

Catalogue no. 75-001-XIE



PERSPECTIVES

ON LABOUR AND INCOME

JULY 2007

Vol. 8, No.7

■ LIFE AFTER
HIGH TECH



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-	not available for a specific reference period
...	not applicable
p	preliminary
r	revised
x	confidential
E	use with caution
F	too unreliable to be published

Highlights

In this issue

■ Life after high tech

- The high-tech sector experienced a sharp decline in 2001 after leading economic growth during the 1990s. Nationally, the permanent layoff rate in this sector jumped from 2.1% in 2000 to 5.3% in 2001.
- Among the major high-tech centres, Ottawa-Gatineau registered the largest increase in its high-tech permanent layoff rate, from 2.2% in 2000 to 10.9% in 2001.
- Among high-tech workers who were laid off in 2001, average annual earnings declined from \$50,200 in 2000 to \$37,800 in 2002. Two years after layoff, average earnings were still well below their pre-layoff level (\$42,300 in 2003).

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Life after high tech

Marc Frenette

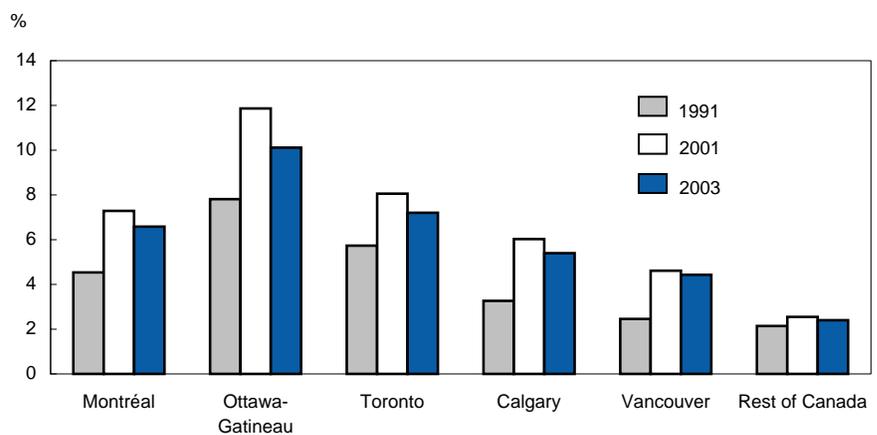
The leading role of the high-tech sector¹ in the economic recovery of the second half of the 1990s has been well documented. In 1991, this sector accounted for 3.2% of employees. During the 1990s, it expanded at a greater rate than the rest of the economy, eventually representing 4.5% of the workforce in 2000. Much of the increase was fuelled by explosive growth in the high-tech sector in Ottawa-Gatineau. Prior to the boom, this area led the country with 7.8% of its workforce employed in the high-tech sector, but this jumped to 11.8% by 2000 (Chart A).

As demand for workers increased, so too did real earnings. Between 1991 and 2000, average earnings in the industry rose from \$48,000 to \$58,900 (2003 dollars) while those in the rest of the economy grew at a much slower pace. Ottawa-Gatineau showed dramatic increases—from \$54,500 to \$77,000 (Chart B).

Then came the meltdown in 2001 with its headlines of large-scale layoffs. But what was the statistical evidence of the downturn and how it affected employment numbers and average earnings in the sector?² In 2001, high-tech employment

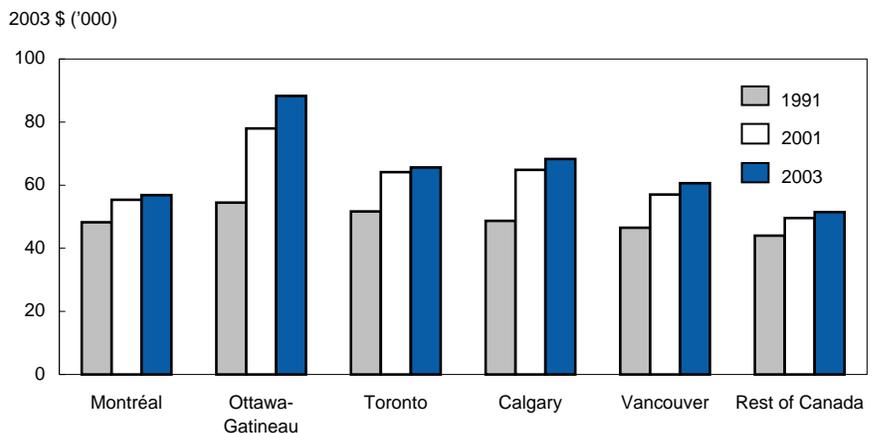
Marc Frenette is with the Business and Labour Market Analysis Division. He can be reached at 613-951-4228 or perspectives@statcan.ca.

Chart A Ottawa-Gatineau has consistently had the highest ratio of CT workers



Source: Statistics Canada, Longitudinal Worker File

Chart B Mean earnings of CT workers increased most dramatically in Ottawa-Gatineau



Source: Statistics Canada, Longitudinal Worker File

began to stabilize and shortly thereafter showed signs of contracting, accounting for 4.2% of the overall workforce in 2003 compared with 4.6% in 2001. Once again, Ottawa-Gatineau led the way, its share of high-tech employment declining sharply from 11.9% in 2001 to 10.1% in 2003. But earnings showed no decline at the national level—not surprising given the downward rigidity of nominal wages and the modest inflation at the time. High-tech workers in Ottawa-Gatineau, however, did see a substantial decline in earnings between 2001 and 2002 (\$78,000 to \$73,600). Nevertheless, they rebounded quickly, reaching \$88,300 in 2003. Given the large declines in employment at the time, the sudden increase in earnings may have been due to a change in the composition of the workforce in the high-tech sector as manufacturing jobs, which are typically lower-paying than service jobs, disappeared (Bowlby and Langlois 2002).

Although employment numbers suggest an important reversal, they may leave the impression that the sector ceased to grow. While this may be true in the aggregate, little can be said about how many workers were

actually affected by the meltdown. Overall employment can decline as a result of reduced hiring and natural attrition. And average earnings among high-tech workers say nothing about the fortunes of those laid-off workers who had to find a new job, possibly in a different sector. The well-being of laid-off workers is of particular concern given the rapid growth of ‘technology clusters’ (Jackson and Khan 2003). In such a cluster, employment opportunities may be limited for workers not considered part of the elite, which includes engineers, computer scientists and consultants. In a downturn, however, technology clusters may not have the infrastructure in place to accommodate a sudden influx of elite job seekers.

Using longitudinal administrative data, this study seeks to answer two questions (see *Data sources and definitions*). First, how likely were high-tech workers to face permanent layoffs during the downturn relative to other industries and time periods? Second, how substantial were the earnings losses of those who were laid off?

Table 1 Means of the explanatory variables used in model

	CT			Non-CT manufacturing			All other industries		
	At risk	No change	Laid off	At risk	No change	Laid off	At risk	No change	Laid off
	%								
Firm size (employees)									
Less than 20	12.1	7.5	21.4	11.0	6.9	20.7	23.5	15.1	42.7
20 to 99	15.6	12.0	23.1	20.2	17.0	28.1	16.5	13.2	22.3
100 to 499	15.9	13.6	18.1	21.0	21.0	21.1	13.0	12.4	12.3
500 and over	56.5	67.0	37.5	47.9	55.1	30.1	47.0	59.3	22.7
Earnings									
Less than \$50,000	55.5	47.8	69.8	71.1	62.9	87.9	78.8	70.5	90.9
\$50,000 to \$99,999	37.1	44.4	24.2	26.6	34.4	11.4	19.5	27.4	8.6
\$100,000 and over	7.4	7.8	6.1	2.3	2.7	0.7	1.7	2.1	0.6
Men	61.7	61.0	60.4	71.0	73.7	67.7	48.2	47.2	59.7
Women	38.3	39.0	39.6	29.1	26.3	32.4	51.8	52.8	40.3
Montréal	17.4	17.6	14.8	12.9	12.0	14.3	11.2	11.4	11.1
Ottawa-Gatineau	9.9	10.2	15.5	1.2	0.9	2.6	4.1	4.7	2.9
Toronto	28.0	27.2	25.1	17.8	16.9	17.1	14.6	14.4	10.8
Calgary	4.2	3.3	5.5	2.2	1.8	2.1	3.6	3.2	2.8
Vancouver	5.6	4.4	8.8	4.7	4.1	6.0	6.7	6.5	6.2
Rest of Canada	35.0	37.3	30.3	61.3	64.3	58.0	59.9	59.9	66.2
Age	35.8	36.5	35.0	36.7	37.4	35.9	36.6	37.7	35.7

Note: The explanatory variables correspond to the year prior to the potential permanent layoff, for the years 1991, 1996, and 2000.
Source: Statistics Canada, Longitudinal Worker File

High-tech workers profiled

Most of the analysis focuses on 1992 (end of the general recession and beginning of the 'jobless recovery'), 1997 (the beginning of a rapid growth period), and 2001 (beginning of the meltdown in high tech, despite continued growth in the rest of the economy).

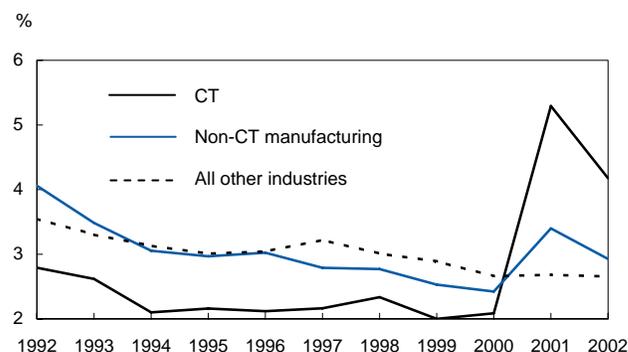
High-tech workers were more likely than other workers to be employed in large firms (500 employees or more) (Table 1). Not surprisingly, they had higher earnings than other workers; 7% earned \$100,000 or more, compared with only 2% in other industries. High tech is also male-dominated (62%), although not as much as manufacturing outside the computer and telecommunications (CT) sector (71%). On average, high-tech workers were about one year younger than other workers (35.8 compared with 36.7 in non-CT manufacturing and 36.6 in other industries). They were also far more likely to reside in major centres (especially Ottawa-Gatineau).

As in other industries, laid-off high-tech workers were more likely than those not laid off to be employed in small firms. However, this was less the case in CT and in non-CT manufacturing than in other industries. Also as in other industries, laid-off high-tech workers earned less than those not laid off. Laid-off workers in CT industries were as likely as those not laid off to be women. Laid-off workers in all industries were on average somewhat younger than those not laid off. Finally, laid-off high-tech workers were far more likely than those who kept their jobs to reside in Ottawa-Gatineau.

Focusing on a much less restrictive sample, an earlier study found 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 (Morissette 2004). The present study with its more stringent definition found a permanent layoff rate of only about 4% in the entire economy in 1992 (Chart C). Workers in the CT sector had a lower probability of experiencing a permanent layoff than workers in other industries. Over the remainder of the 1990s, permanent layoff rates declined slowly in CT industries and non-CT manufacturing, while remaining steady in other industries.

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

Chart C The permanent layoff rate in CT spiked in 2001



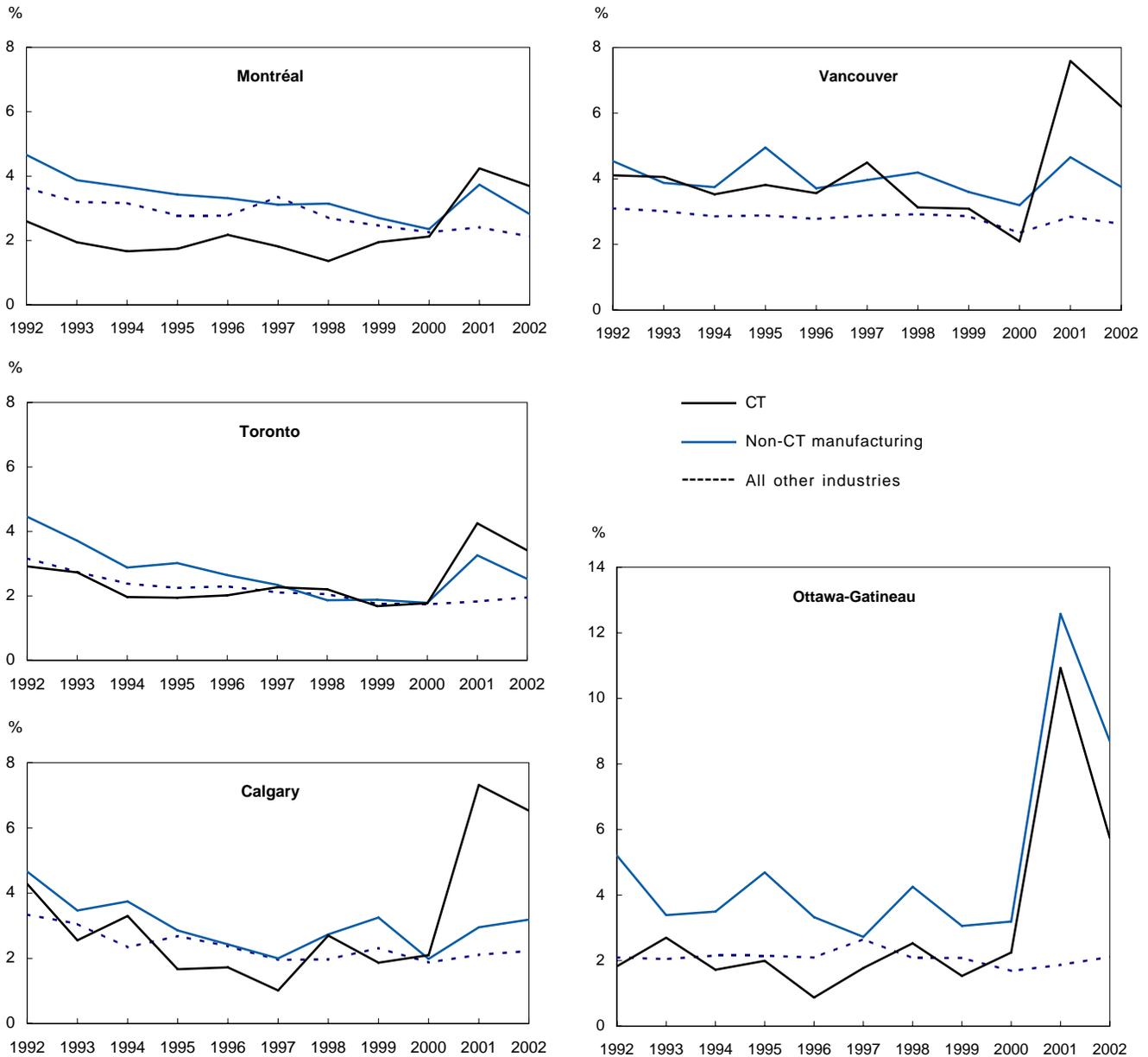
Source: Statistics Canada, Longitudinal Worker File

increase in layoffs in the CT sector. Here the rate more than doubled, from 2.1% in 2000 to 5.3% in 2001. In 2002, the probability of layoff was still relatively high (4.2%). Historically, the permanent layoff rates associated with the high-tech meltdown were unprecedented.

High-tech workers in all the major technology clusters appeared to face a greater risk of being laid off at the onset of the meltdown (Chart D). In no city was this more evident than in Ottawa-Gatineau, where the permanent layoff rate in high-tech jumped fivefold, from 2.2% in 2000 to 10.9% in 2001. Interestingly, a similar increase was registered in the non-CT manufacturing sector, all of which can be attributed to one particular industry: NAICS 3359, which includes communication and energy wire and cable manufacturing. This is part of the broader high-tech sector (information and communication technology, or ICT), and it cannot be separately identified with the Longitudinal Worker File used for this study. Ottawa-Gatineau was the only city that saw a substantial increase in the permanent layoff rate among non-CT manufacturing workers. High-tech workers in Calgary and Vancouver were also hard hit, each registering more than a threefold increase. In Toronto and Montréal, the rate doubled.

Based on a probit model, the probability of experiencing a permanent layoff was more or less equal across all three industry groups prior to the high-tech

Chart D Ottawa-Gatineau CT workers were hardest hit by permanent layoffs



Source: Statistics Canada, Longitudinal Worker File

meltdown (Chart E). Moreover, these probabilities were relatively stable prior to the downturn. In 2001, however, the high-tech sector saw a dramatic increase

in permanent layoff rates, even after accounting for pre-layoff differences in firm size, earnings, sex, and city of residence (see *Sample design*).

Data sources and definitions

The term **high tech** is generally associated with the information and communication technology (ICT) sector, which requires the 5-digit North American Industry Classification System (NAICS) code, whereas the 4-digit code allows identification of the computer and telecommunications (CT) sector. CT is an important sub-sector of ICT, accounting for approximately 88% of its workforce. 'High tech' in this paper refers to the CT sector, which includes the following NAICS industries:

Manufacturing: 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)

Services: 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 (518), computer systems design and related services (5415), and electronic and precision equipment repair and maintenance (8112). See Bowlby and Langlois (2002) for more details on the CT sector.

The requirements for the study are substantial: identifying high-tech workers and those who have been permanently laid off, a sample large enough for analysis, longitudinal data, and information on earnings as well as worker and firm characteristics.

Given that the high-tech sector accounts for less than 10% of the Canadian economy, and that reasons for separation are rarely available in large data sources, it should come as no surprise that virtually all Canadian sources are much too small for the required detail. The one exception is the **Longitudinal Worker File**, which is constructed from four administrative sources:

- The **Record of Employment (ROE)** file. The Employment Insurance Act requires employers to submit a form when an employee in insurable employment has an interruption in earnings. For this study, ROEs showing a layoff due to shortage of work were selected.
- The **T4** file. Virtually all workers receive a T4 slip from their employer to file with their income tax return. The T4 file contains earnings information from each firm in which the worker was employed during a given year. The worker's postal code is used to determine the city of residence.

- The **T1** tax file provides the worker's age and sex.
- The **Longitudinal Employment Analysis Program (LEAP)** file contains company-level industry and employment information. Industry is coded to the 4-digit NAICS for 2002 and is available back to 1991. Since not all workers spend the entire year with the same firm, employment is estimated by dividing the firm's total annual payroll by the average T4 earnings of all workers in the same industry and province.

The ROE, T4, and T1 were linked by social insurance number (SIN) for each year from 1983 to 2003. These 21 files were then linked to LEAP by a company identifier. The Longitudinal Worker File is a 10% random sample of all employees in this linked file. In any given year, those selected will appear more than once if they worked for more than one employer. Selected individuals remain in the sample as long as they are in the paid workforce and the last digit of their SIN does not change.³ If workers become self-employed and have no paid job in a given year, they leave the sample.

This study looks at the probability of experiencing a permanent layoff in a given year t . The sample consists of workers who are 25 to 49 years old in the year prior to the reference year. Since older workers may opt to retire following a permanent layoff, they are excluded. Only the main job (the one with the highest T4 earnings in the year before the layoff) is considered. In the event of more than one job with the same earnings, one is chosen at random. A permanent layoff occurs when a worker is laid off from their main job and does not return to the same employer in the same or following year. As a result of these criteria, this study focuses more on significant jobs than other studies of permanent layoff rates. The result is lower permanent layoff rates than those 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 permanent layoff rate is usually around 3%.

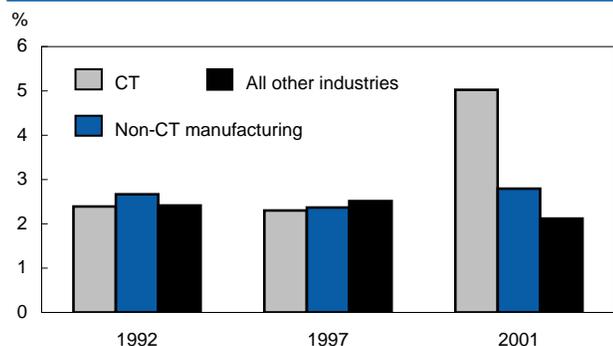
The study also looks at the change in earnings between year $t-1$ and year $t+2$. Only workers with positive earnings in year $t+2$ were included. For workers who were not permanently laid off in year t , only those who had the same main job in years $t-1$ through $t+2$ were selected.

The same model was estimated for each city in 2001 (Chart F).⁴ Again, the results confirm that among the major cities, high-tech workers in Ottawa-Gatineau faced the highest probability of permanent layoff during the meltdown. Calgary and Vancouver ranked second and third, followed by Montréal and Toronto.

Earnings losses of high-tech workers

In the business cycle, the early to mid-1990s was known as the jobless recovery. This was reflected in substantial earnings losses among workers laid off in 1992 from all industries excluding non-CT manufacturing, and computer and telecommunications (Chart G).

Chart E The predicted probability of experiencing a permanent layoff jumped significantly for CT in 2001



Source: Statistics Canada, Longitudinal Worker File

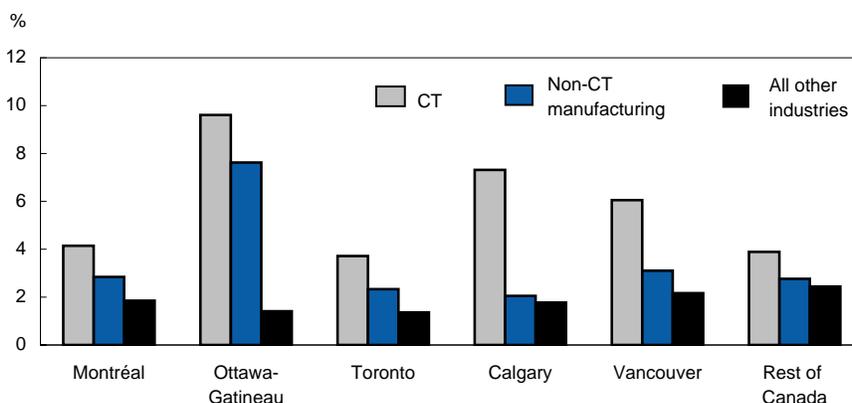
Among this group, average earnings declined from \$25,500 in the year prior to the layoff to \$21,200 in the year following the layoff. However, in the second year after the layoff they bounced back to \$25,600 so that over the three-year period, average earnings increased by \$100. By comparison, workers not laid off saw their earnings increase by \$2,800 over the same period. In contrast, workers laid off in the midst of the economic recovery (1997) saw their average earnings increase by \$4,800 between 1996 and 1999. This bettered the gains registered among workers not laid off at this time (\$4,100). Since 2000, the economy has been operating at a ‘sustained peak.’ Among workers laid off in 2001, average earnings increased by \$1,700, compared with \$3,400 for those not laid off. In general, it appears that laid-off workers outside the non-CT manufacturing and computer and telecommunications sectors did not incur large earnings losses. The one exception was during the jobless recovery of the first half of the 1990s, when earnings of permanently laid-off workers dipped suddenly but then recovered quickly.

In the non-CT manufacturing sector, earnings losses appear to be more substantial (Chart G). Here,

workers laid off in 1992 saw a decline of \$1,100 between 1991 and 1994, while those not laid off experienced an increase of \$5,400. During the economic recovery of the late 1990s, laid-off workers saw average gains of about \$3,400 over the three-year period surrounding the layoff, compared with \$5,200 among their counterparts who were not laid off. For those laid off in 2001, the loss was about \$2,600, compared with a gain of about \$1,500 for those not laid off. Clearly, non-CT manufacturing workers experienced larger earnings losses if they were laid off than those in the other industries category. This is true in absolute terms and also relative to the gains experienced by workers who were not laid off.

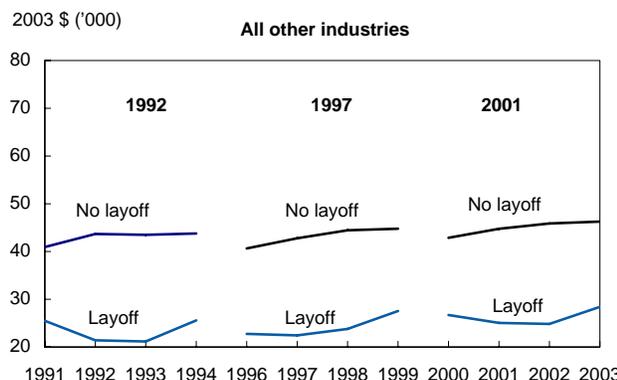
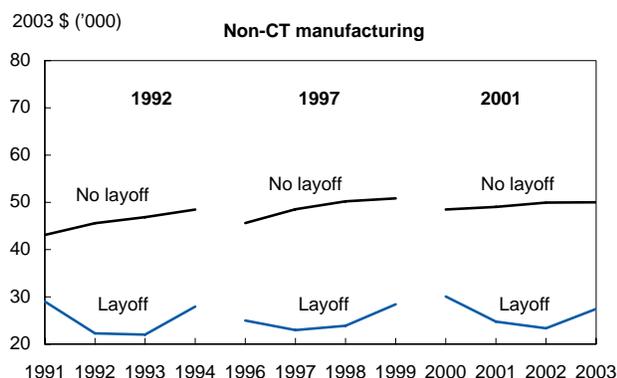
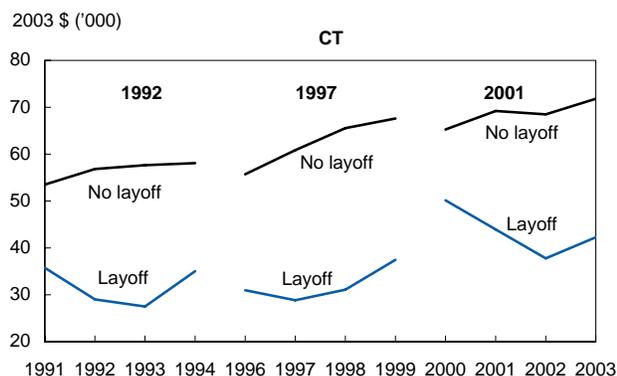
Although earnings losses in the non-CT manufacturing sector were large, they were nowhere near those experienced by laid-off CT workers. High-tech workers laid off in 1992 experienced a loss of about \$700 in annual earnings between 1991 and 1994. The nascent high-tech boom had already begun driving wages upwards, with increases among those not laid off of about \$4,600 during this time. In 1997, even laid-off workers saw substantial earnings gains over the three-year period surrounding their layoff (about \$6,500)—not surprising given that the sector was expanding rapidly and jobs were plentiful (Chart A). However, some may have missed opportunities for advancement and higher earnings since their counterparts who remained employed saw gains of about

Chart F Ottawa-Gatineau and Calgary CT workers had the highest predicted probabilities of experiencing a permanent layoff in 2001



Source: Statistics Canada, Longitudinal Worker File

Chart G Mean earnings of CT workers, even those laid off, continued above average



Source: Statistics Canada, Longitudinal Worker File

\$11,900. During the meltdown, the situation was very different. Laid-off high-tech workers had earnings losses of about \$7,900 while those who managed to keep their jobs saw increases of about \$6,600.

Two points are evident: First, laid-off high-tech workers experienced far greater earnings losses than workers in other industries (Chart H). Second, those who were laid off during the meltdown saw the greatest losses of all, including workers laid off during the jobless recovery of the 1990s. Only time will tell the extent to which these losses will be recovered.

Mobility of laid-off CT workers

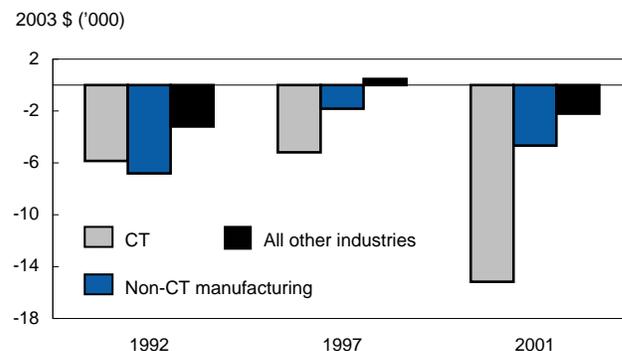
Another potential consequence of being laid off is failure to find a job in the same industry. Moving to another city may become necessary to continue one's career or find a job in a different industry. Both cases may entail significant financial and psychological costs. Only one in five laid-off CT workers found a job in the same sector. Among those who moved out of CT, the most common destination was business services, followed by consumer services and manufacturing.

Among laid-off CT workers living in the five major cities, about 1 in 3 moved to another city. Most targeted a non-major centre. Ottawa-Gatineau ranked last in terms of retaining laid-off CT workers, with only 3 in 5 remaining in the city (Table 2).

Conclusion

The high-tech sector made tremendous economic gains throughout the 1990s. Jobs were plentiful and pay was high. However, the momentum generated by the sector came to a sudden halt in 2001, as Canada and the rest of the industrialized world experienced a

Chart H Laid-off CT workers had the largest predicted net loss in earnings in 2001



Source: Statistics Canada, Longitudinal Worker File

Table 2 High-tech workers permanently laid off in 2001 by city in 2000 and 2003

	City in 2000				
	Montréal	Ottawa-Gatineau	Toronto	Calgary	Vancouver
City in 2003	%				
Montréal	74.4	1.0	0.3	0.0	0.7
Ottawa-Gatineau	0.0	60.6	0.6	0.0	0.0
Toronto	1.3	2.0	69.9	0.0	0.7
Calgary	0.0	0.7	0.0	76.1	0.0
Vancouver	0.0	1.0	0.3	0.9	71.2
Rest of Canada	24.4	34.8	28.9	23.0	27.3

Source: Statistics Canada, Longitudinal Worker File

high-tech meltdown. Despite countless news reports of mass layoffs and the plight of unemployed high-tech workers, very little statistical evidence exists on these two fronts.

This study shows that the high-tech meltdown resulted in an unprecedented increase in the probability of experiencing a permanent layoff, the likes of which had never

been seen in the sector or the rest of the economy. High-tech workers in Ottawa-Gatineau, a major technology cluster, were hit particularly hard. Those laid off saw a steep decline in their earnings—well above that experienced by any other group, even during the jobless recovery of the 1990s. Among laid-off high-tech workers overall, about 4 in 5 did not find jobs in the sector, and about 1 in 3 moved to another city. In Ottawa-Gatineau, about 2 in 5 left the city.

The meltdown may also have had a significant impact on workers who kept their jobs. Workers with a high level of job insecurity generally report higher levels of long-term psychological and physical health problems (Dekker and Schaufeli 1995; De Witte 1999; Van Vuuren et al. 1990). In the case of the high-tech meltdown, evidence

Sample design

Year	t-1	t	t+2
Sample	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 , two models were estimated. The first was 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 AGE²), and the city of residence (CITY).

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

The second model, estimated by ordinary least squares (OLS), looked at the absolute change in earnings ($\Delta EARN$) as a function of similar variables, except that the industry variables were interacted with a dummy variable indicating a permanent layoff.

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

suggests that job insecurity has a greater impact on stress than employment status. A survey of employed and unemployed high-tech workers during the meltdown found that unemployed high-tech workers reported higher levels of stress than those who were employed (Mantler et al. 2005). The difference was fully explained by a higher level of job uncertainty among unemployed workers.

Perspectives

■ Notes

1 High tech is defined in this article as the computer and telecommunications sector. See *Data sources and definitions* for more details.

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

3 In most instances, a change in social insurance number occurs after a temporary resident working in Canada with a temporary number becomes a permanent resident and is issued a permanent one.

4 Small sample sizes did not permit detailed analysis for Calgary in earlier years.

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