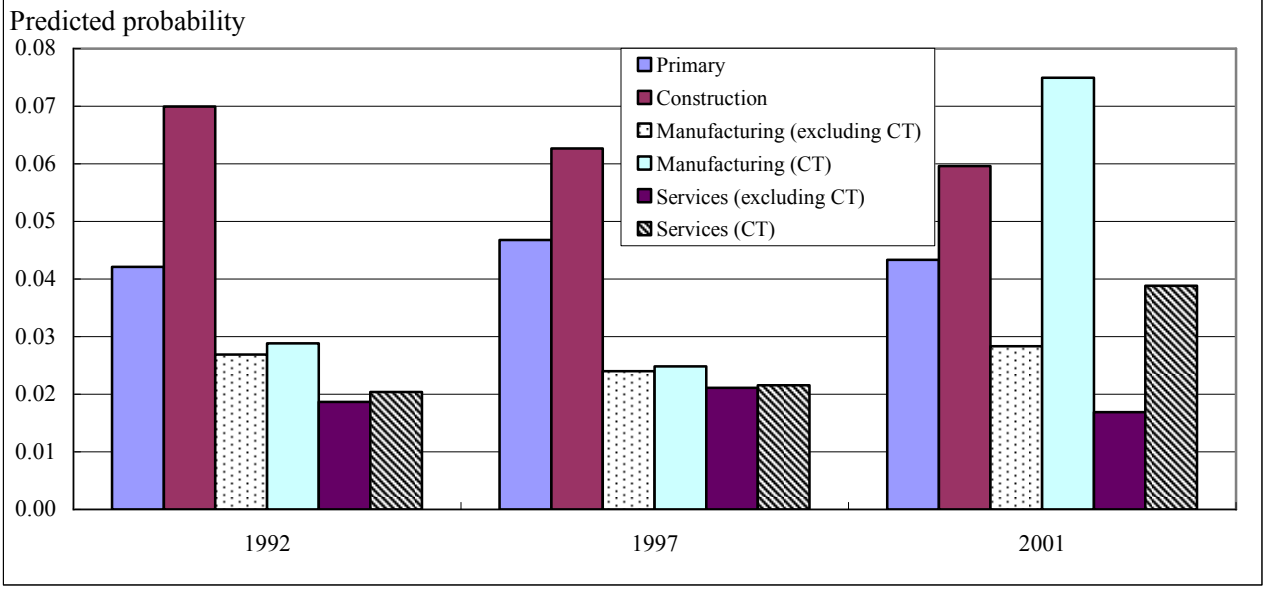
4.1.2 Econometric evidence

We now turn to econometric evidence on the probability of experiencing a permanent layoff. First, Model 1 (see Methodology section) was estimated for the years 1992, 1997 and 2001. The detailed results of these models appear in the Appendix (Table A.1). In Figure 10, I show the predicted probability of experiencing a permanent layoff by industry for each year. These predicted probabilities were generated from the model coefficients, which were applied to the full sample based on alternating industries in each year. The individual predicted probabilities were then averaged over the entire sample, yielding the results shown below.[6]

The findings confirm the descriptive evidence in the previous section. Essentially, the probability of experiencing a permanent layoff was more or less stable in each industry during the 1990s. In 2001, however, the high-tech sector saw a dramatic increase in permanent layoff rates even when we account for pre-layoff differences in firm size, earnings, sex and the city of residence of the workers. The predicted increase was quite large on the manufacturing side of the high-tech sector, rising from 2.5% in 1997 to 7.5% in 2001. Although less dramatic, the predicted increase was also substantial in high-tech services, rising from 2.2% in 1997 to 3.9% in 2001.

6. See Jacobson, Lalonde and Sullivan (1993) for more general evidence of the earnings losses of displaced workers.

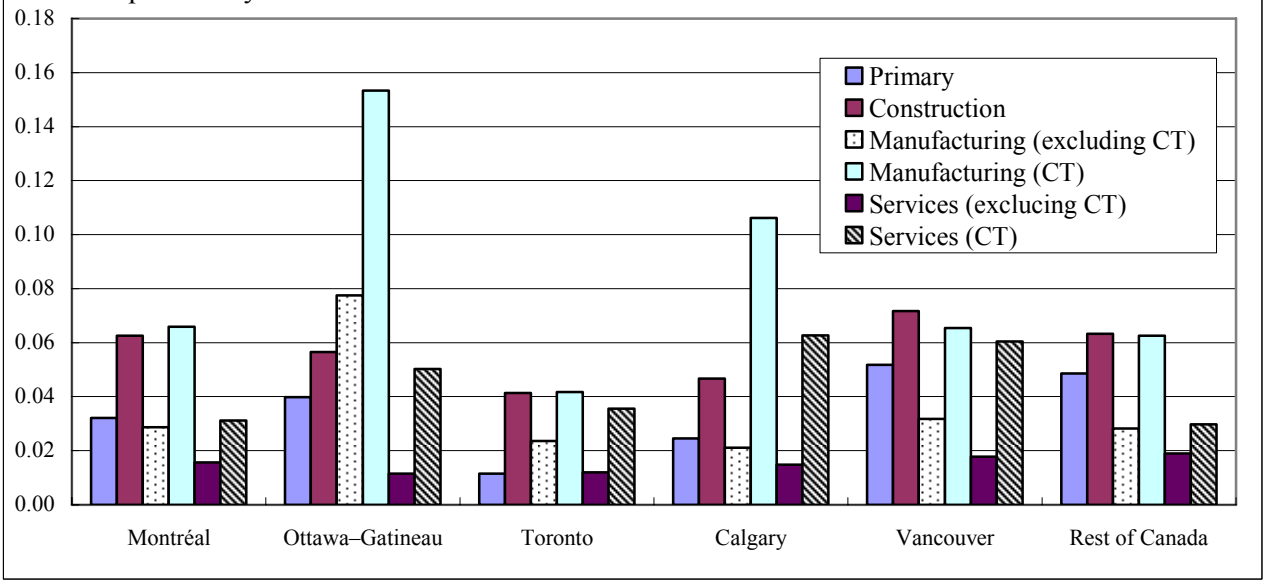
Figure 10
Predicted probability of experiencing a permanent layoff, by industry, 1992, 1997 and 2001



Notes: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff. Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

In Figure 11, the same model was estimated for each city in 2001. The detailed results appear in the Appendix in Table A.2. Again, the results confirm that manufacturing high-tech workers in Ottawa–Gatineau faced the highest probability of experiencing a permanent layoff during the downturn. Calgary ranked second, followed by Vancouver, Montréal and Toronto (in that order).

Figure 11
Predicted probability of experiencing a permanent layoff in 2001, by city and industry



Notes: The industry (city) corresponds to the worker's main job (residence) in the year prior to the (potential) permanent layoff. Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

4.2 Earnings losses of high-tech workers

4.2.1 Descriptive evidence

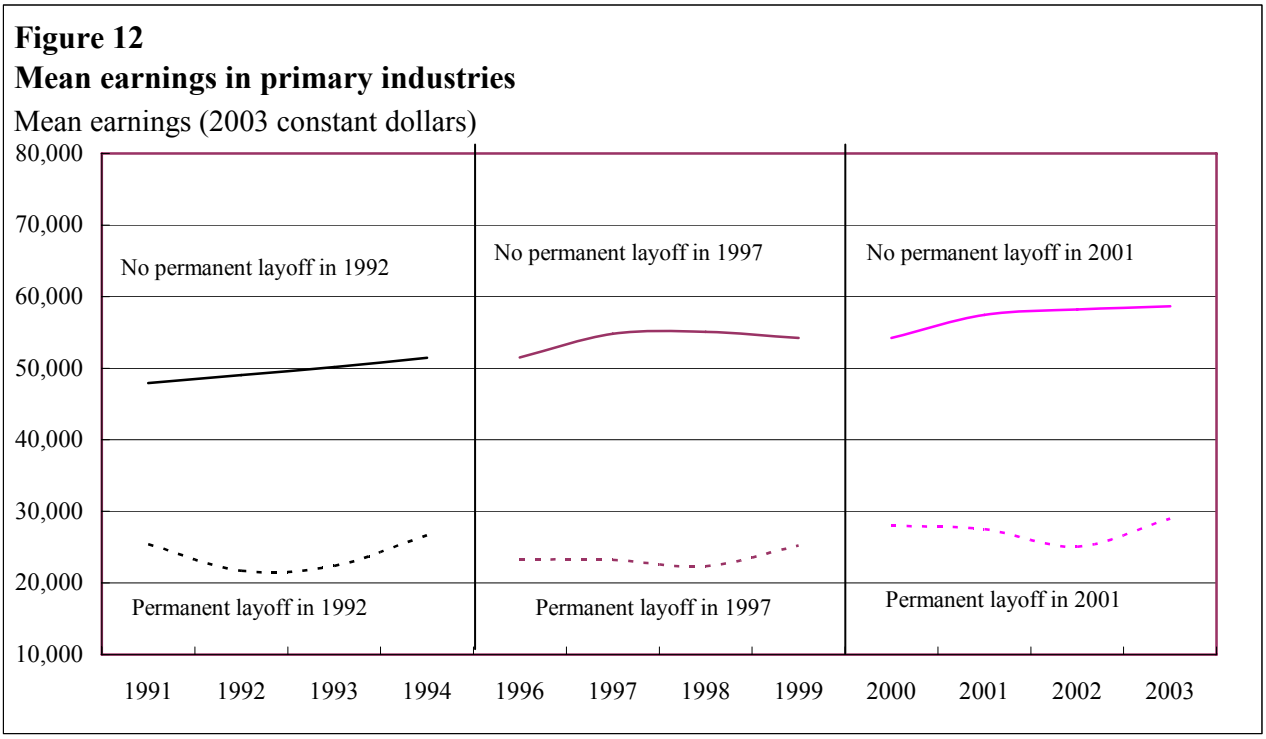
The previous section established the magnitude of the high-tech downturn in terms of job losses. Unlike the general recession of the early 1990s, high-tech workers who were laid off in 2001 faced a buoyant economy with plenty of job opportunities, albeit in other industries. In this section, I investigate the earnings losses of laid-off high-tech workers, using laid-off workers in other industries and time periods as benchmarks.

Results by industry are shown in Figures 12 to 17. In primary industries, the earnings losses associated with a permanent layoff are generally quite moderate (Figure 12). This is also true for construction industries, except during the jobless recovery of the early 1990s (Figure 13). In non-CT manufacturing, earnings losses are generally more substantial (Figure 14). However, the declines are far greater in high-tech manufacturing firms (Figure 15). This was especially the case during the downturn, when laid-off workers saw earnings losses of about $11,700 from 2000 to 2003. By contrast, industry workers who kept their jobs saw their earnings rise by $12,900 from 2000 to 2003, on average (for a difference of $24,600). In service industries, earnings losses are usually more moderate in the non-CT sector (Figure 16) than in the high-tech sector (Figure 17). However, the losses registered in the high-tech services sector during the downturn were no more substantial than the losses observed during the jobless recovery. They were also much smaller than the losses registered in the high-tech manufacturing sector during the downturn.[7]

Two points are evident from these results. First, laid-off high-tech workers generally experience far greater earnings losses than workers in other industries. Second, manufacturing high-tech workers who were laid off during the downturn saw the greatest earnings losses of all groups of workers examined, including those who were laid off during the 'jobless recovery' of the 1990s.

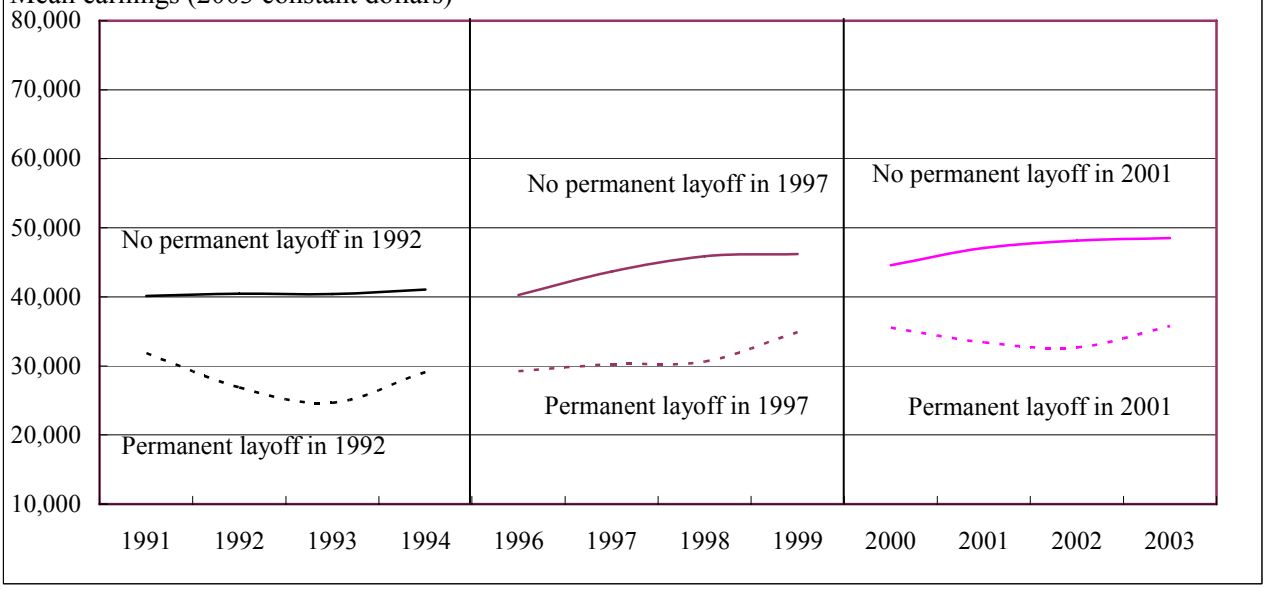
7. One point that is obvious from the figures is that workers who lose their job have far lower earnings than workers who keep their job. This may imply that they were also on different wage paths before they lost their job. However, the earnings losses are still quite large when I condition on pre-layoff earnings.

Figure 12
Mean earnings in primary industries



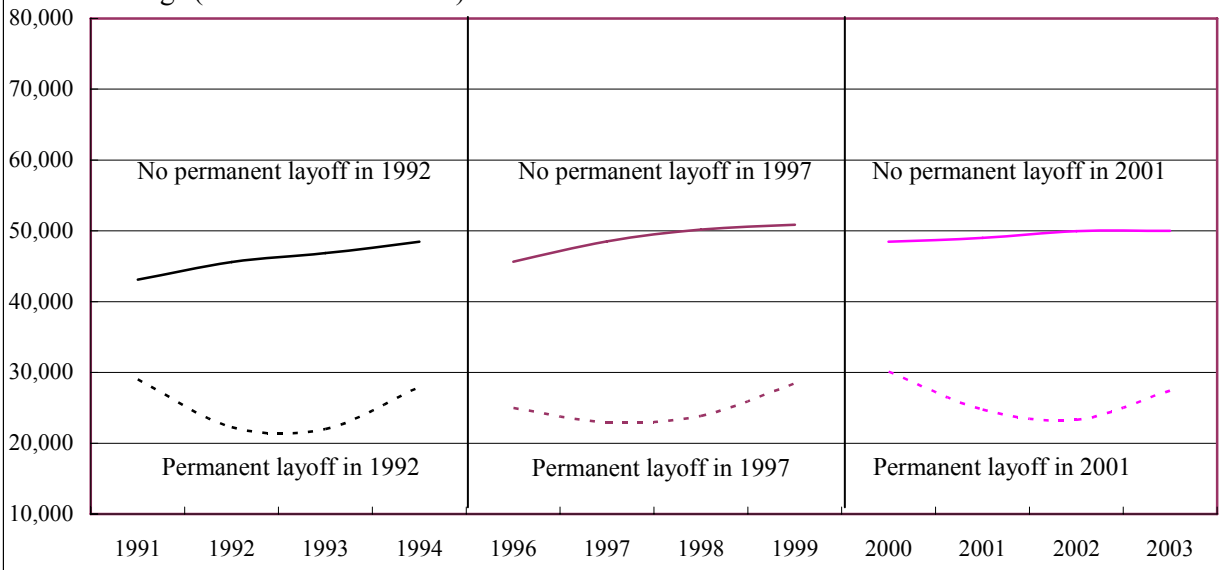
Note: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Source: Statistics Canada, Longitudinal Worker File.

Figure 13
Mean earnings in construction



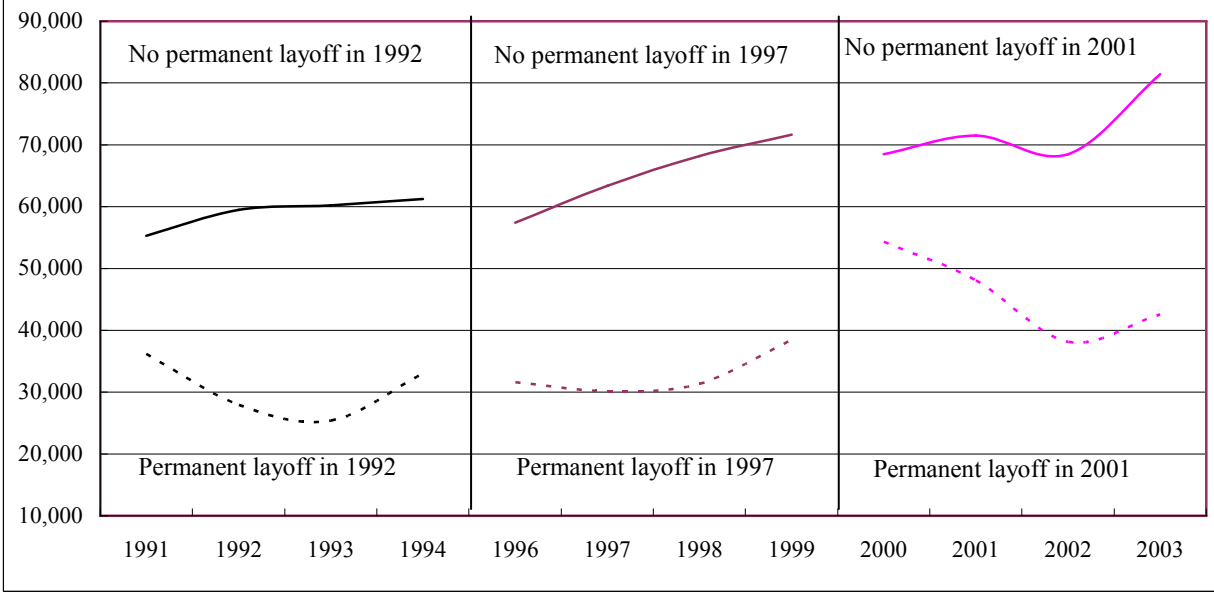
Note: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Source: Statistics Canada, Longitudinal Worker File.

Figure 14
Mean earnings in manufacturing (excluding computer and telecommunications)
Mean earnings (2003 constant dollars)



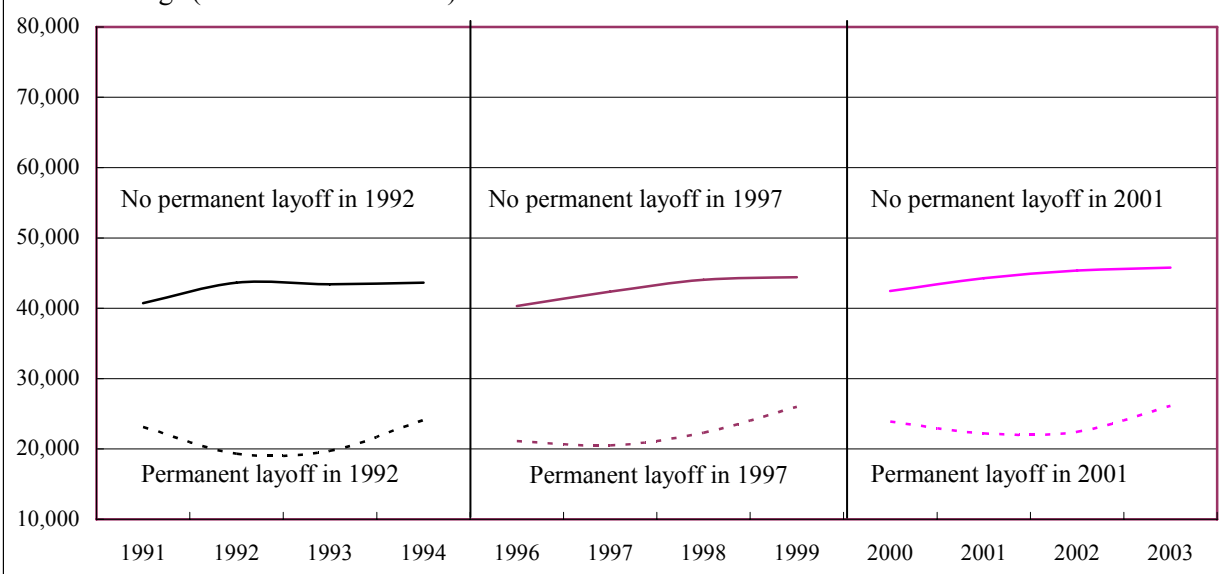
Note: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Source: Statistics Canada, Longitudinal Worker File.

Figure 15
Mean earnings in manufacturing (computer and telecommunications)
Mean earnings (2003 constant dollars)



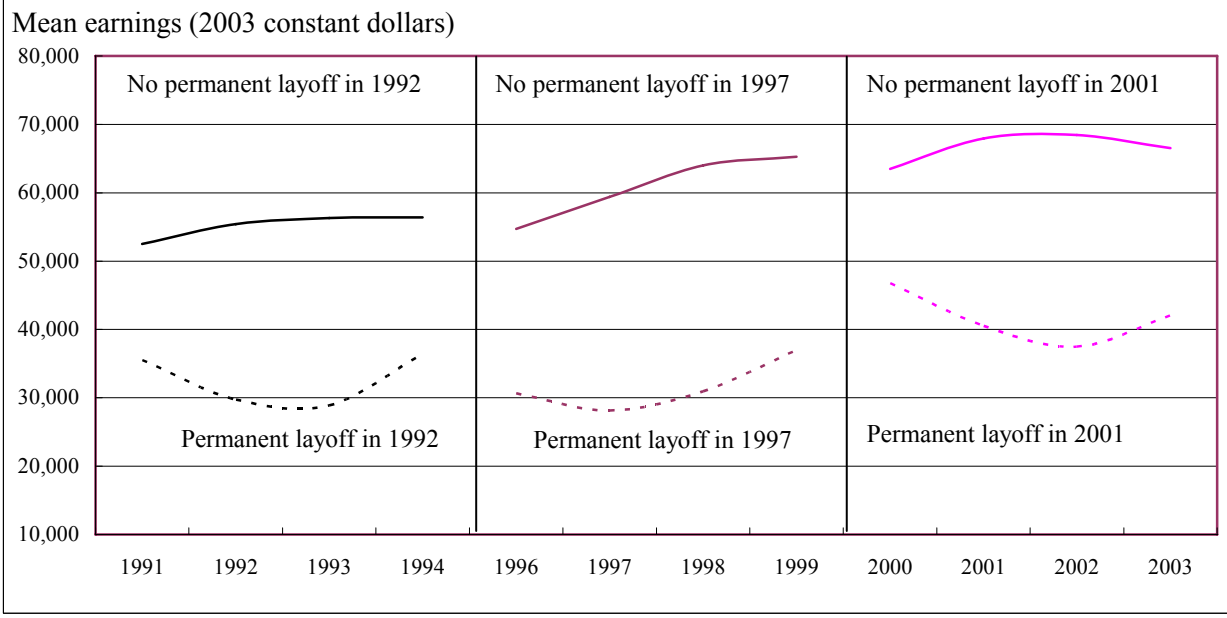
Note: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Source: Statistics Canada, Longitudinal Worker File.

Figure 16
Mean earnings in services (excluding computer and telecommunications)



Note: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Source: Statistics Canada, Longitudinal Worker File.

Figure 17
Mean earnings in services (computer and telecommunications)



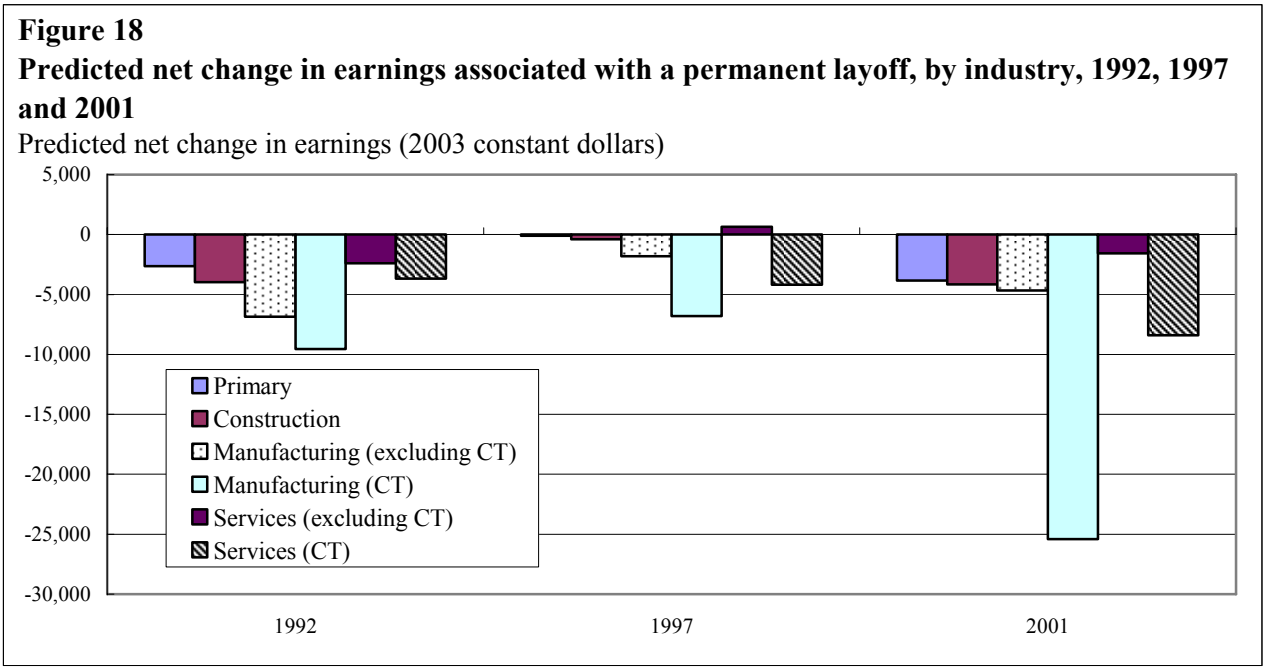
Note: The industry corresponds to the worker's main job in the year prior to the (potential) permanent layoff.
Source: Statistics Canada, Longitudinal Worker File.

4.2.2 Econometric evidence

I now turn to the econometric evidence on the net change in earnings associated with a permanent layoff. The net change in earnings is defined as the change in earnings of laid-off workers between years $t - 1$ and $t + 2$ (where t represents the year of the permanent layoff) minus the change in earnings of workers who were not laid off over the same period.

Model 2 (see Methodology section) was estimated for the years 1992, 1997 and 2001. The detailed results appear in the Appendix (Table A.3). In Figure 18, I show the predicted net change in earnings associated with a permanent layoff by industry for each year. As was the case with the econometric results for permanent layoffs, these predicted values were generated from the model coefficients, which were applied to the full sample based on alternating industries in each year. The individual predicted probabilities were then averaged over the entire sample, yielding the results shown below.

Figure 18
Predicted net change in earnings associated with a permanent layoff, by industry, 1992, 1997 and 2001



Notes: The industry corresponds to the worker's main job in the year prior to the potential permanent layoff. The predicted net change in earnings associated with a permanent layoff corresponds to the predicted change in earnings of laid-off workers between years $t - 1$ and $t + 2$ (where t represents the year of the permanent layoff) minus the predicted change in earnings of workers who were not laid off over the same period. Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

The results confirm the descriptive evidence: manufacturing high-tech workers who were laid off during the downturn experienced a dramatic decline in average earnings relative to their co-workers who kept their job. Even workers who were laid off during the jobless recovery of the early 1990s experienced far more moderate earnings losses. Only time will tell the extent to which these workers will have recovered part or all of their earnings losses.

4.3 Industrial and geographic mobility of CT workers laid off amid the downturn

Another potential consequence of being laid off is failing to find a job in the same industry, which may imply that a career change is in the works. In an attempt to continue in one's career or to find a job in a different industry, a move to another city may also become necessary. In both cases, there may be significant financial and psychological costs. In this section, I look at the industrial and geographic mobility of high-tech workers who were laid off during the downturn.

Beginning with industrial mobility, 21.6% of laid-off high-tech workers found jobs in the CT sector (Table 2). Among those who located employment outside of the CT sector (about four out of five workers), the most common industry was business services, followed by manufacturing and consumer services.

In Table 3, the focus is on the geographic mobility of laid-off high-tech workers. Among laid-off high-tech workers in the five major cities, one in three moved to another city (figure not shown). Among those who moved to another city, most targeted a non-major centre. Ottawa–Gatineau ranked last in terms of retaining laid-off high-tech workers, as only 60.6% (or three out of five) remained in the city. In other words, 39.4% moved to another city.

Table 2
Industrial distribution in 2003 of workers who were permanently laid off from a high-tech job in 2001

All laid-off high-tech workers	Proportion
Computer and telecommunications (CT)	0.216
Employed outside of CT	
Primary	0.005
Construction	0.042
Manufacturing	0.183
Business services	0.284
Distributive services	0.086
Consumer services	0.156
Education, health, and social assistance	0.118
Public administration	0.092
Other services	0.035
Employed in public administration	
Federal	0.587
Provincial	0.173
Municipal	0.231
Other	0.010
	Sample sizes
All laid-off high-tech workers	2,027
Employed outside of CT	1,132
Employed in public administration	104

Source: Statistics Canada, Longitudinal Worker File.

Table 3
Distribution of cities in 2003 of high-tech workers who were permanently laid off in 2001 by city in 2000

	City in 2000				
	Montréal	Ottawa–Gatineau	Toronto	Calgary	Vancouver
City in 2003					
Montréal	0.744	0.010	0.003	0.000	0.007
Ottawa–Gatineau	0.000	0.606	0.006	0.000	0.000
Toronto	0.013	0.020	0.699	0.000	0.007
Calgary	0.000	0.007	0.000	0.761	0.000
Vancouver	0.000	0.010	0.003	0.009	0.712
Rest of Canada	0.244	0.348	0.289	0.230	0.273
Total	1.000	1.000	1.000	1.000	1.000
Sample sizes	238	302	349	113	139

Source: Statistics Canada, Longitudinal Worker File.

5. Conclusion

The high-tech sector made tremendous economic gains throughout the 1990s. Jobs were plenty and workers enjoyed high pay. However, the momentum generated by the sector came to a sudden halt in 2001, when Canada and the industrialized world experienced a high-tech downturn. Despite countless news reports of mass layoffs and the plight of unemployed high-tech workers, there exists very little statistical evidence on these two fronts. The goal of this study was to fill the gap in our knowledge of the high-tech downturn with evidence of permanent layoff rates in high-tech and the earnings losses associated with layoffs in the sector. To accomplish this goal, I used a unique administrative data source containing information on workers who were laid off from high-tech firms and their earnings following the layoff.

The findings suggest that the high-tech downturn resulted in a sudden and dramatic increase in the probability of experiencing a permanent layoff, which quadrupled in the manufacturing sector from 2000 to 2001. Ottawa–Gatineau workers in the industry were hit particularly hard on this front, as the permanent layoff rate rose by a factor of 11 from 2000 to 2001. High-tech firms in the service industry saw a more moderate increase in permanent layoffs. The results also demonstrate that laid-off manufacturing high-tech workers who found a new job saw a very steep decline in earnings. The decline in earnings was well above the declines registered among any other group of laid-off workers, including workers who were laid off during the 'jobless recovery' of the 1990s.

In addition to the economic consequences of experiencing a permanent layoff and suffering a loss of earnings, the high-tech downturn affected workers in other ways. Among laid-off high-tech workers, about four out of five did not locate employment in high tech, and about one out of three moved to another city. In Ottawa–Gatineau, about two in five laid-off high-tech workers left the city. Mantler et al. (2005) conducted a survey of employed and unemployed high-tech workers during the downturn (in fall 2001 and winter 2002). Not surprisingly, they found that unemployed high-tech workers reported higher levels of stress than employed high-tech workers.

The high-tech downturn may have also had a significant impact on workers who kept their jobs. Workers with a higher level of job insecurity generally report higher levels of long-term psychological and physical health problems—Dekker and Schaufeli (1995), De Witte (1999) and van Vuuren et al. (1991). However, the data used in this study cannot shed light on these issues.

Appendix

Table A.1
Probit model results by year of potential permanent layoff

	1992		1997		2001	
	b	t	b	t	b	t
Construction	0.2608	14.75	0.1494	8.21	0.1601	8.92
Manufacturing (excluding CT)	-0.2109	-12.31	-0.3107	-18.00	-0.1976	-11.72
Manufacturing (CT)	-0.1792	-4.90	-0.2961	-7.96	0.2817	11.17
Services (excluding CT)	-0.3701	-23.51	-0.3668	-23.24	-0.4211	-26.69
Services (CT)	-0.3321	-10.92	-0.3578	-12.42	-0.0523	-2.32
20<=Firm size<100	-0.1008	-10.48	-0.1106	-11.86	-0.0910	-9.80
100<=Firm size<500	-0.2282	-20.78	-0.2245	-20.92	-0.2013	-19.28
Firm size>=500	-0.5070	-54.36	-0.3727	-42.67	-0.3880	-43.18
$50,000<=Earnings<$100,000	-0.2844	-26.64	-0.4470	-39.05	-0.3062	-31.61
Earnings>=$100,000	-0.4671	-11.01	-0.6120	-13.64	-0.3975	-15.29
Female	-0.1714	-22.38	-0.0686	-9.60	-0.1272	-17.78
Age	-0.0170	-2.99	-0.0059	-1.12	-0.0170	-3.23
Age Squared	0.0002	1.95	0.0000	0.18	0.0002	2.42
Ottawa–Gatineau	-0.1279	-5.48	-0.0365	-1.77	0.1432	7.52
Toronto	-0.0167	-1.20	-0.1509	-11.09	-0.0639	-4.77
Calgary	0.0311	1.43	-0.2356	-9.91	0.0078	0.38
Vancouver	-0.0278	-1.57	-0.0618	-3.71	0.0797	4.91
Rest of Canada	-0.0043	-0.39	0.0004	0.04	0.0499	4.64
Intercept	-0.9116	-8.96	-1.1255	-11.68	-1.0274	-10.72
Log likelihood	-71,805		-78,078		-78,999	
Sample size	679,624		715,487		758,903	

Notes: The explanatory variables correspond to the year prior to the potential permanent layoff. The dependent variable is a dummy variable indicating a permanent layoff. Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

Table A.2
Probit model results by city (year of potential permanent layoff = 2001)

	Montréal		Ottawa–Gatineau		Toronto		Calgary		Vancouver		Rest of Canada	
	b	t	b	t	b	t	b	t	b	t	b	t
Construction	0.3294	2.94	0.1733	0.85	0.5510	5.21	0.2958	2.90	0.1700	1.77	0.1353	6.82
Manufacturing (excluding CT)	-0.0525	-0.48	0.3404	1.70	0.2963	2.90	-0.0653	-0.65	-0.2338	-2.54	-0.2568	-13.70
Manufacturing (CT)	0.3574	3.01	0.7526	3.74	0.5549	5.06	0.7366	6.25	0.1207	0.98	0.1289	3.16
Services (excluding CT)	-0.3147	-2.92	-0.5344	-2.72	0.0174	0.17	-0.2132	-2.42	-0.4869	-5.54	-0.4281	-25.02
Services (CT)	-0.0141	-0.12	0.1135	0.56	0.4801	4.56	0.4446	4.31	0.0797	0.78	-0.2325	-6.78
20<=Firm size<100	-0.1771	-6.37	0.0814	1.39	-0.0343	-1.25	-0.0589	-1.07	-0.0023	-0.06	-0.1005	-8.69
100<=Firm size<500	-0.1992	-6.69	-0.0009	-0.01	-0.1967	-6.61	-0.1206	-2.04	-0.1860	-4.55	-0.2085	-15.71
Firm size>=500	-0.5185	-18.34	-0.1168	-2.21	-0.3353	-12.88	-0.2579	-5.19	-0.3997	-11.02	-0.3917	-34.73
$50,000<=Earnings<$100,000	-0.3529	-10.94	-0.4265	-9.49	-0.2136	-9.04	-0.3449	-6.93	-0.2655	-7.31	-0.3209	-25.05
Earnings>=$100,000	-0.4664	-5.22	-0.4710	-6.13	-0.3519	-6.73	-0.5924	-5.54	-0.4398	-4.37	-0.4223	-9.89
Female	-0.0738	-3.52	-0.1002	-2.76	-0.0992	-5.16	-0.1082	-2.79	-0.1180	-4.26	-0.1507	-16.29
Age	-0.0439	-2.78	-0.0964	-3.60	-0.0182	-1.23	-0.0101	-0.35	-0.0129	-0.61	-0.0080	-1.20
Age Squared	0.0005	2.42	0.0012	3.41	0.0002	1.07	0.0002	0.40	0.0001	0.34	0.0000	0.55
Intercept	-0.5958	-1.97	0.2731	0.53	-1.6131	-5.72	-1.5214	-2.92	-0.9804	-2.54	-1.0934	-9.07
Log likelihood	-8,578		-3,073		-10,031		-2,608		-5,052		-49,342	
Sample size	88,499		29,709		120,706		27,218		47,041		445,730	

Notes: The explanatory variables correspond to the year prior to the potential permanent layoff. The dependent variable is a dummy variable indicating a permanent layoff. Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

Table A.3
Ordinary least squares model results, by year of potential permanent layoff

	1992		1997		2001	
	b	t	b	t	b	t
Construction	-2,886	-14.64	3,431	14.86	-533	-2.09
Manufacturing (excluding CT)	1,602	10.39	2,624	14.32	-3,041	-14.69
Manufacturing (CT)	2,348	9.36	10,215	35.09	8,153	25.65
Services (excluding CT)	-519	-3.53	2,092	11.86	-940	-4.72
Services (CT)	513	2.46	7,394	29.72	-1,439	-5.34
Permanent layoff	-2,630	-5.46	-92	-0.17	-3,825	-6.01
Construction*Permanent layoff	-1,339	-2.37	-291	-0.43	-340	-0.45
Manufacturing (excluding CT)*Permanent layoff	-4,229	-7.54	-1,708	-2.62	-835	-1.16
Manufacturing (CT)*Permanent layoff	-6,910	-5.28	-6,695	-4.31	-21,580	-20.53
Services (excluding CT)*Permanent layoff	240	0.47	737	1.27	2,268	3.38
Services (CT)*Permanent layoff	-1,038	-0.95	-4,088	-3.44	-4,578	-4.66
20<=Firm size<100	286	3.32	586	6.07	457	4.24
100<=Firm size<500	880	10.15	827	8.35	530	4.83
Firm size>=500	772	11.00	1,042	12.91	1,469	16.15
$50,000<=Earnings<$100,000	-2,180	-40.12	-1,112	-17.37	-2,204	-31.85
Earnings>=$100,000	1,581	9.17	11,642	61.92	-1,977	-11.71
Female	-1,534	-31.82	-1,812	-32.08	-1,891	-30.28
Age	247	6.66	73	1.66	-134	-2.74
Age Squared	-5	-9.71	-4	-6.27	0	-0.59
Ottawa–Gatineau	451	3.61	2,332	15.54	1,468	8.87
Toronto	1,089	12.62	2,810	27.82	1,697	15.20
Calgary	1,682	11.62	2,933	17.05	3,784	20.62
Vancouver	2,765	24.42	-23	-0.18	173	1.21
Rest of Canada	319	4.53	-101	-1.22	448	4.84
Intercept	1,310	1.90	4,431	5.35	9,996	10.80
Adjusted R^2	0.0162		0.0297		0.0148	
Sample size	488,350		467,175		483,264	

Notes: The explanatory variables correspond to the year prior to the potential permanent layoff. The dependent variable is the difference between the earnings two years following the year of potential permanent layoff and the earnings one year prior to the year of potential layoff. Computer and telecommunications are denoted by 'CT.'
Source: Statistics Canada, Longitudinal Worker File.

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