The Effects of Computers on Workplace Stress, Job Security and Work Interest in Canada

Final Report

Zhengxi Lin and Andrija Popovic
Applied Research Branch
Strategic Policy
Human Resources Development Canada

December, 2002

SP-566-01-03E
(également disponible en français)

This is one of a series of studies on workplace computer use, computer technology and skills upgrading, computer effects, and the acquisition of computer skills. Views expressed in the paper are those of the authors and as such, do not represent those of Human Resources Development Canada. An earlier version was presented at the 2002 Canadian Economics Association annual meeting and Statistics Canada Economic Conference 2002. Valuable comments and suggestions from Gilles Bérubé and our CEA and SCEC discussants, Sébastien LaRochelle-Côté and Marc Frenette, are gratefully acknowledged. Errors remaining are the authors' sole responsibilities.

Paper/Papier
ISBN: 0-662-33897-9
Cat. No./N° de cat.: RH63-1/566-01-03E

Internet
ISBN: 0-662-33898-7
Cat. No./N° de cat.: RH63-1/566-01-03E-IN

General enquiries regarding the documents published by the Applied Research Branch should be addressed to:

Human Resources Development Canada
Publications Centre
140 Promenade du Portage, Phase IV, Level 0
Hull, Quebec, Canada
K1A 0J9

Facsimile: (819) 953-7260
http://www.hrdc-drhc.gc.ca/sp-ps/arb-dgra

Si vous avez des questions concernant les documents publiés par la Direction générale de la recherche appliquée, veuillez communiquer avec :

Développement des ressources humaines Canada
Centre des publications
140 Promenade du Portage, Phase IV, niveau 0
Hull (Québec) Canada
K1A 0J9

Télécopieur : (819) 953-7260
http://www.hrdc-drhc.gc.ca/sp-ps/arb-dgra

Abstract

Information and communication technologies, especially computers, have reached nearly every corner of our lives, whose impacts are inevitably wide-spread and profound. Using GSS 2000 of Statistics Canada, this paper empirically investigates the effects of computers on several measures of job quality.

Does having to learn new computer skills cause stress in the workplace? Over 18% of computer-using workers think so. Our logistic regression results demonstrate that attributes that are significantly associated with workplace stress caused by the need to learn new computer skills include age, education attainment, country of birth, industry and occupation.

Is work affected by the introduction of computers and automated technology? Nearly four in ten workers report that their work has been greatly affected, another 21% somewhat affected, while the remaining 40% hardly or not at all affected. Our ordered-logistic regression results reveal that characteristics that are significantly correlated to work being affected by computers include gender, age, education, country of birth, work schedule, employment type, industry and occupation.

Has job become more or less secure as a result of the introduction of computers and automated technology? Of those who state that their work has been affected, 23% feel that their job has become more secure, 10% less secure, and the remaining two-thirds think that their job security has stayed the same. Our ordered-logistic regression results show that observable attributes that are significantly correlated with job security change as a result of the introduction of computers and automated technology include gender, age, work schedule, industry, and occupation. This is largely as true for those who feel that their work has been greatly affected as for those who think that their work has only been somewhat affected.

Has work become more or less interesting as a result of the introduction of computers and automated technology? Of those who feel that their work has been affected, nearly six out of ten report that their work has become more interesting, 4% less interesting, while the remaining one in three says that their work has become neither more nor less interesting. Our ordered-logistic regression results display that observable characteristics that are significantly associated with work interest change as a result of the introduction of computers and automated technology include gender, age, education, country of birth, employment type, industry, and occupation. These results apply, to a large extent, only to those who feel that their work has been greatly affected.

Table of Contents

List of Figures

List of Tables

1. Introduction

Information and communication technologies (ICTs), especially computers, have dramatically changed the way we work and live. According to the 2000 General Social Survey (GSS 2000) of Statistics Canada, nearly six out of ten Canadian workers used a computer (personal computer, mainframe or word processor) at work, with the majority (78%) using it to perform various tasks on a daily basis (Marshall (2001)). This usage rate is up from one in two in 1993 (Morissette and Drolet (1998)) and from 39% in 1989 (Lowe (1997)).

The adoption of ICTs and its far-reaching effects have attracted considerable interest.[1] The majority of earlier literature centres around the effects on productivity and job quality, which Rubery and Grimshaw (2001) sub-divide into three main dimensions: 1) employment relations and protection (e.g., employment opportunities, employment relations, career opportunities, job protection and collective bargaining, pay); 2) time and work autonomy (e.g., work intensity, power and autonomy, work/life balance, work relations); and 3) skills and careers (e.g., skills, job prospects). Polarized views on the effects of ICTs can be found in the literature in terms of each of these dimensions. For example, the pessimistic argues that ICTs destroy employment opportunities through automation and rationalization, reduce pay by downgrading skills and weakening workers' collective bargaining power. To the exact opposite, the optimistic hypothesizes that ICTs create jobs through developing new markets and human capital, increase pay by augmenting skills.[2]

Many previous studies have found a positive relationship between productivity and the use of ICTs (e.g., Greenan and Mairesse (2000); Gera, Gu and Lee (1999); Brynjolfsson and Hitt (1996); Lichtenberg (1995); Siegel and Griliches (1992)). Empirical evidence on the positive association between wages and the use of ICTs is also abundant (e.g., Autor, Latz and Kruger (1998); Baldwin, Gray and Johnson (1997); Bound and Johnson (1992)). While supporting the finding that there is a positive linkage between wages and the use of computers and other advanced technologies, work by others (e.g., Morissette and Drolet (1998); Dinardo and Pischke (1997); Entorf and Kramarz (1996)) has argued that workers who use computers earn more than other employees (those who do not) not because of their computing skills per se, but rather because they are endowed with more other unobservable or unmeasureable skills.

Other work (e.g., Baldwin, Diverty and Sabourin (1995)) has shown that the adoption of computers and other new technologies is a key element to firms' success because these technologies are correlated with market share increases, productivity gains, product and delivery quality improvements, increased flexibility, production costs reduction, and so on (e.g., Baldwin and Lin (2002)).

---

[1] Earlier work cited here is only a very small sample of the existing large literature.

[2] See Rubery and Grimshaw (2001, Table 1) for detailed discussions on effects of ICTs on each of these dimensions from these opposite views.

There are many other aspects on which ICTs may have significant impacts too. For example, using a special supplement to the December 1998 Current Population Survey (CPS), Kuhn and Skuterud (2000) show that 15% of unemployed job seekers in the United States used the internet to search for jobs in 1998, so did half of all job seekers with online access from home. They further demonstrate that internet job search rates exceeded those of traditional job search methods such as services provided by private employment agencies, contacting friends and relatives, using trades unions or professional associations.

With employers fiercely competing for technological advantages by widely adopting and frequently upgrading ICTs, workers constantly find themselves being surrounded by these technologies. What impacts does the adoption of ICTs have on workers? Specifically, what psychological impacts do ICTs and the constant need to learn new computer skills may have on workers? Do they cause extra stress or worry? Are some workers affected more than others? Answers to questions such as these are important if we are going to better understand the profound impacts the ICTs revolution has caused. To quote a commentary in CQ Researcher,

> "The computer revolution has given the modern workplace an array of new options and improved efficiency. But far from having a calming effect on overworked employees, computerization has itself become a source of increasing psychological stress." (August 14, 1992: 703)

Further, although actual overall job stability and security changed very modestly in both Canada and the United States up to the mid-1990s, this small change in the aggregate masks rather sharp declines or rises for certain groups of workers (e.g., Neumark, Polsky and Hansen (1999), Picot, Lin and Pyper (1998), Schmidt and Svorny (1998), Picot and Lin (1997)). Does the adoption of ICTs contribute in any way to changes in job security and stability? If so, are the impacts felt uniformly across the board or diversely across different groups of workers?

In addition, ICTs have increasingly replaced humans to perform a great number of complex and challenging tasks. As a result, many processes and tasks have been automated or routinized. Has this made work more or less interesting/boring? If yes, are the impacts invariant across all workers or some workers are affected more than others?

While effects of ICTs on such areas as productivity, wages, firm performance are well researched and documented, there has been far less effort and work on job quality as measured in psychological stress, job security and work interest. The objective of this paper is hence to add to the literature empirical evidence on effects of ITCs on dimensions as mentioned above.

Using the nationally representative survey on access to and use of information and communication technology of Statistics Canada, this paper attempts to empirically address the following specific questions: Does having to learn new computer skills cause extra stress?[3] Do computers affect work and to what extent? To the extent that work is affected, do computers make job more or less secure?[4] Do computers make work more or less interesting? Are the effects of computers on these measures of job quality felt invariably in the same way by all workers or differently by workers with different attributes?

The presentation of materials proceeds as the following. Section 2 briefly describes the data used for the analysis, discusses our model and explanatory variable specifications, sample restrictions, and estimation. Section 3 presents and discusses our results on the effects of computers and automated technology: 3.1 for findings on stress in the workplace; 3.2 on work being affected; 3.3 on job security change; and 3.4 on work interest change. Finally, Section 4 concludes.

[3] The use of computers may cause work-related stress in many ways, see detailed descriptions in Carayon-Sainfort (1992) and Brod (1984). In the context of our data, we are only able to assess the effects of the need to learn new computer skills on stress.

[4] What we examine here is perceived rather than actual job security, i.e., if workers feel that computers make their job more or less secure.

2. Data, Model, Sample, and Estimation

We use data extracted from the public use microdata file of the 14th cycle of the General Social Survey of Statistics Canada, conducted from January through December 2000 (GSS 2000). The target population for this survey is all Canadians 15 years of age and older, who are not residents of the three territories (Yukon, Northwest and Nunavut) or full-time residents of institutions (e.g., the armed forces, correctional facilities, health-care institutions).

GSS 2000 is a household-based survey and has 25,090 respondents, representing approximately 24.6 million Canadians. It contains a wealth of information on access to and use of ICTs in Canada, especially computers and the internet, in the 12 months prior to the survey date. It also contains a wealth of information on respondents' personal and socio-economic characteristics.[5]

All research questions addressed in the paper are derived from the GSS direct questioning of respondents on the effects of computers and automated technology, see Appendix 1 for details. For notational convenience, we term "computers and automated technology" in short as "computers".

The first question we try to address is whether having to learn new computer skills causes excess worry or stress in the workplace and if so, whether the stress varies with observable demographic attributes, geographic locations, and work characteristics. The dependent variable takes on the value of 1 if it does and 0 otherwise. Given that the dependent variable is dichotomous, logit or probit regression is the appropriate estimation technique.

The second question we attempt to answer is whether work is affected by computers and if so, the extent to which work is affected. The survey provides four mutually exclusive answers. We combine the "hardly" and "not at all" cases into one category and thus, the dependent variable takes on three values: one for "work being greatly affected"; another for "work being somewhat affected"; and the remaining for "work being hardly or not at all affected". Since the dependent variable has more than two discrete values and these values are ordinal, ordered logit or probit regression is the appropriate estimation technique.

The sub-sample of those who state that their work is greatly or somewhat affected by computers is further asked if computers have changed their job security and work interest. Our third research question is thus how computers have changed job security. In the context of the survey, the dependent variable has three discrete and ordinal values: one for "job security has increased"; another for "job security has stayed the same"; and the rest for "job security has decreased". Like the previous case, ordered logit or probit regression is the appropriate estimation technique.

[5] See Statistics Canada (2001) for details on the survey's sample design, collection method, processing and weighting process, contents, and so on.

Finally, the fourth question addressed in the paper is how computers have changed work interest. The survey provides three mutually exclusive answers: "work has become more interesting"; "no change in work interest"; and "work has become less interesting". So, the dependent variable has three discrete and ordinal values corresponding to each answer and as such, ordered logit or probit regression is the appropriate estimation technique.

Explanatory variables for all four models are workers' demographic attributes, geographic areas, and work characteristics. Within the context of our data, demographic attributes include gender, age, education attainment, and country of birth. These demographic attributes are commonly used controls in the literature and as such, their inclusion in the models as regressors warrants no further justification.

Canada is a large country composed of economically diverse regions. As computer use varies somewhat from one area to another (Lin and Popovic (2002a)), effects of computers are also expected to vary. Hence, geographic locations indicated by province and urban/rural area of residence are entered into the models as additional regressors.

Further, as computer usage differs substantially across a set of work characteristics, effects of computers are also expected to vary along these dimensions. Within the context of our data, these work characteristics include full-time or part-time work schedule, employee or self-employed (with or without paid help) employment type, industry, and occupation.

The final empirical samples used to estimate these equations include respondents aged 15 to 64 who were not full-time students at the time of the survey and were at work during the reference week. The sample for the stress equation consists of 7,741 observations, representing about 7.9 million workers who used computers at work. The work effect equation is modelled with the sample of 13,150 observations, representing about 13.4 million workers. The job security model is estimated on the sample of 7,744 observations, representing about 7.9 million workers who stated that their work has been greatly or somewhat affected by computers. Finally, the sample used to estimate the work interest model is made up of 7,779 observations, representing about 7.9 million workers who stated that their work has been greatly or somewhat affected by computers.[6] All the equations are estimated with weighted data using the survey sample weight.

Appendix 2 itemizes variable definitions and relevant sample statistics. The job security and work interest equations are also estimated on the sub-samples split by whether work has been greatly or somewhat affected by computers, and descriptive statistics for these sub-samples are presented in Appendix 3.

[6] Although the job security and work interest equations are estimated on the sub-sample of those who state that their work is greatly or somewhat affected by computers, the final samples for these equations differ slightly because of missing values in the explanatory variables, which also slightly affects the final samples for these equations when those who state that their work is greatly affected by computers are split from those who state that their work is somewhat affected.

For the purpose of our analysis, the GSS offers a number of advantages. First of all, it is the first nationally representative survey focusing on ICTs. Along with the wealth of information on respondents' personal characteristics, the data permit an in-depth analysis for the first time on use of and particularly, the effects of computers.[7] Secondly, its large sample size ensures the statistical reliability of findings and also makes sub-national analysis possible. Of course, it also suffers numerous limitations. Most noticeably, the lack of information on employer characteristics (e.g., firm size by the number of employees or assets/revenues; ownership (Canadian vs foreign); human resources management practices such as compensation pay, employee involvement); business strategy such as increasing employees' skills, expanding into new markets) prevents us from examining if the effects of computers are felt differently by workers working for different types of employers.[8] Also, a sizeable portion of the sample has missing information on annual income, which undesirably reduces the useful empirical samples if this variable is used as a covariate.[9]

[7] Other surveys also have questions on use of computers and other advanced technologies (e.g., GSS 1989 and GSS 1994 of Statistics Canada, the longitudinal Workplace and Employee Survey of Statistics Canada, the 1999 survey of Information and Communications Technologies and Electronic Commerce of Statistics Canada, the 1997-98 survey on Information Highway and the Canadian Communications Household of Ekos Research Associates Inc.). But their focus is not on computers and as a result, they lack the detailed questioning on the effects to allow an in-depth analysis as conducted here.

[8] This is nonetheless a limitation all household-based surveys face.

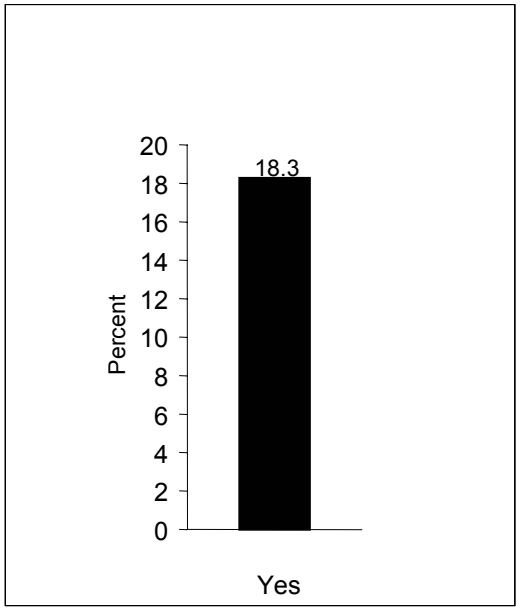
[9] Non-respondents ("Don't know" or "Refused") to this variable amount to about one-third of the sample. Our final specification excludes income as an explanatory variable to gain sample size but we did try to include it as an additional regressor at the expense of reduced samples in our earlier runs and the results did not make any meaningful difference.

3. Empirical Results

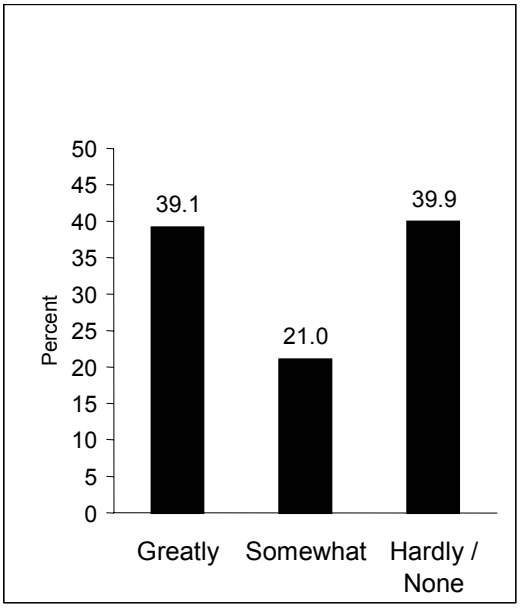
3.1 Workplace stress

Figure 1
Effects of computers

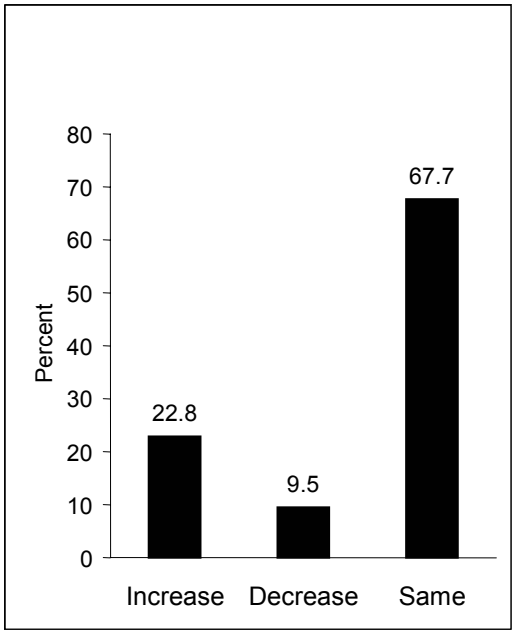
a: Does the need to learn new computer skills cause workplace stress?



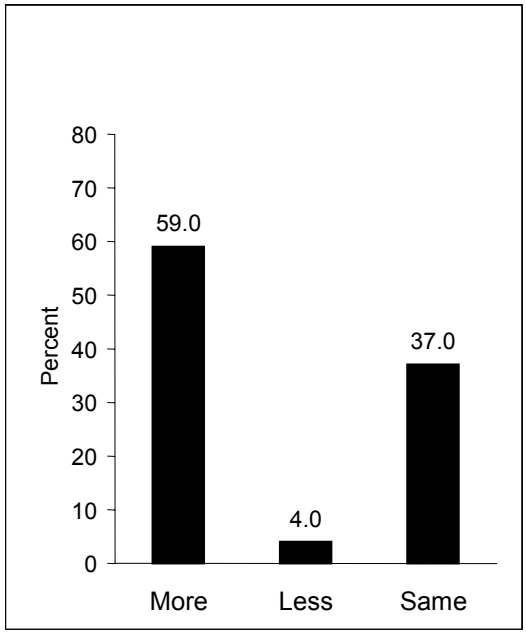
b: To what extent is work affected by computers?



c: How do computers change job security?



d: Do computers make job more or less interesting?



In the country as a whole, over 18% of workers who used computers stated that having to learn new computer skills caused them excess stress (Figure 1a). Table 1 reports the estimated probabilities that having to learn new computer skills causes stress (Column 1) and that work is affected by the introduction of computers (Columns 2, 3 and 4), calculated from the logit and ordered-logit regression results which are shown in Appendix 4.[10]

Table 1
Estimated probabilities of stress caused and work affected by computers

	Stress %	Work affected Hardly/not at all %	Work affected Somewhat %	Work affected Greatly %
Male	16.7	34.8	25.6	39.6
Female	16.7	41.4	25.5	33.1
Age1524	13.1	44.9	25.1	30.0
Age2534	13.1	40.5	25.6	34.0
Age3544	17.0	35.8	25.6	38.5
Age4554	21.4	33.7	25.5	40.8
Age5564	20.5	39.6	25.6	34.8
Edulhs	18.7	60.7	20.8	18.4
Eduhs	18.7	44.5	25.1	30.3
Edups	18.7	34.6	25.6	39.8
Eduuni	13.5	26.8	24.3	48.8
Can	16.3	35.9	25.6	38.4
Notcan	18.8	46.4	24.8	28.8
ONT	17.1	38.1	25.7	36.3
NFL	17.1	48.3	24.5	27.2
PEI	17.1	38.1	25.7	36.3
NS	17.1	38.1	25.7	36.3
NB	17.1	38.1	25.7	36.3
QC	17.1	38.1	25.7	36.3
MAN	17.1	38.1	25.7	36.3
SAS	17.1	38.1	25.7	36.3
AL	17.1	33.2	25.5	41.3
BC	14.7	38.1	25.7	36.3
Rural	16.7	36.1	25.7	38.2
Urban	16.7	38.2	25.7	36.2
Full	16.7	36.6	25.7	37.8
Part	16.7	47.9	24.5	27.6
Emp	16.7	36.9	25.7	37.4
See	16.7	36.9	25.7	37.4
Sene	16.7	44.7	25.1	30.2

(continued)

[10] Probit and ordered probit regressions are also run and show very similar qualitative results, which are not reported here but available from the authors upon request. These regressions are also run for the work effect, job security and work interest equations to be discussed later.

Table 1 (concluded)
Estimated probabilities of stress caused and work affected by computers

	Stress %	Hardly/not at all %	Work affected Somewhat %	Greatly %
Manu	15.2	30.7	25.2	44.1
Agri	15.2	30.7	25.2	44.1
Forest	15.2	30.7	25.2	44.1
Util	15.2	30.7	25.2	44.1
Cons	15.2	55.7	22.5	21.8
Trade	15.2	37.6	25.7	36.8
Trans	15.2	37.8	25.7	36.5
Finance	18.9	23.9	23.4	52.7
Profes	15.2	25.7	24.0	50.3
Manage	20.7	39.9	25.6	34.5
Educ	22.2	41.5	25.5	33.1
Health	15.2	53.5	23.2	23.3
Info	15.2	30.7	25.2	44.1
Accom	14.6	53.9	23.1	23.1
Others	13.7	50.6	23.9	25.5
Public	18.2	30.7	25.2	44.1
Mana	15.0	28.0	24.6	47.4
Prof	21.4	25.2	23.8	51.0
Tech	15.0	28.0	24.6	47.4
Clerical	15.0	28.0	24.6	47.4
Sales	15.0	45.7	24.9	29.3
Trades	15.0	49.2	24.3	26.5
Primary	15.0	60.5	20.9	18.6
Process	20.8	57.6	21.9	20.5

Note: Coefficients of explanatory variables that are not significantly different from zero at the 10% level are set to zero. The estimated probability is evaluated at the mean. For dummy variables, this is done by using the sum of the unweighted coefficients of the variable and the weighted coefficients of other groups of dummy variables, where the weight is the corresponding variable's share in the sample.

Everything else being equal, there does not appear to be any gender difference as male and female workers are equally likely to report stress caused by having to learn new computer skills (at 16.7%).

The likelihood for the need to learn new computer skills to cause stress in the workplace positively increases with age. The incidence of stress caused by having to learn new computer skills is estimated at 13% for workers under 35 and rises above 20% for workers over 45. This may in part be explained by the hypothesis that young workers are able to master computer skills faster/more easily than their older counterparts and hence feel less frustrated/stressed by the need to learn these skills.

Whether or not the worker has a university education makes a big difference. The estimated incidence of stress caused by having to learn new computer skills among workers with a university degree or beyond is only two-thirds of that estimated for workers whose education is below the university level (13.5% compared to 18.7%). This may also in part be explained by the hypothesis that better educated workers are able to master computer skills faster/more easily than their counterparts with lower education.

Foreign-born workers are more likely to report stress caused by having to learn new computer skills than those born in Canada (18.8% vs 16.3%). This may have something to do with the language barrier foreign-born workers face, especially among those newly arrived.

Stress caused by the need to learn new computer skills does not appear to be related to where a worker lives (an urban vs rural area or province), his/her work schedule (full-time relative to part-time), his/her employment type (paid work, self-employed with paid help, or own-account self-employed). But it does vary significantly with where a worker works in terms of industry and occupation. It is less likely to report this stress in accommodation and other services (around 14%), markedly more likely to experience it in education, management, finance and public administration (all over 18%), than in other industrial sectors (at 15%). By occupation, it is substantially more likely to report this stress in professional and processing occupations (above 20%) than in other professions (15%).[11]

3.2 Work being affected

Overall, nearly 40% of workers who used computers reported that their work has been greatly affected by the introduction of computers, 21% somewhat affected, and the remaining 40% hardly or not at all affected (Figure 1b). After controlling for other observables, male workers seem more likely to be affected by computers than their female counterparts. The probability that work is greatly affected by computers is estimated at 40% for men compared to 33% for women. On the other hand, the likelihood that computers hardly or not at all affect work is around 35% for men compared to 41% for women.[12]

The effect of computers on work appears to rise with age. The likelihood that work is greatly affected is estimated at 30% for the youngest group of workers, steadily rises for older groups and reaches 41% for those 45 to 54 years of age. On the contrary, the probability that computers hardly or not at all affect work is 45% for workers aged 15 to 24, gradually declines for older groups and reaches 34% those aged 45 to 54.

[11] The industrial and occupational variations in this incidence may be caused by factors that cannot be investigated in this paper (e.g., workers' existing level of computer skills, the degree of complexity of the skills that need to be learned). But they are not caused by the different levels of having to learn new computer skills as the industries and occupations observed with high incidence of stress here are not necessarily observed with high levels of the need to learn new computer skills, and vice versa, see Lin and Popovic (2002b).

[12] There is not much variation in the probability that computers somewhat affect work along the gender line. In fact, there is not much variation in this probability across all the explanatory variables.

Computers have a significantly greater impact on better-educated workers. It is estimated that the work of 18% of workers with less than high school education is greatly affected by computers. This likelihood dramatically increases for better-educated workers and reaches 49% for those who have obtained at least a university degree. In contrast, the likelihood that computers hardly or not at all affect work is estimated at over 60% for workers with less than high school education, substantially drops for better-educated workers and reaches 26% for workers with at least a university degree.

Native-born workers are more likely than their foreign-born counterparts to be affected by computers. The likelihood that work is affected greatly is estimated at 38% and hardly or not at all at 36% for workers born in Canada. In comparison, the corresponding likelihood is 29% and 46% for workers born outside of the country, respectively.

Computers do not affect work much differently across the provinces except for Alberta where a bigger impact is observed and for Newfoundland where a smaller impact is detected. Workers living in rural areas are slightly more likely to be affected by computers than their counterparts residing in urban areas. It is estimated that the work of 38% of workers living in rural areas is greatly affected by computers compared to that of 36% of those residing in urban areas. The exact opposite hold true with respect to hardly or no impact at all (36% for rural residents vs 38% for urban residents).

Work schedule makes a big difference --- full-time workers are significantly more likely to be affected by computers than those working part-time. The probability that computers greatly affect work is estimated at 38% for full-time workers, 10 percentage points higher than that for their part-time counterparts. On the other hand, the likelihood that work is hardly or not at all affected by computers is estimated at 37% for those working full-time, 11 percentage points lower than that for part-time workers.

Computers have a smaller impact on the work of the own-account self-employed than that of the self-employed who hire others as well as that of wage and salary workers. On average, the probability that work is greatly affected by computers is 30% and hardly or not at all 45% for the self-employed who do not hire any paid help. In contrast, the corresponding likelihood is 37% and 37% for the self-employed with employees and regular paid employees, respectively.

The effect of computers varies significantly across industrial sectors. The most affected ones are finance and professional services where the work of over half of workers is affected greatly and under a quarter hardly or not at all. And the least impacted ones are construction, health and accommodation in which the work of under a quarter of workers is affected greatly and over half hardly or not at all.

There are also significant variations in the effects of computers on work by occupations. The estimated likelihood of work being greatly affected by computers ranges from a high of 51% in professional occupations to a low of under 20% in primary and processing professions. On the other hand, the probability that work is hardly or not at all affected is estimated at 25% for professional compared to around 60% for primary and processing professions.

All these results are not surprising as they, to a large degree, point to a positive association between the extent to which work is affected by computers and the extent/frequency of computer usage. When a characteristic is observed to be associated with a higher/more frequent use of computers, it is also identified to be associated with work being more affected; and vice versa (detailed analysis on incidence and frequency of computer use is provided in Lin and Popovic (2002a)).[13]

Respondents who stated that their work has been greatly or somewhat affected by computers are further asked how their work is affected in terms of whether their job security has increased, decreased or stayed the same and whether their work has become more interesting, less interesting or stayed the same. Answers to these questions are also analyzed and what follows shows the results.

3.3 Has job become more/less secure?

Of those who stated that their work has been affected (greatly or somewhat) by the introduction of computers, 23% felt that their job security has increased, 68% thought that their job security has stayed the same, and the remaining 10% reported that their job security has decreased (Figure 1c). Table 2 reports the estimated probabilities that job security and work interested are affected by the introduction of computers, calculated from the ordered-logit regression results as shown in Appendix 4.

Everything else being equal, male workers benefit more from computers in terms of job security than their female counterparts. It is estimated that 22% of men are observed with a job security increase as a result of the introduction of computers compared to 16% among women. On the other hand, 8% of men are detected with a job security decrease relative to 12% for women.[14]

[13] Note that the three measures refer to different timeframes: work effects to the past five years; computer use to the past year; and frequency of computer use to the past month. Nevertheless, the positive link among the three is apparent.

[14] There are only small variations in the probability that job security has not changed as a result of the introduction of computers across all the explanatory variables.

Table 2 Estimated probabilities of job security and work interest changed by computers						
	Job security			Work interest		
	Decreased	Same	Increased	Decreased	Same	Increased
	%	%	%	%	%	%
Male	8.4	69.8	21.8	4.0	38.5	57.5
Female	11.5	72.0	16.5	3.6	36.1	60.3
Age1524	6.2	66.0	27.7	3.4	34.7	62.0
Age2534	7.5	68.5	24.1	3.4	34.7	62.0
Age3544	9.1	70.6	20.3	4.0	38.5	57.5
Age4554	13.3	72.4	14.3	4.1	38.9	57.0
Age5564	14.2	72.4	13.4	4.3	40.0	55.7
Edulhs	9.7	71.0	19.3	3.7	36.5	59.8
Eduhs	9.7	71.0	19.3	4.8	42.0	53.2
Edups	9.7	71.0	19.3	3.7	36.5	59.8
Eduuni	9.7	71.0	19.3	3.7	36.5	59.8
Can	9.8	71.2	19.0	3.9	38.0	58.1
Notcan	8.7	70.2	21.1	3.3	34.4	62.2
ONT	9.5	70.9	19.6	4.0	38.2	57.8
NFL	9.5	70.9	19.6	4.0	38.2	57.8
PEI	9.5	70.9	19.6	4.0	38.2	57.8
NS	9.5	70.9	19.6	4.0	38.2	57.8
NB	9.5	70.9	19.6	4.0	38.2	57.8
QC	11.2	72.0	16.8	4.0	38.2	57.8
MAN	9.5	70.9	19.6	4.0	38.2	57.8
SAS	9.5	70.9	19.6	4.0	38.2	57.8
AL	7.6	68.7	23.8	2.8	31.2	66.0
BC	9.5	70.9	19.6	4.0	38.2	57.8
Rural	9.7	71.0	19.3	3.8	37.4	58.8
Urban	9.7	71.0	19.3	3.8	37.4	58.8
Full	9.4	70.8	19.7	3.8	37.4	58.8
Part	12.6	72.3	15.0	3.8	37.4	58.8
Emp	9.7	71.0	19.3	3.9	37.8	58.3
See	9.7	71.0	19.3	3.9	37.8	58.3
Sene	9.7	71.0	19.3	3.2	33.6	63.2

(continued)

Table 2 (concluded)
Estimated probabilities of job security and work interest changed by computers

	Job security			Work interest		
	Decreased	Same	Increased	Decreased	Same	Increased
	%	%	%	%	%	%
Manu	7.3	68.1	24.6	3.2	33.7	63.1
Agri	7.3	68.1	24.6	3.2	33.7	63.1
Forest	11.1	71.9	16.9	3.2	33.7	63.1
Util	11.9	72.2	15.9	5.0	42.9	52.1
Cons	7.3	68.1	24.6	5.2	43.7	51.2
Trade	8.7	70.2	21.1	4.2	39.5	56.3
Trans	10.2	71.5	18.3	4.9	42.6	52.5
Finance	12.7	72.4	14.9	4.0	38.3	57.7
Profes	7.6	68.6	23.8	3.2	33.7	63.1
Manage	9.9	71.2	18.9	3.2	33.7	63.1
Educ	13.1	72.4	14.5	4.3	40.0	55.7
Health	13.4	72.4	14.2	6.0	46.8	47.2
Info	9.7	71.1	19.1	3.2	33.7	63.1
Accom	7.3	68.1	24.6	3.2	33.7	63.1
Others	9.4	70.9	19.7	3.2	33.7	63.1
Public	12.2	72.3	15.5	3.2	33.7	63.1
Mana	9.1	70.6	20.3	3.1	33.2	63.7
Prof	6.9	67.4	25.8	3.1	33.2	63.7
Tech	7.6	68.6	23.8	3.9	37.5	58.7
Clerical	9.1	70.6	20.3	3.1	33.2	63.7
Sales	12.5	72.3	15.2	5.1	43.6	51.3
Trades	15.4	72.3	12.3	5.6	45.4	49.0
Primary	9.1	70.6	20.3	5.3	44.4	50.3
Process	13.1	72.4	14.5	6.5	48.5	44.9

Note: Coefficients of explanatory variables that are not significantly different from zero at the 10% level are set to zero. The estimated probability is evaluated at the mean. For dummy variables, this is done by using the sum of the unweighted coefficients of the variable and the weighted coefficients of other groups of dummy variables, where the weight is the corresponding variable's share in the sample.

While the impact of computers on job security is not correlated with workers' education attainment, it varies significantly across age groups and younger workers benefit more than their older counterparts. The probability that computers have increased job security is estimated at 28% for those aged 15 to 24, steadily declines for older groups and reaches less than half as high (13%) for the oldest group of workers. In comparison, the probability that job security has decreased is 6.2% for the youngest group of workers, gradually rises for older groups and reaches over twice as high (14%) for those aged 55 and over.

Foreign-born workers are affected by computers slightly more favourably in terms of job security change than their native-born counterparts. The likelihood that computers have made jobs more secure is 21% for the former, slightly higher than that of 19% for the latter, and the probability that computers have decreased job security is 8.7% for the former, slightly lower than that of 9.8% for the latter.

The impact of computers on job security does not differ much across the country except for two provinces. Compared to the rest of the country, the likelihood that job security has increased as a result of the introduction of computers is lower for Quebec (17% vs 20%) and the probability that jobs have become less secure higher (11.2% vs 9.5%). On the contrary, the probability that computers have made jobs more secure is higher for Alberta (at 24%) and the likelihood that job security has decreased lower (7.6%).

Whether a worker lives in a rural or an urban area is not associated with how his/her job security is affected by computers, nor is whether he/she is a regular wage and salary employee or self-employed with or without hiring any paid help. However, the number of hours he/she works on a weekly basis makes quite a difference. It is estimated that 20% of full-time workers felt that their jobs have become more secure as a result of the introduction of computers, 25% higher than that for part-time workers. On the other hand, 9.4% of those working full-time indicated that computers have made their jobs less secure, 25% lower than that for those working part-time.

The impact of computers on job security varies significantly across industries. Workers in manufacturing, agriculture, construction and accommodation gain the most as the probability that computers have made job more secure is the highest (nearly 25%) and that computers have made job less secure the lowest (at 7.3%). On the other hand, workers in finance and health services benefit the least as the estimated probability that computers have made job more/less secure is the lowest/highest (under 15% and over 13%, respectively).

The impact of computers on job security also differs markedly across occupations. The highest estimated probability that jobs have become more secure as a result of the introduction of computers is detected in the professional occupations (over 25%), over twice as high as in the trade professions (at 12%). The former is also observed with the lowest probability that computers have made jobs less secure (7%), under half of the highest also observed in the latter (over 15%).

To distinguish those whose work has been greatly affected by computers from those whose work has only been somewhat affected, we also run ordered-logit regressions on job security change on the respective sub-samples. While these regression results are shown in Appendix 5, Table 3 reports the estimated probability based on these results that job has become more or less secure as a result of the introduction of computers for these two groups of workers.

Table 3
Estimated probability of job security changed by computers, conditional on work being greatly or somewhat affected

	Job security (work greatly affected)			Job security (work somewhat affected)		
	Decreased	Same	Increased	Decreased	Same	Increased
	%	%	%	%	%	%
Male	8.6	64.0	27.4	4.6	79.8	15.6
Female	12.0	67.3	20.7	5.7	81.5	12.8
Age1524	5.5	56.6	37.9	3.7	77.5	18.8
Age2534	7.3	61.6	31.1	3.7	77.5	18.8
Age3544	9.4	65.1	25.4	4.9	80.4	14.7
Age4554	13.6	68.0	18.4	8.2	82.8	9.0
Age5564	15.8	68.3	15.9	6.2	81.9	11.9
Edulhs	10.0	65.7	24.3	7.5	82.6	9.8
Eduhs	10.0	65.7	24.3	5.1	80.7	14.2
Edups	10.0	65.7	24.3	4.6	79.9	15.5
Eduuni	10.0	65.7	24.3	5.1	80.8	14.1
Can	10.0	65.7	24.3	5.1	80.7	14.3
Notcan	10.0	65.7	24.3	5.1	80.7	14.3
ONT	9.6	65.3	25.1	5.3	81.0	13.6
NFL	9.6	65.3	25.1	5.3	81.0	13.6
PEI	9.6	65.3	25.1	5.3	81.0	13.6
NS	9.6	65.3	25.1	5.3	81.0	13.6
NB	9.6	65.3	25.1	5.3	81.0	13.6
QC	12.3	67.5	20.2	5.3	81.0	13.6
MAN	9.6	65.3	25.1	5.3	81.0	13.6
SAS	9.6	65.3	25.1	5.3	81.0	13.6
AL	7.2	61.3	31.5	5.3	81.0	13.6
BC	9.6	65.3	25.1	3.8	77.9	18.3
Rural	10.0	65.7	24.3	5.1	80.7	14.3
Urban	10.0	65.7	24.3	5.1	80.7	14.3
Full	9.8	65.5	24.7	4.9	80.4	14.8
Part	12.1	67.4	20.5	6.8	82.4	10.8
Emp	10.0	65.7	24.3	5.1	80.7	14.3
See	10.0	65.7	24.3	5.1	80.7	14.3
Sene	10.0	65.7	24.3	5.1	80.7	14.3

(continued)

Table 3 (concluded)
Estimated probability of job security changed by computers conditional on work being greatly or somewhat affected

	Job security (work greatly affected)			Job security (work somewhat affected)		
	Decreased	Same	Increased	Decreased	Same	Increased
	%	%	%	%	%	%
Manu	7.5	62.0	30.6	4.7	80.0	15.4
Agri	7.5	62.0	30.6	4.7	80.0	15.4
Forest	15.8	68.3	16.0	4.7	80.0	15.4
Util	13.1	67.8	19.1	4.7	80.0	15.4
Cons	7.5	62.0	30.6	2.7	73.1	24.2
Trade	7.5	62.0	30.6	4.7	80.0	15.4
Trans	11.9	67.3	20.8	4.7	80.0	15.4
Finance	13.6	68.0	18.4	8.1	82.7	9.1
Profes	7.8	62.7	29.5	4.8	80.2	14.9
Manage	7.8	62.7	29.5	4.8	80.2	14.9
Educ	13.4	67.9	18.7	8.1	82.7	9.2
Health	14.0	68.1	17.9	4.7	80.0	15.4
Info	10.9	66.6	22.5	4.7	80.0	15.4
Accom	7.5	62.0	30.6	4.7	80.0	15.4
Others	11.0	66.7	22.3	4.7	80.0	15.4
Public	12.6	67.6	19.8	7.9	82.7	9.3
Mana	10.2	66.0	23.8	3.9	78.1	18.1
Prof	7.3	61.7	31.0	3.9	78.1	18.1
Tech	7.6	62.2	30.3	3.9	78.1	18.1
Clerical	10.2	66.0	23.8	3.9	78.1	18.1
Sales	13.0	67.8	19.2	6.4	82.1	11.5
Trades	14.8	68.2	17.0	8.8	82.8	8.4
Primary	10.2	66.0	23.8	8.8	82.8	8.4
Process	13.4	67.9	18.7	3.9	78.1	18.1

Note: Coefficients of explanatory variables that are not significantly different from zero at the 10% level are set to zero. The estimated probability is evaluated at the mean. For dummy variables, this is done by using the sum of the unweighted coefficients of the variable and the weighted coefficients of other groups of dummy variables, where the weight is the corresponding variable's share in the sample.

These results demonstrate that while the magnitudes of computers' effects on job security differ from one group of workers to the other, substantially in some cases, the qualitative patterns observed above largely remain unchanged for both groups. That is, male workers benefit more than their female counterparts; younger workers profit more than older ones; workers in Quebec are disadvantaged while those in Alberta gain relative to the rest of the country. Full-time workers benefit more than those working part-time. In terms of industries and occupations, while the manufacturing, agriculture, construction and accommodation sectors benefit the most, the finance and health industries gain the least; the professional occupations gain the most, the trades professions benefit the least.

3.4 Has work become more/less interesting?

For the country as a whole, nearly six out of ten workers who stated that their work has been affected (greatly or somewhat) by the introduction of computers reported that their work has become more interesting as a result of the introduction of computers, over one-third reported that their work has become neither more nor less interesting, and 4% stated that their work has become less interesting (Figure 1d). Controlling for other observable characteristics, women gain marginally more than men from computers in terms of work interest change. The likelihood that work has become more interesting as a result of the introduction of computers is 60% for women compared to 58% for men, and the probability that work has become less interesting is 3.6% for women compared to 4.0% for men (Table 2).[15]

Although education attainment does not make much of a difference, the impact of computers on work interest varies across age groups and younger workers gain more. The probability that computers have made work more interesting is estimated at 62% for those under 35 years of age, gradually declines to 56% for the oldest group. On the other hand, the likelihood that work has become less interesting as a result of the introduction of computers is 3.4% for those aged 15-34, gradually rises to 4.3% for those aged 55 and over.

Foreign-born workers benefit more from computers than their native-born counterparts. It is estimated that the work of 62% of the former has become more interesting as a result of the introduction of computers compared to 58% for the later. On the other hand, the likelihood that computers have made work less interesting is 3.3% for the former compared to 3.9% for the later.

The impact of computers on work interest does not differ with respect to where a worker lives, an urban or rural area or which province except for Alberta where the estimated probability that computers have made work more interesting is higher (66% vs 58%) and the probability that work has become less interesting lower (2.8% vs 4%) relative to other provinces.

The impact of computers on work interest does not vary whether a worker works full-time or part-time. Nor does it if he/she is a regular employee or a self-employed with paid help. However, those working on their own without hiring others benefit more. It is estimated that 63% of the own-account self-employed felt that their work has become more interesting as a result of the introduction of computers and 3.2% thought that their work has become less interesting compared to 58% and 3.9%, respectively, for employees and the self-employed employers.

[15] The probability that work interest has stayed the same as a result of the introduction of computers does not vary much across all the explanatory variables.

There are significant industrial variations in the effects of computers on work interest. The estimated probability that computers have made work more interesting ranges from a low of 47% for health and 51% for construction and to a high of 63% for manufacturing, agriculture, forestry, professional services, management, information services, accommodation services, public administration and other services. And the contrary holds true for the likelihood that work has become less interesting as a result of the introduction of computers.

There are also significant variations in the impact of computers on work interest by profession. At the high end, the likelihood that work has become more interesting as a result of the introduction of computers is estimated at 64% for the managerial, professional and clerical occupations. At the other end of the scale, it is as low as 45% for processing and 49% for trades. The reverse is true for the probability that work has become less interesting.

As in the case of computers impact on job security, we also run the ordered-logit regressions for the impact of computers on work interest on the sub-samples of those whose work has been greatly affected by computers and those whose work has only been somewhat affected. While these regression results are also shown in Appendix 5, Table 4 presents the estimated probability from these results that work has become more or less interesting as a result of the introduction of computers for these sub-samples.

Table 4
Estimated probability of work interest changed by computers technology, conditional on work being greatly or somewhat affected

	Work interest (work greatly affected)			Work interest (work somewhat affected)		
Decreased	**Same**	**Increased**	**Decreased**	**Same**	**Increased**	**Decreased**
%	**%**	**%**	**%**	**%**	**%**	**%**
Male	5.0	31.7	63.2	2.6	44.9	52.5
Female	5.0	31.7	63.2	2.2	40.9	56.9
Age1524	4.5	29.8	65.7	2.4	43.1	54.5
Age2534	4.5	29.8	65.7	2.4	43.1	54.5
Age3544	4.5	29.8	65.7	2.4	43.1	54.5
Age4554	5.9	34.8	59.3	2.4	43.1	54.5
Age5564	6.5	36.7	56.9	2.4	43.1	54.5
Edulhs	5.0	31.7	63.2	3.8	53.4	42.8
Eduhs	5.0	31.7	63.2	2.5	44.0	53.5
Edups	5.0	31.7	63.2	2.2	41.1	56.7
Eduuni	5.0	31.7	63.2	2.3	42.1	55.6
Can	5.2	32.3	62.5	2.5	43.7	53.8
Notcan	4.3	28.9	66.7	2.0	39.2	58.7
ONT	5.1	32.0	62.9	2.4	43.1	54.5
NFL	5.1	32.0	62.9	2.4	43.1	54.5
PEI	5.1	32.0	62.9	2.4	43.1	54.5
NS	5.1	32.0	62.9	2.4	43.1	54.5
NB	5.1	32.0	62.9	2.4	43.1	54.5
QC	5.1	32.0	62.9	2.4	43.1	54.5
MAN	5.1	32.0	62.9	2.4	43.1	54.5
SAS	5.1	32.0	62.9	2.4	43.1	54.5
AL	3.4	24.6	72.0	2.4	43.1	54.5
BC	6.5	36.8	56.7	2.4	43.1	54.5
Rural	5.0	31.7	63.2	2.4	43.1	54.5
Urban	5.0	31.7	63.2	2.4	43.1	54.5
Full	5.0	31.5	63.6	2.4	43.1	54.5
Part	6.0	35.3	58.7	2.4	43.1	54.5
Emp	5.1	32.1	62.7	2.5	43.6	53.9
See	5.1	32.1	62.7	2.5	43.6	53.9
Sene	4.1	27.7	68.3	2.0	38.3	59.8

(continued)

Table 4 (concluded) Estimated probability of work interest changed by computers conditional on work being greatly or somewhat affected						
	Work interest (work greatly affected)			Work interest (work somewhat affected)		
Decreased	Same	Increased	Decreased	Same	Increased	Decreased
%	%	%	%	%	%	%
Manu	4.2	28.4	67.4	2.1	40.2	57.6
Agri	4.2	28.4	67.4	2.1	40.2	57.6
Forest	4.2	28.4	67.4	1.3	29.0	69.7
Util	4.2	28.4	67.4	2.1	40.2	57.6
Cons	6.5	36.8	56.7	2.1	40.2	57.6
Trade	5.7	34.1	60.3	2.1	40.2	57.6
Trans	7.1	38.6	54.3	3.7	52.9	43.4
Finance	4.2	28.4	67.4	3.8	53.1	43.1
Profes	5.6	34.0	60.4	2.1	40.2	57.6
Manage	4.2	28.4	67.4	4.0	54.4	41.7
Educ	5.6	34.0	60.3	2.1	40.2	57.6
Health	7.1	38.5	54.4	3.6	52.4	44.0
Info	4.2	28.4	67.4	2.1	40.2	57.6
Accom	4.2	28.4	67.4	2.1	40.2	57.6
Others	4.2	28.4	67.4	2.1	40.2	57.6
Public	4.2	28.4	67.4	2.1	40.2	57.6
Mana	4.4	29.2	66.4	1.8	36.4	61.8
Prof	4.2	28.5	67.2	1.8	36.4	61.8
Tech	4.2	28.5	67.2	2.9	47.3	49.8
Clerical	4.2	28.5	67.2	1.8	36.4	61.8
Sales	6.4	36.5	57.1	3.1	49.0	47.9
Trades	8.1	41.0	50.9	2.7	45.9	51.4
Primary	8.5	41.9	49.7	3.5	51.4	45.2
Process	8.5	42.0	49.5	3.8	53.4	42.8

Note: Coefficients of explanatory variables that are not significantly different from zero at the 10% level are set to zero. The estimated probability is evaluated at the mean. For dummy variables, this is done by using the sum of the unweighted coefficients of the variable and the weighted coefficients of other groups of dummy variables, where the weight is the corresponding variable's share in the sample.

It is clear from these results that the overall impact of computers on work interest observed above is dominated by the greatly-affected sub-group as there is not much variation across most of the explanatory variables for the somewhat-affected group. Such as, it is not surprising that the qualitative patterns the overall sample displays above are strengthened, in most cases, when the analysis is done for the greatly-affected sub-group only. To recap, those aged under 45 gain more from computers in terms of work interest change than their older counterparts; foreign-born workers are affected more favourably than their native-born counterparts; workers living in Alberta are advantaged and in British Columbia disadvantaged relative to the rest of the country; the own-account self-employed gain more than wage and salary workers as well as the self-employed employers. Breakdown by industry and occupation, the health services and transportation industries profit less relative to other sectors; and the trades, primary and processing professions benefit less relative to other occupations.

4. Summary and discussion

Computers have reached nearly every corner of our lives, whose impacts are inevitably wide-spread and profound. Using the GSS 2000 of Statistics Canada, this paper has empirically investigated the effects of computers on several measures of job quality.

Does having to learn new computer skills cause extra stress in the workplace? The data on hand show that over 18% of computer-using workers thought so. Our regression results demonstrate that attributes that are significantly associated with workplace stress caused by the need to learn new computer skills include age, education, country of birth, industry and occupation. Specifically, having to learn new computer skills is more likely to cause workplace stress for older workers (e.g., workers aged 45 and over are nearly twice as likely to report this stress as those under 35). Workers with university education or beyond are less likely to experience this stress than their counterparts with below-university education. Foreign-born workers are more likely to report this stress than their native-born counterparts. It is less likely to report this stress in accommodation and other services, markedly more likely to experience it in education, management, finance and public administration. By occupation, it is substantially more likely to report this stress in professional and processing occupations.

Is work affected by the introduction of computers? The survey shows that 39% of workers reported that their work has been greatly affected, another 21% said that their work has been somewhat affected, while the remaining 40% felt that their work has been hardly or not at all affected. Our regression results reveal that characteristics that are significantly correlated to work being affected by computers include gender (greater impact on men), age (greater impact on older workers), education (greater impact on the better-educated), country of birth (greater impact on the native-born), area of residence (greater impact on those living in rural areas), work schedule (significantly greater impact on full-time workers), employment type (smaller impact on the own-account self-employed), industry (the most affected are finance and professional services and the least are health and accommodation), and occupation (professional occupations are the most affected and the primary and processing professions the least).

Has job become more or less secure as a result of the introduction of computers? Of those who stated that their work has been affected (greatly or somewhat), 23% felt that their job has become more secure, another 9% reported that their job has become less secure, while the majority (68%) thought that their job security has stayed the same. Our regression results demonstrate that observable attributes that are significantly correlated with job security change as a result of the introduction of computers include gender (men benefit more), age (younger workers benefit more), country of birth (foreign-born workers are affected more favourably), work schedule (full-time workers benefit more), industry (the manufacturing, agriculture, construction and accommodation sectors benefit the most, the finance and health industries gain the least), and occupation (the professional occupations gain the most, the trades professions benefit the least). This is largely as true for those who felt their work has

been greatly affected by computers as for those who thought their work has only been somewhat affected.

Have computers made work more or less interesting? Of those who felt that their work has been affected, nearly six out of ten felt that their work has become more interesting, while 37% said that their work has become neither more nor less interesting and 4% stated that their work has become less interesting. Our regression results reveal that observable characteristics that are significantly associated with work interest change as a result of the introduction of computers include gender (women gain more), age (those aged under 35 benefit more), country of birth (foreign-born workers are affected more favourably), and employment type (the own-account self-employed benefit more). There are also significant variations across industry and occupation. By industry, health and construction benefit the least and manufacturing, agriculture, forestry, professional services, management, information services, accommodation services, public administration and other services are the bigger winners. Across occupations, the managerial, professional and clerical occupations benefit more and the processing and trades professions gain the least. These results apply, to a large extent, only to those who felt that their work has been greatly affected. There is not much variation across most of the explanatory variables for those who thought that their work has only been somewhat affected.

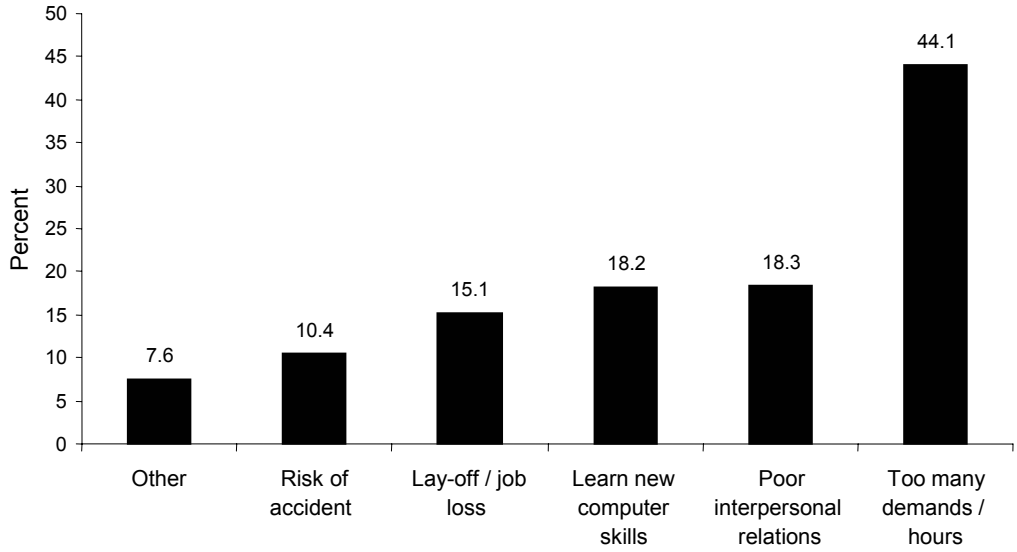
In short, our data clearly demonstrate that computers have profound impacts on the workplace --- six out of ten workers feel that their work has been affected. Taken together, these results paint a pretty good-news picture of computer effects on job quality. Measured by job security (perceived by workers rather than reflected in actual statistics on turnover or job tenure/duration), winners outnumber losers by a ratio of 2.4 to 1. Measured by work interest, nearly fifteen workers feel that their work has become more interesting for every worker reporting that work has become less interesting. True, computers also have negative effects --- nearly one out of five computer-using workers feel that having to learn new computer skills causes them extra stress at work.

There is also an issue of equity --- not all workers are affected in the same way. There indeed exist substantial variations in these effects over demographic and job-specific characteristics. For example, older workers are affected more and they are affected less favourably. Some industries are affected more, and some industries are affected more favourably.

What do all of these imply then? While the effects of computers on job security and work interest may be the inherent nature of the computer revolution and there does not seem to be much individual workers, employers and public policy makers can do about them, there is certainly something we can do about the need to learn new computer skills as a workplace stressor.

Workplace stress can be caused by many factors: 1) factors related to the job (e.g., noise, boredom, shiftwork, fear to exposures to dangerous materials); 2) the role of the individual worker in the organization (e.g., insufficient information to perform tasks, lots of responsibility but little authority and control); 3) social relationships and interpersonal demands; 4) prospects for promotion and advancement (e.g., inadequate recognition or reward for good performance); and 5) organizational structure and culture (e.g., inability to voice complaints or express feelings, prejudice) (see Sutherland and Cooper (1988)). Now our results also show that the need to learn new computer skills is an important source of stress in the workplace. Among the few workplace stressors surveyed in the GSS, having to learn new computer skills constitutes the third biggest source of stress, far behind too many demands/hours and close to poor interpersonal relations (see Figure 2).

Figure 2
Workplace stressors among computer users



Workplace stress can be very costly to both the employer and employee. In the short run, stress can lead to job dissatisfaction, which often results in absenteeism and reduced productivity. For example, Malik (1993) estimates that stress-related absenteeism costs the United States over $150 billion each year. Over the long run, stress can lead to health problems (e.g., heart disease, increased accident occurrence, poor mental health), substance abuse, and social/domestic problems (e.g., Friedman et al. (1996), Wheeler and Lyon (1992)).

Given all the negative outcomes of workplace stress, its reduction will be beneficial to workers, employers, and the society as a whole. As for having to learn new computer skills as a source of stress in the workplace, one effective way in reducing it is to equip workers with the required skills, be that general or specific.

Workers can explore various venues to learn and acquire these skills, be that formal or informal. Employers may encourage employees to do so by providing financial support and/or time off as well as providing direct training. From a public policy point of view, governments can encourage the population and employers to do so by providing financial incentives.

Training is generally regarded as an effective way for individuals to acquire various skills. We attempted in our modelling to address if participation in training helps reduce the incidence of workplace stress caused by the need to learn new computer skills. Unfortunately, we obtained no conclusive evidence largely due to the fact that nearly every computer-using worker took one form of training or another to learn computer skills. Future work (Lin, Carter and Popovic (2003)) will examine how Canadian workers acquire their computer skills, by way of formal training, on-the-job training, or through self-learning.[16]

With all of these in mind, we close with a couple of caveats. First, we would like to stress that the effects of computers on job quality examined here are self-rated by survey respondents. There may very well be discrepancy between perceived effects and actual ones.[17]

Second, the time period during which the survey is conducted (from January through December 2000) can be argued to be a very special phase of the business cycle. The overall economy, the high-tech sector in particular, has suffered a slowdown which resulted in massive layoffs ever since the completion of the survey. Coupled with accelerating advancements in computer and other advanced technologies, it may be reasonable to expect that responses could be different from what we have observed should the survey be conducted today. We therefore eagerly await data sources in the future to assess the impact of computers for different phases of the business cycle.

[16] GSS surveys 9 types of training respondents may take to learn computer skills and asks them to rate the importance of each method. WES asks similar questions. These training activities range from taking a formal course at an education institution, taking a course or program provided by an employer, to informal help from a coworker/friend/family member.

[17] A good example is the perceived rapid increases in job instability in the early 1990s compared to the actual mild change measured either by permanent layoffs (e.g., Picot and Lin (1997)) or job tenure (e.g., Heisz (1996)).

References

Autor, D., L. Katz and A. Krueger (1998), "Computing Inequality: Have Computers Changed the Labor Market?" *Quarterly Journal of Economics*, 113(4), 1169-1213.

Bakker, C. (2000), *Information and Communications Technologies and Electronic Commerce in Canadian Industry*, Ottawa: Statistics Canada Catalogue 88F0006XIB-00004.

Baldwin, J. and Z. Lin (2002), "Impediments to Advanced Technology Adoption for Canadian Manufacturers," *Research Policy*, 31, 1-18.

Baldwin, J., T. Gray and J. Johnson (1997), "Technology-Induced Wage Premia in the Canadian Manufacturing Plants during the 1980s," *Analytical Studies Branch Research Paper 92*, Ottawa: Statistics Canada.

Baldwin, J., B. Diverty and D. Sabourin (1995), "Technology Use and Industrial Transformation: Empirical Perspectives," *Analytical Studies Branch Research Paper 75*, Ottawa: Statistics Canada.

Bound, J. and G. Johnson (1992), "Changes in the Structure of Wages in the 1980's: An Evaluation of Alternative Explanations," *American Economic Review*, 82, 371-92.

Bresnahan, T. and S. Greestein (2001), "The Economic Contribution of Information Technology: Towards Comparative and User Studies," *Journal of Evolutionary Economics*, 11, 95-118.

Brod, C. (1984), *Technostress: The Human Cost of the Computer Revolution*, MA: Addison-Wesley.

Carayon-Sainfort, P. (1992), "The Use of Computers in Offices: Impact on Task Characteristics and Worker Stress," *International Journal of Human-Computer Interaction*, (4(3), 245-61.

Cohen, R. (1995), "The Economic Impact of Information Technology," *Business Economics*, 30(4), 21-25.

CQ Researcher (1992) "Workplace Stress: Is the Computer a Friend or Foe?" *Work, Family and Stress: Can Overworked Americans Cope with Today's Time Crunch?* 2(30), 703, Washington: Congressional Quarterly Inc.

Dinardo, J. and J. Pischke (1997), "The Returns to Computer Use Revisited: Have Pencils Changed the Wage Structure too?" *Quarterly Journal of Economics,* 112(1), 291-303.

Edwards, J. (1985), "Job Satisfaction and Job Stress as Competing Predictors of Job Outcomes," *Graduate School of Industrial Administration Working Paper 14*, Schenley Park: Carnegie-Mellon University.

Ekos (1998), *The Information Highway and the Canadian Communication Household*, Ottawa: Ekos Research Associates Inc.

Entorf, H. and F. Kramarz (1997), "Does Unmeasured Ability Explain the Higher Wages of New Technology Workers?" *European Economic Review*, 41(8), 489-509.

French, M. and L. Dunlap (1998), "Compensating Wage Differentials for Job Stress," *Applied Economics*, 30(8), 1067-75.

Friedman, M., C. Thoresen, J. Gill (1996), "Alteration of Type A Behavior and Its Effects on Cardiac Recurrences in Post Myocardial Infarction Patients: Summary Results of the Recurrent Coronary Prevention Project," *American Heart Journal*, 112, 653-65.

Gera, S., G. Wulong and F. Lee (1999), "Information Technology and Labour Productivity Growth: An Empirical Analysis for Canada and the United States," *Canadian Journal of Economics*, 32(2), 384-407.

Greenan, N. and J. Mairesse (2000), "Computers and Productivity in France: Some Evidence," *Economics of Innovation and New Technology*, 9(3), 275-315.

Groot., W. and H. Maassen van den Brink (1999), "The Price of Stress," *Journal of Economic Psychology*, 20, 83-103.

Heisz, A. (1996), "Changes in Job Tenure and Job Stability in Canada," *Analytical Studies Branch Research Paper 95*, Ottawa: Statistics Canada.

HRDC (2002), *Knowledge Matters: Skills and Learning for Canadians*, Ottawa: Human Resources Development Canada Catalogue SP-482-02-02.

ILO (2001), "Life at Work in the Information Economy," *World Employment Report 2001*, Geneva: International Labour Organization.

Kling, R. and C. Dunlop (1993), "Controversies about Computerization and the Character of White Collar Worklife," *The Information Society*, 9, 1-29.

Kuhn, P. and M. Skuterud (2000), "Job Search Methods: Internet versus Traditional," *Monthly Labor Review*, 123(10), 3-11.

Lehr, B. and F. Lichtenberg (1999), "Information Technology and Its Impact on productivity: Firm-Level Evidence from Government and Private Data Sources, 1977-1993," *Canadian Journal of Economics*, 32 (2), 335-62.

Lichtenberg, F. (1995), "The Output Contributions of Computer Equipment and Personnel: A Firm-Level Analysis," *Economics of Innovation and New Technology,* 4(3), 201-17.

Light, G. and D. Moch (1999), "Innovation and Information Technology in Services," *Canadian Journal of Economics*, 32(2), 363-83.

Lin, Z. and A. Popovic (2002a), *Working with Computers in Canada: An Empirical Analysis of Incidence, Frequency and Purpose*, Ottawa: Applied Research Branch, Human Resources Development Canada (forthcoming).

Lin, Z. and A. Popovic (2002b), *Workplace Computer Technology and Skill Upgrading in Canada*, Ottawa: Applied Research Branch, Human Resources Development Canada (forthcoming).

Lin, Z., C. Carter and A. Popovic (2003), *Acquisition of Computer Skills in Canada: Formal Training, on-the-job Training, or Self-learning?* Ottawa: Applied Research Branch, Human Resources Development Canada (forthcoming).

Long, R. (1993), "The Impact of New Office Information Technology on Job Quality of Female and Male Employees," *Human Relations*, 46 (8), 93-61.

Lowe, G. (1997), "Computers in the Workplace," *Perspectives on Labour and Income* (Summer), 29-36, Ottawa: Statistics Canada Catalogue 75-001-XPE.

Malik, M. (1993), "All Stressed up and No Place to Go?" *Modern Office Technology*, 38, 27-28.

Marshall, K. (2001), "Working with Computers," *Perspectives on Labour and Income* (May), 5-11, Ottawa: Statistics Canada Catalogue 75-001-XIE.

Morissette, R. and M. Drolet (1998), "Computers, Fax Machines and Wages in Canada: What Really Matters", *Analytical Studies Branch Research Paper 126*, Ottawa: Statistics Canada.

Neumark, D., D. Polsky and D. Hansen (1999), "Has Job Stability Declined Yet?" *Journal of Labor Economics*, 17(4), 29-64.

OECD (2001), *Understanding the Digital Divide*, Paris: Organisation for Economic Co-Operation and Development.

Picot, G., Z. Lin and W. Pyper (1998), "Permanent Layoffs in Canada: Overview and Longitudinal Analysis," *Canadian Journal of Economics*, 31(5), 1154-78.

Picot, G. and Z. Lin (1997), "Are Canadians More Likely to Lose Their Jobs in the 1990s?" *Analytical Studies Branch Research Paper 96*, Ottawa: Statistics Canada.

Rubery, J. and D. Grimshaw (2001) "ICTs and Employment: The Problem of Job Quality," *International Labour Review*, 140(2), 165-92.

Appendix

Appendix 1 **GSS questions on computers and workplace stress, work being affected, job security and work interest**	
C6	Have any of the following things in your work environment caused you excess worry or stress in the past 12 months …
	a) Too many demands or too many hours? b) Risk of accident or injury? c) Poor interpersonal relations? d) Threat of layoff or job loss? e) Having to learn new computer skills? f) Anything else?
C7	In the last five years, how much has your work been affected by the introduction of computers or automated technology? Would you say …
	a) Greatly? b) Somewhat? c) Hardly? d) Not at all affected?
C8*	In the last five years, has your job security increased, decreased or stayed the same as a result of the introduction of computers or automated technology?
	a) Increased b) Decreased c) Stayed the same
C9*	In the last five years, has your work become more interesting, less interesting or stayed the same as a result of the introduction of computers or automated technology?
	a) More interesting b) Less interesting c) Stayed the same
* Only applicable to those who reported that their work has been greatly or somewhat affected by the introduction of computers or automated technology.	

Appendix 2
Variable definition and means (entire samples)

	Stress	Work affected	Job security	Work interest
Dependent Variable				
wstress = 1 if stressed or worried	0.1827	-	-	-
gaffect = 1 if work greatly affected	-	0.3909	-	-
saffect = 1 if work affected somewhat	-	0.2101	-	-
hnaffect = 1 if work hardly or not at all affected	-	0.3990	-	-
isecure = 1 if job security increased	-	-	0.2284	-
ssecure = 1 if job security stayed same	-	-	0.6770	-
dsecure = 1 if job security decreased	-	-	0.0946	-
minter = 1 if job became more interesting	-	-	-	0.5896
sinter = 1 if job became neither less nor more interesting	-	-	-	0.3702
linter = 1 if job became less interesting	-	-	-	0.0402
Independent Variable				
Male = 1 if gender is male	0.5180	0.5474	0.5589	0.5577
Female = 1 if gender is female	0.4820	0.4526	0.4411	0.4423
Age1524 = 1 if aged 15 to 24 years	0.0839	0.1072	0.0844	0.0847
Age2534 = 1 if aged 25 to 34 years	0.2631	0.2446	0.2462	0.2478
Age3544 = 1 if aged 35 to 44 years	0.3306	0.3082	0.3272	0.3256
Age4554 = 1 if aged 45 to 54 years	0.2439	0.2438	0.2570	0.2556
Age5564 = 1 if aged 55 to 64 years	0.0785	0.0963	0.0852	0.0862
Edulh = 1 if has less than a high school education	0.0403	0.1291	0.0645	0.0641
Eduhs = 1 if has a high school diploma	0.1592	0.2018	0.1703	0.1698
Edups = 1 if has some post secondary education	0.4552	0.4322	0.4480	0.4473
Eduuni = 1 if has a university diploma	0.3453	0.2369	0.3172	0.3187
Can = 1 if born in Canada	0.8227	0.8200	0.8384	0.8379
Notcan = 1 if born outside of Canada	0.1773	0.1800	0.1616	0.1621
ONT = 1 if residing in Ontario	0.3905	0.3672	0.3726	0.3732
NFL = 1 if residing in Newfoundland	0.0132	0.0179	0.0145	0.0144
PEI = 1 if residing in Prince Edward Island	0.0041	0.0049	0.0041	0.0042
NS = 1 if residing in Nova Scotia	0.0284	0.0324	0.0306	0.0308
NB = 1 if residing in New Brunswick	0.0219	0.0255	0.0232	0.0230
QC = 1 if residing in Quebec	0.2434	0.2591	0.2507	0.2498
MAN = 1 if residing in Manitoba	0.0346	0.0371	0.0364	0.0361
SAS = 1 if residing in Saskatchewan	0.0285	0.0317	0.0303	0.0301
AL = 1 if residing in Alberta	0.1085	0.1018	0.1076	0.1083
BC = 1 if residing in British Colombia	0.1268	0.1223	0.1300	0.1302
Rural = 1 if residing in a rural area	0.1757	0.2102	0.1970	0.1965
Urban = 1 if residing in an urban area	0.8203	0.7898	0.7989	0.7994
Full = 1 if working 30 hours a week or more	0.9184	0.8922	0.9153	0.9155
Part = 1 if working less than 30 hours a week	0.0816	0.1078	0.0847	0.0845
Emp = 1 if person is an employee	0.8414	0.8281	0.8356	0.8357
See = 1 if a person is self-employed with employees	0.0702	0.0659	0.0711	0.0715
Sene = 1 if a person is self-employed with no employees	0.0885	0.1060	0.0933	0.0928

(continued)

Appendix 2 (concluded) Variable definition and means (entire samples)				
	Stress	**Work affected**	**Job security**	**Work interest**
Independent Variable				
Manu = 1 if Industry is manufacturing	0.1291	0.1544	0.1516	0.1510
Agri = 1 if Industry is agriculture	0.0109	0.0225	0.0155	0.0156
Forest = 1 if Industry is forestry, fishing, mining, oil and gas	0.0169	0.0250	0.0228	0.0230
Util = 1 if Industry is utilities	0.0104	0.0076	0.0106	0.0104
Cons = 1 if Industry is construction	0.0292	0.0597	0.0378	0.0375
Trade = 1 if Industry is trade	0.1400	0.1424	0.1341	0.1351
Trans = 1 if Industry is transportation and warehousing	0.0384	0.0518	0.0497	0.0494
Finance = 1 if Industry is finance, insurance, real estate and leasing	0.0964	0.0625	0.0836	0.0843
Profes = 1 if Industry is professional, scientific and technical services	0.1052	0.0674	0.0923	0.0926
Manage = 1 if Industry management, administrative and other support	0.0317	0.0336	0.0295	0.0289
Educ = 1 if Industry is educational services	0.0964	0.0726	0.0901	0.0901
Health = 1 if Industry is health care and social assistance	0.0910	0.0975	0.0847	0.0845
Info = 1 if Industry is information, culture and recreation	0.0564	0.0449	0.0541	0.0540
Accom = 1 if Industry is accommodation and food services	0.0285	0.0532	0.0328	0.0330
Others = 1 if Industry is other services	0.0307	0.0434	0.0324	0.0322
Public = 1 if Industry is public administration	0.0887	0.0616	0.0784	0.0785
Mana = 1 if Occupation is management occupations	0.1304	0.0986	0.1220	0.1223
Prof = 1 if Occupation is professional occupations	0.2620	0.1782	0.2395	0.2398
Tech = 1 if Occupation is technologists, technicians and technical occupations	0.0844	0.0667	0.0771	0.0778
Clerical = 1 if Occupation is clerical occupations	0.2263	0.1556	0.1910	0.1916
Sales = 1 if Occupation is sales and services occupations	0.1673	0.2341	0.1717	0.1720
Trades = 1 if Occupation is trades, transport and equipment operators	0.0739	0.1459	0.1124	0.1110
Primary = 1 if Occupation is unique to primary industries	0.0161	0.0395	0.0262	0.0264
Process = 1 if Occupation is unique to processing, manufacturing and utilities	0.0395	0.0815	0.0601	0.0591
N (raw)	7,741	13,150	7,744	7,779
N (weighted)	7,879,967	13,356,378	7,906,653	7,932,500

Appendix 3 (concluded)
Variable definition and means (sub-samples of work being greatly or somewhat affected)

	Work interest		Job security	
	Work affected greatly	**Work affected somewhat**	**Work affected greatly**	**Work affected somewhat**
Independent Variable				
Manu = 1 if Industry is manufacturing	0.1485	0.1557	0.1487	0.1569
Agri = 1 if Industry is agriculture	0.0105	0.0251	0.0104	0.0251
Forest = 1 if Industry is forestry, fishing, mining, oil and gas	0.0208	0.0270	0.0206	0.0270
Util = 1 if Industry is utilities	0.0105	0.0102	0.0107	0.0105
Cons = 1 if Industry is construction	0.0288	0.0536	0.0293	0.0536
Trade = 1 if Industry is trade	0.1280	0.1485	0.1276	0.1462
Trans = 1 if Industry is transportation and warehousing	0.0474	0.0531	0.0474	0.0540
Finance = 1 if Industry is finance, insurance, real estate and leasing	0.0996	0.0557	0.0993	0.0545
Profes = 1 if Industry is professional, scientific and technical services	0.1168	0.0476	0.1165	0.0474
Manage = 1 if Industry management, administrative and other support	0.0283	0.0298	0.0288	0.0306
Educ = 1 if Industry is educational services	0.0906	0.0890	0.0908	0.0887
Health = 1 if Industry is health care and social assistance	0.0737	0.1046	0.0735	0.1057
Info = 1 if Industry is information, culture and recreation	0.0623	0.0386	0.0627	0.0383
Accom = 1 if Industry is accommodation and food services	0.0203	0.0566	0.0201	0.0564
Others = 1 if Industry is other services	0.0259	0.0441	0.0259	0.0445
Public = 1 if Industry is public administration	0.0881	0.0607	0.0878	0.0608
Mana = 1 if Occupation is management occupations	0.1332	0.1019	0.1329	0.1019
Prof = 1 if Occupation is professional occupations	0.2679	0.1875	0.2675	0.1875
Tech = 1 if Occupation is technologists, technicians and technical occupations	0.0870	0.0606	0.0865	0.0598
Clerical = 1 if Occupation is clerical occupations	0.2042	0.1681	0.2033	0.1681
Sales = 1 if Occupation is sales and services occupations	0.1489	0.2152	0.1490	0.2138
Trades = 1 if Occupation is trades, transport and equipment operators	0.0887	0.1524	0.0905	0.1530
Primary = 1 if Occupation is unique to primary industries	0.0187	0.0407	0.0183	0.0407
Process = 1 if Occupation is unique to processing, manufacturing and utilities	0.0513	0.0737	0.0520	0.0752
N (raw)	5,037	2,742	5,008	2,736
N (weighted)	5,161,464	2,771,036	5,138,245	2,768,408

Appendix 3 (concluded)
Variable definition and means (sub-samples of work being greatly or somewhat affected)

	Work interest		Job security	
	Work affected greatly	**Work affected somewhat**	**Work affected greatly**	**Work affected somewhat**
Independent Variable				
Manu = 1 if Industry is manufacturing	0.1485	0.1557	0.1487	0.1569
Agri = 1 if Industry is agriculture	0.0105	0.0251	0.0104	0.0251
Forest = 1 if Industry is forestry, fishing, mining, oil and gas	0.0208	0.0270	0.0206	0.0270
Util = 1 if Industry is utilities	0.0105	0.0102	0.0107	0.0105
Cons = 1 if Industry is construction	0.0288	0.0536	0.0293	0.0536
Trade = 1 if Industry is trade	0.1280	0.1485	0.1276	0.1462
Trans = 1 if Industry is transportation and warehousing	0.0474	0.0531	0.0474	0.0540
Finance = 1 if Industry is finance, insurance, real estate and leasing	0.0996	0.0557	0.0993	0.0545
Profes = 1 if Industry is professional, scientific and technical services	0.1168	0.0476	0.1165	0.0474
Manage = 1 if Industry management, administrative and other support	0.0283	0.0298	0.0288	0.0306
Educ = 1 if Industry is educational services	0.0906	0.0890	0.0908	0.0887
Health = 1 if Industry is health care and social assistance	0.0737	0.1046	0.0735	0.1057
Info = 1 if Industry is information, culture and recreation	0.0623	0.0386	0.0627	0.0383
Accom = 1 if Industry is accommodation and food services	0.0203	0.0566	0.0201	0.0564
Others = 1 if Industry is other services	0.0259	0.0441	0.0259	0.0445
Public = 1 if Industry is public administration	0.0881	0.0607	0.0878	0.0608
Mana = 1 if Occupation is management occupations	0.1332	0.1019	0.1329	0.1019
Prof = 1 if Occupation is professional occupations	0.2679	0.1875	0.2675	0.1875
Tech = 1 if Occupation is technologists, technicians and technical occupations	0.0870	0.0606	0.0865	0.0598
Clerical = 1 if Occupation is clerical occupations	0.2042	0.1681	0.2033	0.1681
Sales = 1 if Occupation is sales and services occupations	0.1489	0.2152	0.1490	0.2138
Trades = 1 if Occupation is trades, transport and equipment operators	0.0887	0.1524	0.0905	0.1530
Primary = 1 if Occupation is unique to primary industries	0.0187	0.0407	0.0183	0.0407
Process = 1 if Occupation is unique to processing, manufacturing and utilities	0.0513	0.0737	0.0520	0.0752
N (raw)	5,037	2,742	5,008	2,736
N (weighted)	5,161,464	2,771,036	5,138,245	2,768,408

Appendix 4
Logit/ordered-logit regression results on stress caused, work affected, job security and work interest changed by computers

	Stress		Work affected		Job Security		Work interest	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Intercept	-2.0020***	-8.31						
Female	0.1035	1.51	-0.2832***	-6.84	-0.3425***	-5.96	0.0449	0.81
Age2534	0.1255	0.94	0.1826***	2.80	-0.1913**	-1.99	0.0687	0.73
Age3544	0.3003**	2.32	0.3785***	5.96	-0.4075***	-4.32	-0.0907	-1.00
Age4554	0.5877***	4.45	0.4727***	7.08	-0.8326***	-8.36	-0.1554	-1.64
Age5564	0.5303***	3.41	0.2166***	2.70	-0.9115***	-7.55	-0.1943*	-1.70
Eduhs	-0.0752	-0.45	0.6555***	9.72	-0.0106	-0.09	0.1633	1.54
Edups	-0.1148	-0.73	1.0742***	17.23	0.1458	1.36	0.3531***	3.58
Eduuni	-0.3888**	-2.34	1.4398***	19.44	0.1445	1.23	0.3168***	2.91
Notcan	0.1704**	2.16	-0.4343***	-8.94	0.1316*	1.89	0.2111***	3.12
NFL	-0.3049	-1.07	-0.4188***	-3.07	-0.1174	-0.57	0.0832	0.42
PEI	-0.1358	-0.28	-0.3246	-1.29	-0.0059	-0.02	-0.0389	-0.11
NS	-0.0614	-0.33	-0.1146	-1.13	0.0067	0.05	0.0284	0.21
NB	-0.2060	-0.93	-0.0735	-0.65	0.0132	0.08	0.1443	0.92
QC	0.0481	0.62	-0.0396	-0.86	-0.1883***	-2.95	0.0196	0.32
MAN	-0.0095	-0.06	0.0627	0.66	0.0870	0.65	0.0321	0.25
SAS	-0.0647	-0.34	-0.1063	-1.04	-0.1125	-0.78	0.0021	0.01
AL	-0.1148	-1.08	0.2130***	3.42	0.2433***	2.86	0.3290***	3.90
BC	-0.1786*	-1.80	0.0653	1.15	-0.0256	-0.32	-0.1262*	-1.69
Urban	0.0035	0.04	-0.0859*	-1.90	0.0497	0.77	0.0284	0.47
Part	-0.1440	-1.26	-0.4654***	-7.80	-0.3298***	-3.58	-0.1606*	-1.87
See	-0.0780	-0.59	0.0139	0.18	0.1116	1.11	0.0487	0.50
Sene	0.1039	0.94	-0.3207***	-5.20	0.0604	0.67	0.2219***	2.53
Agri	-0.4718	-0.94	-0.1571	-0.82	-0.2512	-0.82	0.1108	0.38
Forest	0.1494	0.53	-0.1751	-1.21	-0.4718**	-2.26	0.0531	0.26
Util	0.3261	1.11	0.2997	1.48	-0.5482**	-2.21	-0.3729	-1.57
Cons	-0.2621	-1.12	-1.0413***	-10.64	0.0034	0.02	-0.4381***	-3.07
Trade	0.1546	1.13	-0.3035***	-3.93	-0.1994*	-1.90	-0.3238***	-3.16
Trans	0.1311	0.71	-0.3147***	-3.30	-0.3768***	-2.76	-0.5589***	-4.39
Finance	0.2606*	1.85	0.3471***	3.62	-0.6212***	-5.23	-0.1966*	-1.70
Profes	-0.0611	-0.42	0.2513***	2.57	0.0352	0.31	-0.1529	-1.31
Manage	0.3734**	1.96	-0.4040***	-3.56	-0.2920*	-1.79	-0.2385	-1.51
Educ	0.4604***	3.20	-0.4665***	-4.98	-0.6594***	-5.45	-0.3062***	-2.55
Health	0.2061	1.42	-0.9508***	-11.08	-0.6789***	-5.70	-0.6730***	-5.88
Info	0.1068	0.65	0.0714	0.70	-0.3217***	-2.46	0.1287	0.97
Accom	-0.2659	-1.07	-0.9669***	-9.22	-0.1271	-0.80	-0.2807*	-1.84
Others	-0.2526	-1.13	-0.8354***	-8.11	-0.2850*	-1.83	-0.0806	-0.53
Public	0.3423***	2.45	0.0532	0.57	-0.5783***	-4.88	-0.1064	-0.92

(continued)

Appendix 4 (concluded)
Logit/ordered-logit regression results on stress caused, work affected, job security and work interest changed by computers

	Stress		Work affected		Job security		Work interest	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Prof	0.4309***	3.81	0.1436*	1.86	0.3129***	3.39	0.0388	0.42
Tech	0.1259	0.87	-0.1113	-1.21	0.2070*	1.78	-0.1587	-1.38
Clerical	0.0900	0.77	0.0466	0.61	-0.0164	-0.17	-0.0602	-0.64
Sales	0.0186	0.15	-0.7756***	-11.03	-0.3522***	-3.68	-0.5305***	-5.78
Trades	0.0437	0.28	-0.9145***	-11.26	-0.5955***	-5.24	-0.6749***	-6.27
Primary	0.1567	0.39	-1.3714***	-8.42	-0.2580	-0.99	-0.8336***	-3.41
Process	0.3948**	2.05	-1.2546***	-12.56	-0.4032***	-2.81	-0.8673***	-6.39
Cut 1	-		-0.3668***	-3.04	-3.2594***	-18.15	-3.4064***	-19.45
Cut 2	-		0.6833***	5.67	0.4072***	2.34	-0.5229***	-3.14
N	7741		13150		7744		7779	
n (wstress = 1)	1414 (18.3%)		-		-		-	
n (affect = 2)	-		5140 (39.0%)		-		-	
n (affect = 1)	-		2763 (21.0%)		-		-	
n (affect = 0)	-		5247 (39.9%)		-		-	
n (secure = 2)	-		-		1769 (22.8%)		-	
n (secure = 1)	-		-		5243 (67.7%)		-	
n (secure = 0)	-		-		732 (9.5%)		-	
n (inter = 2)	-		-		-		4586 (59.0%)	
n (inter = 1)	-		-		-		2880 (37.0%)	
n (inter = 0)	-		-		-		313 (4.0%)	
Chi-Square	156.24		3184.44		488.45		350.24	

* Significant at 10%; ** significant at 5%; and *** significant at 1%.

Appendix 5

Ordered-logit regression results on job security and work interest changed by computers conditional on work being greatly or somewhat affected

	Job Security				Work Interest			
	Work greatly affected		Work somewhat affected		Work greatly affected		Work somewhat affected	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Female	-0.3640***	-5.37	-0.2378**	-2.03	0.0212	0.30	0.1629*	1.75
Age2534	-0.3025***	-2.40	-0.1943	-1.14	0.0584	0.43	-0.0218	-0.16
Age3544	-0.5803***	-4.71	-0.2909*	-1.73	-0.1653	-1.25	-0.1373	-1.01
Age4554	-0.9938***	-7.75	-0.8455***	-4.63	-0.2749**	-2.02	-0.2315	-1.59
Age5564	-1.1682***	-7.68	-0.5408***	-2.40	-0.3729**	-2.34	-0.0379	-0.21
Eduhs	-0.1730	-1.15	0.4227**	2.08	-0.0003	0.00	0.3970***	2.42
Edups	-0.0206	-0.15	0.5188***	2.75	0.1746	1.25	0.5316***	3.45
Eduuni	0.0336	0.23	0.4082*	1.87	0.1454	0.96	0.5172***	2.92
Notcan	0.0771	0.94	0.2248	1.55	0.1841**	2.12	0.2258*	1.96
NFL	-0.0750	-0.29	-0.1068	-0.27	0.3157	1.14	-0.1793	-0.57
PEI	-0.0676	-0.14	0.1541	0.23	0.1870	0.37	-0.2179	-0.40
NS	0.0800	0.45	-0.0857	-0.32	0.2652	1.37	-0.1737	-0.81
NB	-0.1399	-0.69	0.4316	1.38	0.1570	0.75	0.1035	0.41
QC	-0.2786***	-3.75	0.0018	0.01	0.0305	0.39	-0.0906	-0.85
MAN	0.0885	0.54	0.2524	0.98	0.0244	0.15	0.0718	0.34
SAS	-0.0936	-0.51	-0.0351	-0.13	0.1979	0.98	-0.1384	-0.66
AL	0.3188***	3.17	0.0206	0.12	0.4176***	3.74	0.1631	1.17
BC	-0.1140	-1.15	0.3501***	2.37	-0.2557***	-2.58	0.1810	1.53
Urban	0.1201	1.57	-0.1385	-1.10	0.1009	1.27	-0.0868	-0.86
Part	-0.2386**	-2.01	-0.3563**	-2.17	-0.2062*	-1.72	0.0953	0.73
See	0.1716	1.44	-0.0408	-0.20	0.1650	1.29	-0.1024	-0.62
Sene	0.1764	1.63	-0.2626	-1.46	0.2448**	2.09	0.2583*	1.82
Agri	-0.2516	-0.60	0.1033	0.20	0.0079	0.02	0.3494	0.82
Forest	-0.8411***	-3.17	0.3589	0.96	-0.2005	-0.73	0.4839	1.52
Util	-0.6224**	-2.15	-0.4750	-0.95	-0.3258	-1.07	-0.4837	-1.16
Cons	-0.1331	-0.69	0.5630**	2.14	-0.4560**	-2.31	-0.2706	-1.24
Trade	-0.1634	-1.31	-0.2722	-1.27	-0.3072**	-2.30	-0.3045*	-1.77
Trans	-0.5190***	-3.14	0.0404	0.15	-0.5507***	-3.33	-0.5515***	-2.59
Finance	-0.6720***	-5.05	-0.5942**	-2.15	-0.1786	-1.24	-0.5468***	-2.50
Profes	-0.0709	-0.55	-0.0327	-0.12	-0.3028**	-2.12	-0.1401	-0.61
Manage	-0.2692	-1.38	-0.2866	-0.87	0.0777	0.35	-0.7095***	-2.65
Educ	-0.6506***	-4.60	-0.5847**	-2.30	-0.3046**	-1.96	-0.1361	-0.67
Health	-0.7053***	-4.95	-0.3724	-1.54	-0.5471***	-3.63	-0.5523***	-2.84
Info	-0.4173***	-2.82	-0.1237	-0.42	0.1116	0.67	-0.0050	-0.02
Accom	-0.2063	-0.92	0.2728	1.02	-0.0844	-0.35	-0.1324	-0.59
Others	-0.4309**	-2.14	0.3227	1.17	-0.0133	-0.06	0.1802	0.79
Public	-0.5788***	-4.29	-0.5675**	-2.17	-0.2198	-1.52	0.0930	0.45

(continued)

Appendix 5 (concluded)
Ordered-logit regression results on job security and work interest changed by computers conditional on work being greatly or somewhat affected

	Job Security				Work Interest			
	Work greatly affected		Work somewhat affected		Work greatly affected		Work somewhat affected	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Prof	0.3644***	3.51	-0.0090	-0.04	0.1417	1.24	-0.2568	-1.49
Tech	0.3310***	2.50	-0.3483	-1.32	-0.0225	-0.16	-0.5350***	-2.52
Clerical	0.0555	0.50	-0.1532	-0.73	-0.0520	-0.44	0.0037	0.02
Sales	-0.2726***	-2.41	-0.5262***	-2.72	-0.4319***	-3.64	-0.5618***	-3.57
Trades	-0.4176***	-3.00	-0.8713***	-3.94	-0.6818***	-4.83	-0.4413***	-2.45
Primary	0.2615	0.75	-0.8740**	-1.97	-0.7324**	-2.15	-0.6348*	-1.72
Process	-0.3004*	-1.71	-0.3818	-1.37	-0.7410***	-4.13	-0.7883***	-3.49
Cut 1	-3.3368***	-14.88	-3.2973***	-9.65	-3.3482***	-14.10	-3.6327***	-12.57
Cut 2	-0.0830	-0.38	1.4259***	4.29	-0.9524***	-4.16	0.1571	0.58
N	5008		2736		5037		2742	
n (secureg = 2)	1426 (28.5%)		-		-		-	
n (secureg = 1)	3051 (60.9%)		-		-		-	
n (secureg = 0)	531 (10.6%)		-		-		-	
n (secures = 2)	-		338 (12.4%)		-		-	
n (secures = 1)	-		2197 (80.3%)		-		-	
n (secures = 0)	-		201 (7.4%)		-		-	
n (interg = 2)	-		-		3388 (67.3%)		-	
n (interg = 1)	-		-		1423 (28.2%)		-	
n (interg = 0)	-		-		226 (4.5%)		-	
n (inters = 2)	-		-		-		1193 (43.5%)	
n (inters = 1)	-		-		-		1463 (53.4%)	
n (inters = 0)	-		-		-		86 (3.1%)	
Chi-Square	406.93		123.03		210.71		121.97	

Significant at 10%; ** significant at 5%; and *** significant at 1%.