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Université de Montréal

The Cyclicalities of Skilled and Unskilled Employment in Canada

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The Cyclicity of Skilled and Unskilled Employment in Canada

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## Résumé

Ce rapport de recherche est une analyse du marché du travail Canadien et plus précisément du comportement conjoncturel des inputs de travail « qualifiés » et « non-qualifiés ».

En utilisant des micros données mensuelles provenant de l'Enquête sur la Population Active, nous dérivons des séries chronologiques trimestrielles sur le niveau d'emploi, le nombre d'heures travaillées par semaine et l'input total de travail pour chaque classe de travailleur.

La volatilité et corrélation (par rapport aux cycles économiques) de l'input total de travail pour chaque classe de travailleur sont ainsi obtenues. Ceci permet de vérifier si le travail qualifié est effectivement moins corrélé aux cycles économiques et moins volatiles que le travail non qualifié, comme le suggère des études antérieures.

Les résultats sont également comparés à une étude très similaire réalisée pour les États-unis. Cette dernière démontre que le comportement du travail qualifié a changé de façon flagrante : alors qu'il était très peu volatile ou corrélé aux cycles économiques jusqu'à la fin des années 80, il est devenu beaucoup plus volatile et corrélé aux cycles économiques à partir de cette époque. Le comportement du travail non qualifié est resté inchangé : il a toujours montré une forte volatilité et corrélation aux cycles économiques.

Quantitativement, les résultats de l'étude Canadienne diffèrent des résultats américains. Le travail qualifié se montre beaucoup plus volatile au Canada en général, même au début de la période.

Qualitativement cependant, les résultats sont très proches de ceux de l'étude américaine. Le travail qualifié est devenu relativement beaucoup plus volatile à partir de la deuxième moitié des années 80. Et comme aux États-unis, il est devenu fortement corrélé aux cycles économiques à cette même période. Le comportement du travail non qualifié est également resté inchangé.

**Mots-clés:** Marché du travail, cycles économiques, niveaux de qualification hétérogènes.

## **Abstract**

This paper documents the business cycle behavior of employment and hours worked across skill groups in Canada since 1978. Using monthly Labor Force Survey micro data sets, we construct quarterly measures of employment, weekly hours of work and total hours, where educational attainment is a proxy for skill level.

We are interested in testing the widely shared belief that skilled employment and hours tend to be less volatile and less correlated with the economic cycle than unskilled labor aggregates.

We are also interested in comparing the results to a similar study conducted with U.S. data that showed a major increase in the skilled labor input volatility and correlation to GDP since 1987 and an unchanged behavior of the unskilled aggregates..

Our findings differ quantitatively from U.S. findings. Aggregate employment displays a higher level of relative volatility to output than in the United States. Skilled employment also appears to be much less stable than in the U.S at the beginning of the period.

Qualitatively however, the behavior of skilled employment is very similar to what was observed in the United States: the relative volatility and correlation to output has increased dramatically starting in the mid 1980s. Moreover, as in the United States, the behavior of unskilled employment remained stable over the period.

**Key words:** Labor market, skill heterogeneity, business cycles.

## Symbols and abbreviations.

$g$ = demographic group.

$h$ = weekly hours of work.

$H$ = total hours of work.

$n$ = number of workers.

$s$ = skilled workers.

$t$ = quarterly time unit.

$\hat{t}$  = monthly time unit.

$u$ = unskilled workers.

$w$ = hourly wage.

$\mu$ = demographic weight.

## **Table of contents.**

Abstract. 3

Tables and Figures. 3

Introduction. 4

Literature Survey. 9

Empirical Analysis. 11

*Data. 12*

*Evidence: Broad Aggregates. 16*

Conclusion. 23

Appendix A: Details on the construction of the aggregates. 25

Appendix B: Resolving discontinuity in the series resulting from changes in the LFS questionnaire. 20

Appendix C: Construction of the aggregates using a different series for weekly hours worked. 27

Appendix D: Using an alternative date to define the two sub periods. 30

Appendix E: Statistics and graphs for the entire period (including 1976-78). 34

Bibliography. 35

## Figures

- Figure 1: Total hours per skill groups in the U.S. 5
- Figure 2: Employment per skill group (raw series). 8
- Figure 3: Proportion of Skilled Total Hours to Aggregate Hours. 8
- Figure 4: Aggregate employment (cyclical). 9
- Figure 5: Employment per skill group (cyclical). 10
- Figure 6: Average weekly hours per skill group (raw series). 12
- Figure 7: Average weekly hours per skill group (cyclical). 13
- Figure 8: Total hours per skill group (unweighted approach-cyclical). 14
- Figure 9: Total hours per skill group (efficiency approach –cyclical). 15
- Figure 10: Unadjusted usual weekly hours of work per skill group. (raw series)  
25
- Figure 11: Adjusted usual weekly hours of work per skill group (raw series). 27
- Figure 12: Total hours per skill group (unweighted-actual hours). 28
- Figure 13: Total hours per skill group (efficiency approach-actual hours). 28
- Figure 14: Employment per skill group for the entire period (including 1976-78).  
34

## **Tables.**

Table 1: Volatility and co-movement in Canada. 18

Table 2: Volatility and co-movement in the United States. 18

Table 3: Discontinuity in the reported level of skilled labor input due to classification changes. 25

Table 4: Volatility and co-movement using an alternative measure of weekly hours worked (actual hours). 31

Table 5: Volatility and co-movement using an alternative date to divide the two sub periods (usual hours). 33

Table 6: Volatility and co-movement using an alternative date to divide the two sub periods (actual hours). 33

Table 7: Volatility and co-movement for the entire period (including 1976-78). 34



## **Introduction**

Few studies have documented the business cycle behavior of employment across skill groups. In fact, empirical analyses studying the response of skilled and unskilled employment levels to business cycle variations are only available for the United States. Surprisingly, most of the literature is outdated and does not cover the post-1985 period. Recently, one study looks at the cyclical variations of employment levels across skill groups for the United States for the 1979-2001 period and finds remarkable changes occurring throughout the period. Namely, skilled employment appears very stable and uncorrelated to output prior to 1987. Somewhere in the mid 1980s, the behavior of skilled employment changes dramatically and becomes highly volatile and correlated to output. In this paper we try to study the business cycle behavior of labor input across skill groups in Canada for a similar time frame as the one covered in the U.S. study.

## **Literature survey**

Kydland (1984) uses yearly panel data called The Panel Survey of Income Dynamics for the 1970-80 period and studies the group of prime-age males (believed to be the demographic group least subject to variation according to previous studies). He divides the sample into five fairly evenly-numbered groups by years of education and measures average hours worked by year and the average standard deviation of hours (that is the standard deviation for the up-to-eleven observations per individual was computed and then averaged within each group). Kydland concludes that the standard deviation of annual hours rises substantially in going from the highly educated to the less educated, while the number of hours worked declines. Quantitatively he shows that the average

relative variability in the bottom group (32.4 percent) is about twice as high as that of the top group (16.3 percent)<sup>1</sup>.

Keane and Prasad (1993) use yearly panel micro data to study differences in the cyclical variability of employment, hours, and real wages for skilled and unskilled workers. Their data set is the National Longitudinal Survey of Young Men (NLS), comprising a nationally representative sample of 5225 young males. The participants were between 14 and 24 years of age in 1966 and were interviewed in 12 of the 16 years from 1966 to 1981. Keane and Prasad “do not attempt to develop a single measure of skill level but, instead, examine a variety of plausible proxies for human capital. In particular they focus on education levels, total labor market experience, and tenure on the current job.” Their statistical analysis manages to isolate the effect of educational attainment, and it appears that the college degree variable is significant at accounting for differences in cyclical variation across individuals. In fact, their empirical analysis indicates that “workers with a college degree have essentially acyclical employment patterns”<sup>2</sup>. They also find that unlike lower skilled workers, workers with a college degree are subject to acyclical weekly hours.

The Castro and Coen-Pirani (2004) study is the first to look at a more recent period. Based on Merged Outgoing Rotation Groups (MORG) extracts from 276 Monthly Current Population Surveys (CPS) covering the period from 1979 to 2003, they construct measures of employment and hours of work for skilled and unskilled individuals and extract the cyclical components of the constructed time series. More specifically, they consider an individual skilled if he has completed at least a B.A. degree. Their findings are consistent with those of authors mentioned above for the pre-1985 sub-period. Namely, skilled employment and

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<sup>1</sup> See Kydland, p. 5.

<sup>2</sup> See Keane and Prasad, p. 18.

hours are much less volatile and correlated to output than unskilled employment and hours.

More importantly, the interesting finding of their study lies in the fact that the behavior of skilled total hours changes dramatically between the two sub periods while the unskilled aggregates display an unaltered behavior throughout the period. Post 1987, skilled hours become much more volatile and correlated to output as displayed in Figure 1. We will review the Castro and Coen-Pirani results in more details throughout this paper, in order to draw a comparison with the Canadian analysis which uses a similar approach.

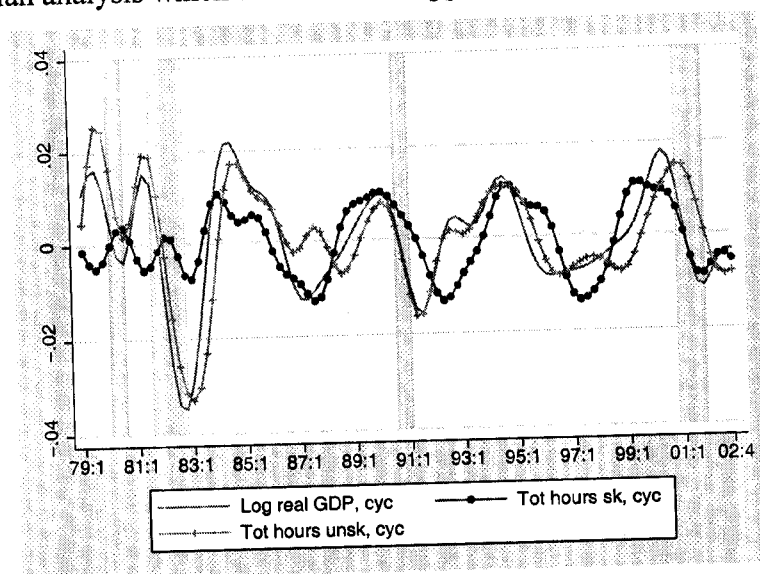


Figure1: Total hours per skill groups in the U.S.

### Empirical analysis.

Our goal in this section is to document the business cycle dynamics of employment, weekly working hours, and total hours of skilled and unskilled individuals. We call an individual skilled if she/he has declared at least having completed a university degree such as Ph. D, Master's, Bachelor and Certificate degrees. Individuals who have not completed a university degree are considered as unskilled.

We are interested in several components of the labor input across skill groups. First, we look at the cyclical variations of the number of workers across skill groups, without worrying about the number of hours worked by each individual. Then, we look at the number of hours worked across skill groups, without adjusting for the fact that an hour worked by a skilled individual is worth more (in terms of productivity) than one hour worked by an unskilled worker. At last, to correct for the differences in human capital, we use an efficiency unit's approach, which amounts to using some time-invariant measure of individuals' hourly wages as weights when computing an aggregate measure of weekly hours worked by skilled or unskilled individuals. One advantage of this procedure is that it is in principle immune to changes in total hours due to pure composition effects.

#### **Data.**

The data set we use are micro data files available to the public from 276 Monthly Labor force Survey and covering the period from 1976 to 2002. Monthly observations are obtained by using information on each individual's interview month. Each monthly sample contains about 70,000 individuals, which are associated with a sample weight and are therefore representative of the Canadian population with 16 years of age and over. In what follows we always use these weights to aggregate observations.

We organize the data by quarters, ending up with 108 observations for the variables of interest. These 108 quarters include 4 recessions as documented by the literature on the Canadian business cycle (1980:1-1980:3, 1981:3-1982:4, 1990:2-1992:2, 2001:1-2001:4)<sup>3</sup>. They are represented by shaded areas in the figures.

For each quarter, we restrict attention to individuals in the labor force the week of the interview that are not self-employed and that are aged 64 years or

younger. We end up with an average of about 275 000 individuals per quarter. For detailed information on the data set and on the construction of the aggregates, please refer to Appendices A, B and C at the end of the paper. In what follows, we will give a literal overview of the constructed time series.

*Employment.* Aggregate employment for skilled (unskilled) individuals in a given quarter is just given by the sum of skilled (unskilled) individuals who report to be employed in that period, weighted by their sampling weight.

*Unweighted Total Hours.* Unweighted total hours for skilled (unskilled) individuals for each quarter is just given by the sum of weekly hours worked by skilled (unskilled) individuals who report to be employed in that period, weighted by their sample weight.

*Total Hours (Efficiency units).* To construct a measure of total hours worked by skilled (unskilled) individuals in a given quarter we use an efficiency units approach. We first partition the sample into 120 demographic groups. Demographic groups are constructed using information on the individual's sex, age, and education. We then compute the average wage of each demographic group, based on the Study of Income Dynamics (from 1981 to 1998) which is an annual supplement to the LFS and reports the yearly wages and salary earning of each individual, along with the number of usual weekly hours and the number of weeks worked during the year. From this information, we are able to compute for each quarter an average hourly wage for each individual, and by extension the average wage of each demographic sub-group. To aggregate hours of work across demographic groups we use the demographic group's sampling weights **and** the time average of the group's mean wages as weights. Total hours for skilled (unskilled) individuals in a quarter are then defined as the weighted sum

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<sup>3</sup>This classification comes from P. Cross (1996) who uses quarterly and six-month GDP growth rates to date recession. The ECRI (Economic Cycle Research Institute) dates who follow similar methods as those

of average weekly hours worked in a demographic groups characterized by skilled (unskilled) individuals.

*Average Weekly Working Hours.* This variable is the average reported usual weekly hours worked (weighted by their sampling weight) for skilled (unskilled) individuals at a certain time period.<sup>4</sup>

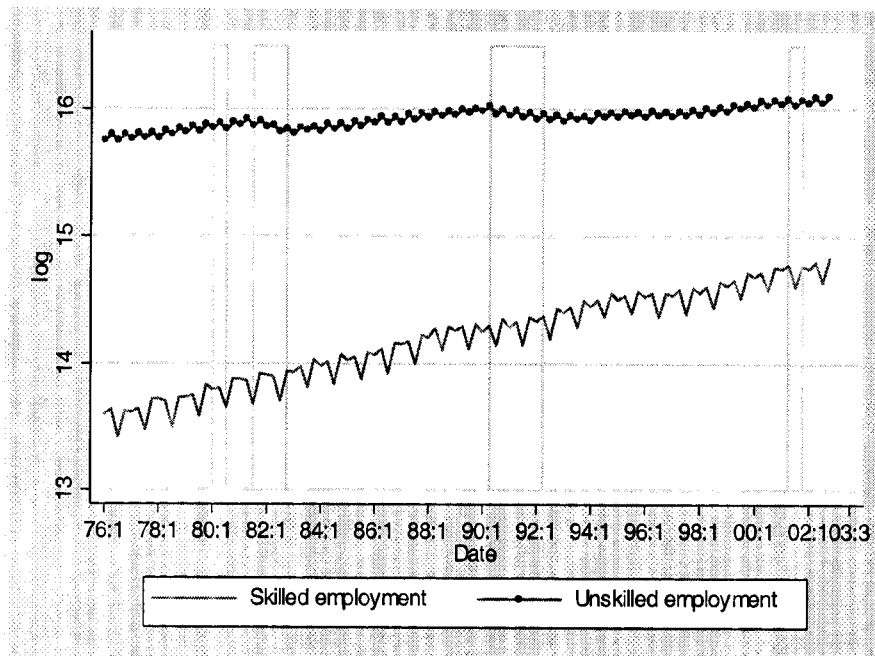


Figure 2: Employment per skill group

We start by reporting the raw series for employment in Figure 2. This figure shows the evolution of employment of skilled and unskilled workers throughout the period. This figure documents an increase in the number of skilled workers: the fraction of skilled employment in the aggregate doubled over the period and went from 10% in 1976 to 21% in 2002. The fractions of total hours using the

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used by the NBER to date US business cycles finds very similar dates.

<sup>4</sup> The LFS questionnaire asked the respondent his/her “usual” and “actual” number of weekly hours worked. As a benchmark for this paper, we used the “usual” number of weekly hours worked to construct

efficiency approach also showed that skilled workers became an increasingly growing fraction of the total labor input: Skilled workers contributed to only 16% of the aggregate labor input in 1976 against 30% in 2002 as shown in Figure 3.

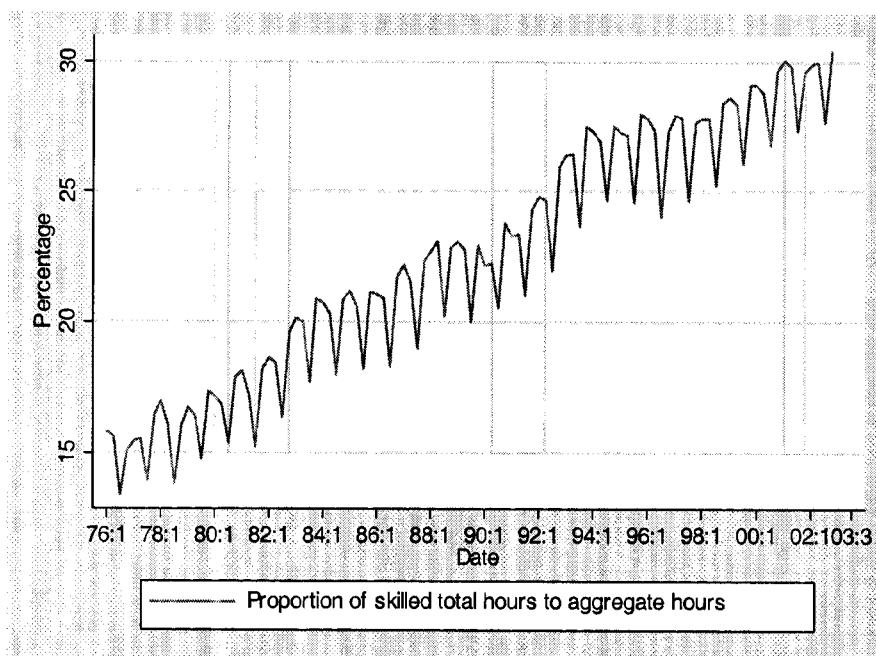


Figure 3: Proportion of Skilled Total Hours to Aggregate Hours.

In what follows we are interested in the behavior of these variables at a business cycle frequency. To extract the cyclical component of each time series we use the band pass filter proposed by Christiano and Fitzgerald (2003). As it is standard in the literature, we concentrate on frequencies in the 1.5 to 8 years range. This filter is especially useful in eliminating short-term fluctuations such as those resulting from seasonality in the data. Moreover, as specified in the instructions of the filter, we excluded the reported cyclical variations of the first two years at the beginning of the sample from the graphs that follow because of potential problems with the filter for the beginning and the end periods of the

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our aggregate series, as Castro and Coen-Pirani (04) did for their U.S. analysis. However, as shown in the Appendix, using "actual" hours rather does not alter the results in a significant way.

time series. We however decided to keep the last two years of our sample in what follows because the 2001 recession is the only reported recession after the 1990-1992 recession and is crucial to our analysis.

**Evidence: broad aggregates.**

First, we can show that the business cycle behavior of aggregate employment (that is if we treat labor as a homogeneous input) does not change in a significant way throughout the period. The volatility of aggregate employment is 0.95 over the period, which is quantitatively above U.S. numbers (0.67) but qualitatively similar in the sense that it remains at a stable level relative to GDP through time.

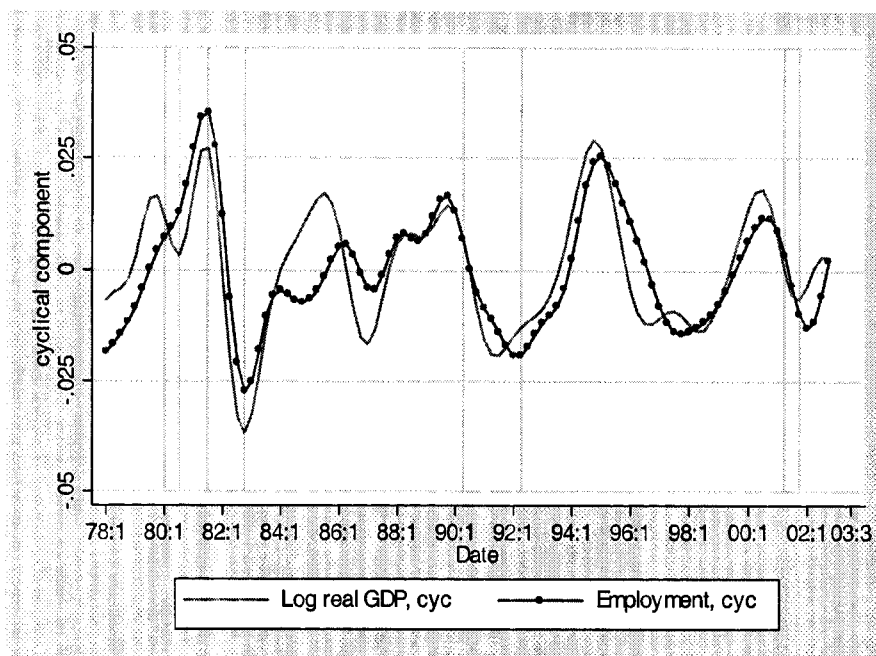


Figure 4: Aggregate employment.

We start by looking at labor as a heterogeneous input in Figure 5. It clearly appears that the behavior of skilled labor changes somewhere in the mid-80s in the sense that it became more volatile and more correlated to the economic cycle. We see this trend visually and we will conduct a rigorous statistical analysis to establish this trend.



To implement our empirical analysis, we choose to divide the sample into two sub-periods and to compute a set of descriptive statistics per sub period. We tried to identify a period that reasonably splits the sample according to the change in cyclical behavior of skilled labor input. Figure 5 suggests splitting the sample at about 1987:1. This date is convenient in the sense that it was also the date chosen by Castro and Coen-Pirani (04) to document the change in cyclical behavior of skilled employment in the US and therefore this will allow us to compare the results of the two countries.

We use two statistical tools in what follows. To describe the changes in volatility of a variable, we compute its *relative volatility* to real GDP. This is simply the ratio of the standard deviation of the cyclical component of a variable (skilled employment for example) over the standard deviation of the cyclical component of real GDP for a specific sub period. The second tool is the *co-movement*, which is simply the correlation coefficient of a certain variable and real GDP for a sub-period. All these statistics (for both the US and Canada) are summarized in Table 1 on page 16.

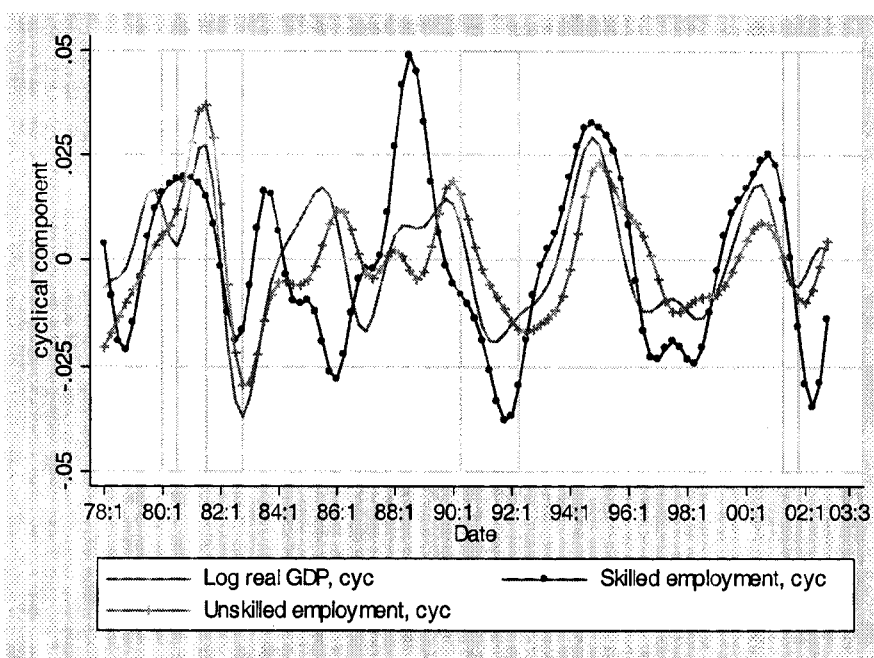


Figure 5: Employment per skill group.

## **Employment.**

*Volatility.* The striking feature of figure 4 is that skilled employment appears to be only slightly less volatile than unskilled employment during the first sub period (the relative volatility of skilled employment to GDP is 1.05 versus 1.00 for unskilled workers). This is a clear contradiction to past U.S. literature that has documented an unambiguous higher relative volatility for unskilled workers. For the same period, Castro and Coen-Pirani (04) reported a relative volatility of 0.29 for skilled workers versus 0.86 for unskilled workers).

During the second sub-period, skilled employment becomes much more volatile than unskilled employment: the relative volatility over real GDP of skilled workers is 1.8 for the second sub-period while unskilled employment relative volatility decreases to 0.84. In the US, over the same sub period, the reported volatility is 0.81 for skilled employment and 0.67 for unskilled employment.

We do observe quantitative differences with US results. Qualitatively however, we observe a remarkable increase in skilled employment volatility between the two sub periods as in United States. The volatility of skilled employment increased by 80% between the two sub-periods. The cyclical behavior of unskilled employment does not change nearly as much between the two sub-periods, which is also consistent with U.S. results.

*Comovement.* As in the U.S. for the pre-1987 sub-period, skilled employment in Canada was far less correlated with output than unskilled employment (we find a correlation coefficient of 0.27 for skilled workers versus 0.76 for unskilled workers). In the second sub-period however, skilled employment correlation to real GDP jumped to 0.77 while unskilled employment correlation to output stayed at a stable level. And as Castro and Coen-Pirani (04) showed, the correlation of skilled employment increased dramatically over the second sub period in the United States as well: from a coefficient of -0.07 prior to 1987, it went up to 0.58 during the 1987-2002 timeframe. While this occurred, unskilled

employment did not experience significant changes either in the United States. Once again, the results are qualitatively very similar across countries.

### Average weekly hours.

The following figure shows the raw series of weekly hours worked (in log form). We are not surprised to notice that on average, skilled individuals tend to work more hours than unskilled individuals. They also appear to be less affected by seasonality than skilled workers.

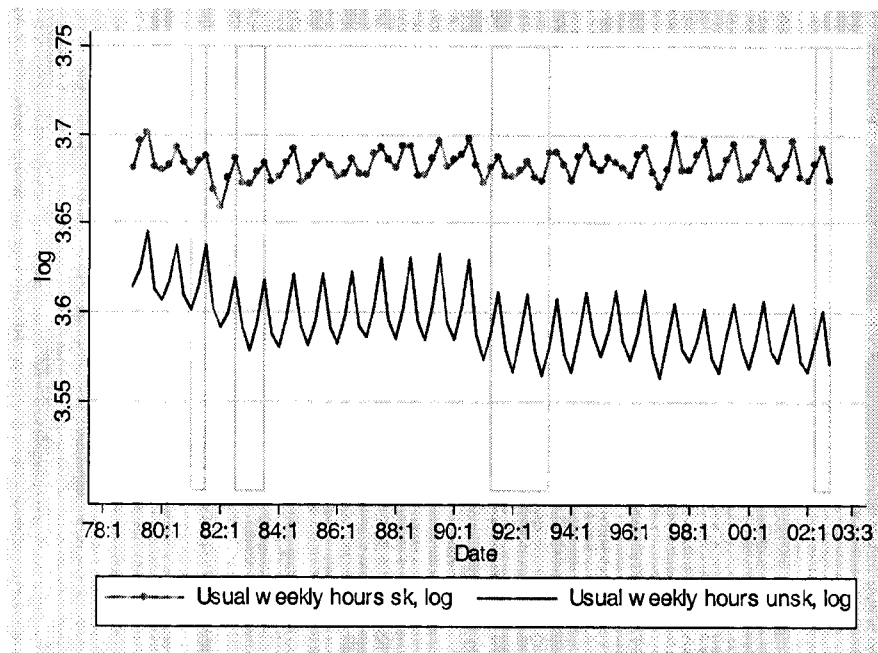


Figure 6: Weekly hours of work per skill group (log).

When looking at the cyclical behavior of weekly hours worked, as shown in Figure 6, we notice two trends that were also observed in the US study. First of all, weekly hours of work tend to be unambiguously procyclical. The correlation between weekly working hours and GDP on the aggregate is 0.81 for the first sub-period and .71 for the second sub-period. We also notice that skilled workers show a substantially lower degree of correlation than unskilled workers, especially during the first sub-period.

In the magnitude of volatility, Canadian findings are very close to US data and show no significant difference across skill groups.

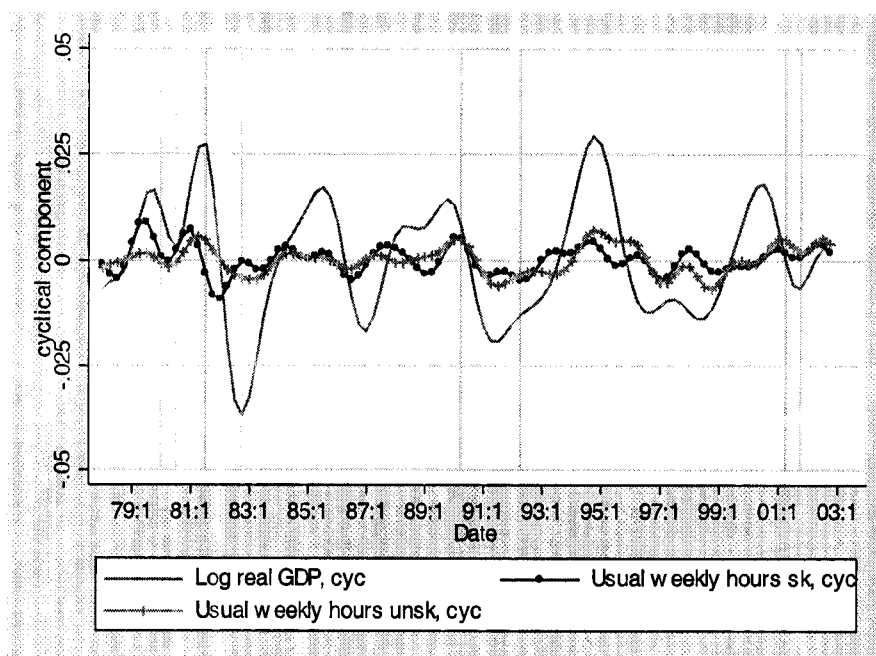


Figure 7: Weekly hours of work per skill group (cyclical).

#### Naïve (unweighted) total hours.

We now look at a similar graph, but this time we include the number of weekly hours worked into the calculation of the labor input (Figure 7). This figure only reinforces the findings displayed by figure 2. During the first sub-period, the volatility of total hours was indeed very similar for the skilled and the unskilled (0.9 and 1.2 respectively), which does not seem to reconcile with the widely accepted fact that skilled labor input is more stable among the higher skilled. The increase in volatility among skilled labor did take place between the first and the second sub-period: it increased from 0.9 to 1.74. The inclusion of hours worked did not produce any significant changes overall. Rather, it reinforced most results; most skilled variables became more correlated to output and more volatile, as the number as hours worked is also always pro-cyclical.

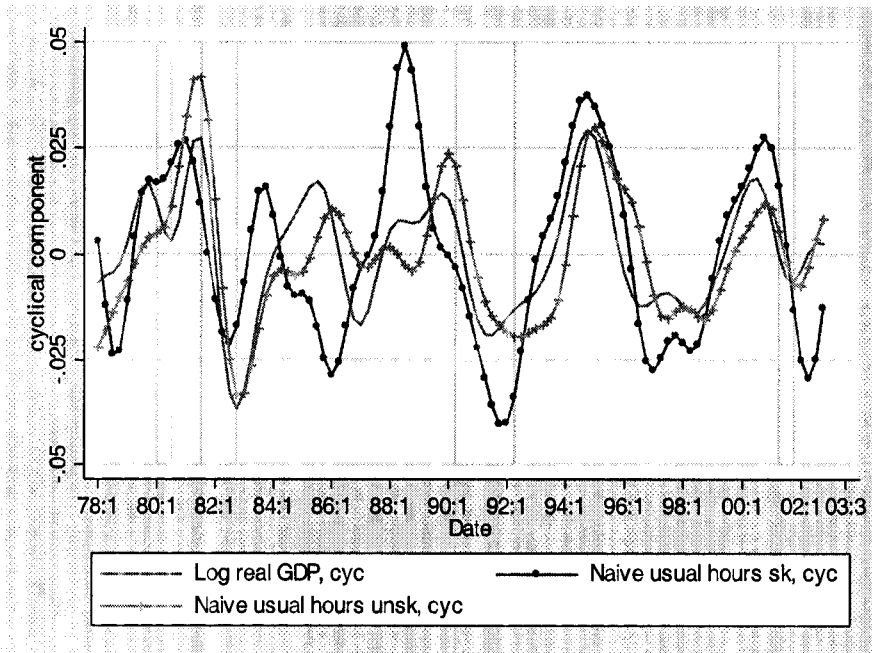


Figure 7: Unweighted (Naïve) hours per skill groups.

## Efficiency units.

We now use an “efficiency units” approach, where the number of hours worked by each individual is weighted by its hourly wage, which we use as a proxy for productivity (Figure 8). One advantage of this procedure is that it is in principle immune to changes in total hours due to pure composition effects.

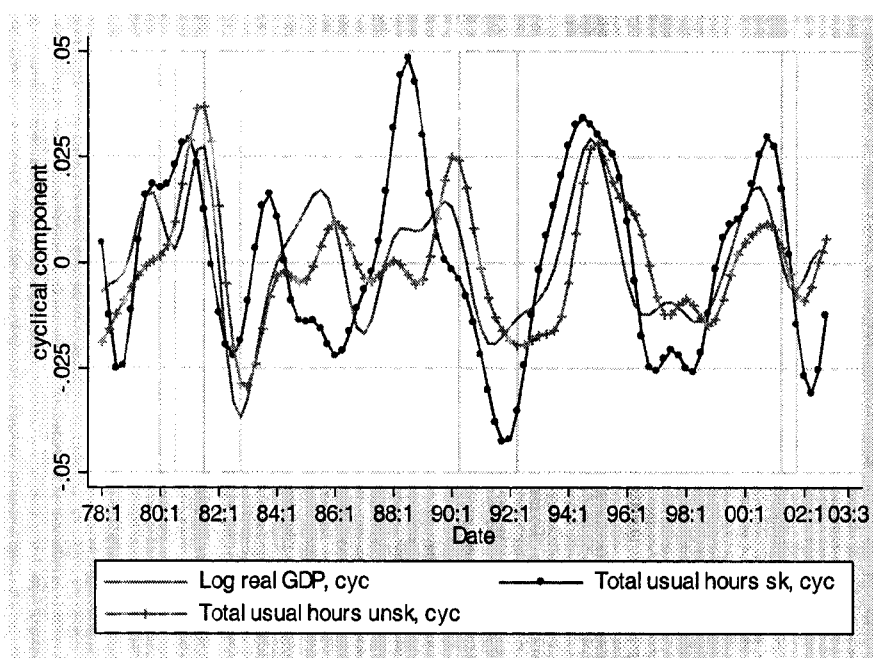


Figure 8: Total hours worked per skill group (cyclical).

This procedure does not alter our results in a significant way and the main findings still hold true: while the unskilled aggregate did not change significantly throughout the period in terms of correlation or relative volatility to output, skilled aggregates experienced increased volatility and correlation to output. In light of the Castro and Coen-Pirani (04) study of the U.S. labor market, the observed results are qualitatively similar, although quantitatively different.

Table 1 presents a summary of our findings. In the relative volatility column we report the standard deviation of the cyclical component of a variable over the

same standard deviation for output. In the co-movement column we report the simple correlation between the cyclical component of a variable and the cyclical component of real output.

Variable	Volatility			Comovement		
	skilled	unskilled	aggregate	skilled	unskilled	aggregate
<i>1978:1-1986:4</i> Total hours: Efficiency Units	1.05	1.00	0.92	0.38	0.78	0.77
Total hours: Unweighted hours	1.03	1.14	1.06	0.34	0.80	0.79
Employment	0.93	1.03	0.96	0.27	0.76	0.74
Weekly hours of work (usual)	0.26	0.15	0.14	0.40	0.87	0.84
<i>1987:1-2002:4</i> Total hours: Efficiency Units	1.91	1.02	1.09	0.79	0.72	0.85
Total hours: Unweighted hours	1.87	1.08	1.13	0.80	0.76	0.85
Employment	1.8	0.84	0.94	0.77	0.74	0.86
Weekly hours of work (usual)	0.21	0.29	0.27	0.49	0.68	0.72

Table 1: Volatility and co-movement of total hours (using both efficiency and naïve approach), employment and average weekly hours per skill group in Canada.

Variable	Volatility			Comovement		
	skilled	unskilled	aggregate	skilled	unskilled	aggregate
<i>1979:1-1986:4</i> Total hours: Efficiency Units	0.29	1.06	0.74	0.37	0.87	0.90
Employment	0.30	0.86	0.68	-0.07	0.85	0.87
Weekly hours of work (usual)	0.16	0.22	0.11	0.80	0.85	0.74
<i>1987:1-2002:4</i> Total hours: Efficiency Units	0.95	0.90	0.77	0.66	0.75	0.85
Employment	0.79	0.75	0.66	0.58	0.72	0.79
Weekly hours of work (usual)	0.28	0.26	0.19	0.60	0.52	0.72

Table 2: Volatility and co-movement of total hours, employment and average weekly hours per skill group in the United States.

## Conclusion

This study seems to confirm several qualitative results of the Castro and Coen-Pirani (04) study. As expected, skilled workers have become a much more important fraction of the labor force throughout the period. Moreover and most importantly, there is an unambiguous increase in skilled employment volatility and correlation to output that occurred sometimes in the mid 1980s. Unskilled

employment, on the other hand, did not display a significant change in behavior during the covered time frame.

From a quantitative standpoint however, the results do display some differences with the US study. If we look at the cyclical variations of aggregate employment as a whole over the entire period, employment is a little more volatile in Canada. The biggest question mark is the behavior of the skilled labour input. Compared to US data, Canadian skilled labour is 3 times more volatile during the first sub-period and more than twice more volatile during the second sub-period. What is also intriguing is the fact that skilled input is not stable during the second sub-period; rather it is almost as volatile as unskilled labor. This is a unexpected drift not only from the Coen-Pirani study but also from the widely shared belief that tends to associate skilled employment with stability and unskilled employment with higher relative volatility. One is left to wonder why there is such an overall difference in volatility. What is even more intriguing is that the Canadian LFS appear to be very similar US CPS data.

One could point out that the definition of skilled was not as selective or restrictive in Canada as it was in the US, and that the Canadian "skilled" subgroup was in fact not as qualified as the US "skilled" subgroup. This is true in the sense that to be considered skilled, individual respondents in the US had to have completed a Bachelor Degree. In Canada even individual respondents with university degrees below the bachelor level were classified as skilled workers. It appears that this classification difference is not significant and could not account for the relatively higher volatility of skilled workers in Canada. At the beginning of the period, whether we consider the US or Canada, the skilled subgroup represents about 10% of the work force. So one other way to present our result would be to say that the most qualified 10% of the US workforce display a very different behavior in volatility from the most qualified 10% of the Canadian work force.



## Appendix A: Details on the construction of the aggregates.

The data set used is the Canadian Labour Force Survey covering the period from 1979 to 2002. The survey is conducted monthly and records the answer of around 70, 000 representative individuals aged between 16 years and older. Each representative individual is associated with a sample weight, which allows us to estimate actual monthly cross-sectional distributions.

Our data set contains seven key variables for each month:

- Labour force status (employed, looking for a job, not in the labour force, etc.);
- Sex;
- Age;
- Level of education;
- Employment status (public or private employee, self-employed, voluntary work, etc.);
- Usual and actual weekly hours worked the week preceding the phone interview ( $h$ );
- Weight of the individual in the population ( $\mu$ )

For each sample month, we kept only individuals showing the following characteristics:

- Employed as a public or private employee (we excluded from the final sample self-employed individuals, voluntary workers and those working for a family business).
- Aged 65 years or younger;

The next step of our analysis was to create a “Skill Level” variable. We also had to make adjustments on the “skilled employment” and “usual weekly hours of work” series to deal with questionnaire changes occurring during the period. See Appendix B for details on the “skill” variable and on adjustment procedures. We also created a “quarter” variable that should become the time unit for the remaining of our analysis. All the figures described below are adjusted values that take into the necessary adjustments.

### Employment level.

At first, we compute aggregates of the respective levels of employment for skilled and unskilled individuals for each time period. Let  $u$  represent the unskilled sub-group and  $s$  the skilled sub-group. For each quarter  $t$ , we compute the employment level  $N$  of each sub-group by summing the weight  $\mu$  of each individual across skill groups:

$$N_{s,t} = \sum_{i \in s} \mu_{i,t}$$

$$N_{u,t} = \sum_{i \in u} \mu_{i,t}$$

Since we are interested in the behaviour of these variables at a business cycle frequency, we compute the log of each time series and then apply the band-pass filter proposed by Christiano and Fitzgerald (2001) to extract the cyclical component. As it is standard in the literature, we concentrate on frequencies in the 1.5 to 8 years range.

### Average Weekly Hours.

We can extract the average number of hours worked by skilled and unskilled individuals by computing a weighted average across skill groups. Let  $h$  be the declared number of weekly hours worked and  $s$  and  $u$  still represent the skilled and unskilled groups. For each quarter  $t$ , we have

$$h_{s,t} = \frac{\sum_{i \in s} \mu_{i,t} h_{i,t}}{\sum_{i \in s} \mu_{i,t}}$$

$$h_{u,t} = \frac{\sum_{i \in u} \mu_{i,t} h_{i,t}}{\sum_{i \in u} \mu_{i,t}}$$

### Unweighted/Naïve Hours.

Since we also have information on the number of hours worked by each individual, we can compute the total number of hours worked across skill groups  $H$ , simply by multiplying the number of total hours worked weekly by the individual by its sample weight, and by summing for each skill group.

We compute:

$$H_{s,t} = \sum_{i \in s} \mu_{i,t} h_{i,t}$$

$$H_{u,t} = \sum_{i \in u} \mu_{i,t} h_{i,t}$$

### Efficiency units approach.

To construct a measure of total hours worked by skilled (unskilled) individuals in a given quarter we use an efficiency units approach. We first partition the sample into 120 demographic groups according to sex, age and education level.

No information on earnings is recorded through the monthly LFS. However, every March a supplement to the LFS records information on yearly earnings, number of weeks worked that year and on the usual hours worked during a representative week. This enables us to compute an hourly wage for each individual, and by extension an hourly wage for each demographic group.

For each individual, the hourly wage for a specific year is:

$$w_{i,t} = \frac{\text{yearly\_earnings}_{i,t}}{\text{weekly\_hours}_{i,t} * \text{yearly\_weeks}_{i,t}},$$

where yearly earnings are expressed in real value (deflated by Consumer Price Index).

For each demographic group  $g$ , the hourly wage  $w$  for each of the 15 years available is:

$$w_{g,t} = \frac{\sum_{i \in g} w_{i,t} * \mu_{i,t}}{\sum_{i \in g} \mu_{i,t}},$$

The group time average is:

$$\bar{w}_g = \frac{1}{15} \sum w_{g,t}$$

For each demographic group, the number of weekly hours  $h$  worked is:

$$h_{g,t} = \frac{\sum_{i \in g} h_{i,t} * \mu_{i,t}}{\sum_{i \in g} \mu_{i,t}},$$

For each demographic group, the labor input  $n$  is:

$$n_{g,t} = \sum_{i \in g} \mu_{i,t}$$

Given those three newly created variables, we can construct the total hours series in efficiency units  $N$  for skilled  $s$  and unskilled  $u$  individuals such that:

## **Appendix B: Resolving discontinuity due to changes in the LFS questionnaire.**

### *1- 1990 Changes in educational attainment question<sup>5</sup>.*

Because there was a major break in the educational attainment section of the LFS questionnaire in January 1990, our time series had to be adjusted to deal with the discontinuity.

Up to December 1989, in part 1 of the educational attainment section, the LFS questionnaire asked the respondent the number of regular schooling years completed. Six categories were available:

- 0) none
- 1) 1 to 8 years
- 2) 9 or 10 years
- 3) 11 years
- 4) 12 years
- 5) 13 years

The respondent was then asked about post secondary education. Provided that he had completed high school **and** that his post secondary education required high school graduation, the respondent's post secondary education was coded into three categories:

- 6) No degree, diploma or certificate
- 7) Certificate or diploma
- 8) University degree.

In the published time series available to the public on which this research was based, Statistics Canada reorganized those eight sub-groups into six education categories:

- (0) 0-8 years of education (LFS group 1 and 2)
- (1) 9-10 years (LFS group 2)
- (2) 11-13 years (LFS group 3, 4 and 5)
- (3) Some post secondary education (LFS group 6)
- (4) Post secondary certificate or diploma (LFS group 7)
- (5) University degree. (LFS group 8)

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<sup>5</sup> Background information for this section was found in the "Labour Force Survey utilization guide" and the staff report "the impact of the 1990 changes to the education questions on the labour force survey" published by Dave Gower for the labour and household surveys analysis division.

For the pre-1990 data, we treated individuals belonging to category 0 through 4 of the LFS as **Unskilled** and individuals belonging to category 5 "University degree" as **Skilled**.

It is important here to note that the "University degree" subgroup includes individuals with university degrees below the bachelor level such as university certificates.

**Starting in January 1990**, the number of group for "years of elementary and secondary schooling" was replaced by a question on "the highest grade completed" and the response categories were reduced to 3:

- 0) Grade 0-8
- 1) Grade 9-10
- 2) Grade 11-13.

Respondents are still asked if they graduated from high school but high school completion is no longer a requirement for post secondary education. New post secondary education categories were added. The new categories are:

- 3) No degree diploma, etc.
- 4) Trades vocational or apprenticeship certificate
- 5) College certificate or diploma
- 6) University certificate below bachelor's level
- 7) Bachelor's degree
- 8) Post graduate degree

LFHR series maintained 5 categories:

- (0) 0-8 years of education (LFS group 0)
- (1) Some high-school (individuals from group 1 and 2 who did not report high school graduation)
- (2) High-school completed (individuals from 2 who reported high school graduation)
- (3) Some post secondary education (LFS group 3)
- (4) Post secondary certificate or diploma (LFS group 4, 5 and 6)
- (5) University degree. (LFS group 7 and 8)

These changes led to a dramatic fall in the employment level of workers with a "University Degree" for two reasons:

- 1) The "University degree" category (group 5) became much more restrictive and did not include "University certificate below bachelor's level" anymore, but only individuals who completed at least a Bachelor degree.

2)

Moreover, the respondents were given more choices of answers for post-secondary education, and therefore some respondents that might have classified themselves as holding a university degree prior to 1990 for the lack of a better option in the questionnaire might now be classified in Post secondary certificate or diploma.

This shows up dramatically in the data. If we look at the difference in the level of employment between the months of December 1989 (see table 2) and January 1990, the major drop just can not just be the result of a real decrease of the number of skilled workers.

	December 1989	January 1990	Difference	% change	Adjustment Coefficient
Number of skilled workers	1602295	1445114	157181	9.81%	1.108767198

Table 2: Discontinuity in the reported level of skilled labor input due to classification changes.

There is a clear need to make adjustments to deal with these changes. To do so we make several hypotheses:

1) The reported drop from December 1989 January 1990 is only due to changes in the questionnaire. Had these changes not occurred, the levels would be the same for each month. The differences (column 3) in level is only due to the fact that some respondents that had a University degree below the bachelor level were now being classified as "Unskilled", even though those same respondents were classified as "Skilled" in December 1989.

2) From the first hypothesis, we know that in January 1990, 1,445,114 people held a university degree at the bachelor level or higher, and that 157,181 held a University degree below the Bachelor level. At this specific point in time, we can say that those with a university degree below the bachelor level amount to represent 0.1087 (157,181/1,445,114) of those that hold a university degree at the bachelor level or above.

3) We take this ratio to be constant throughout the time period. At any point in time post January 1990, we know that in order to re-include those who hold a university degree below the bachelor to the "Skilled" category, we need to add 10.87% to the number of individuals that hold a university degree at the bachelor level or above.

Let  $s$  be the skilled sub-group,  $u$  the unskilled sub-group and  $\hat{t}$  a monthly time unit.

The number of skilled workers for December 1989 and January 1990 is:

$$N_{s,\hat{t}=12/89} = \sum_{i \in s} \mu_{i,\hat{t}=12/89}$$

$$N_{s,\hat{t}=01/90} = \sum_{i \in s} \mu_{i,\hat{t}=01/90}$$

We find an adjustment coefficient ( $\eta=1+\lambda$ ) so that the levels of skilled workers are similar for December 1989 and January 1990. We find  $\eta$  so that:

$$\begin{aligned} N_{s,\hat{t}=12/89} &= N_{s,\hat{t}=01/1990} + \lambda N_{s,\hat{t}=01/1990} \\ &= \eta N_{s,\hat{t}=01/1990} \\ &= \hat{N}_{s,\hat{t}=01/1990} \end{aligned}$$

$\lambda N_{s,\hat{t}=01/1990}$  represents the skilled individuals that hold a university degree below the bachelor level that is a fraction constant through time of individuals that hold a bachelor degree or higher ( $N_{s,\hat{t}=01/1990}$ ).

Because we made the hypothesis that the ratio is constant through time, we can apply this coefficient to any monthly aggregates for the remaining of the period. The adjusted skilled aggregates are such that:

$$\hat{N}_{s,\hat{t} \geq 01/1990} = \eta N_{s,\hat{t} \geq 01/1990}$$

(This adjustment procedure is done homogeneously to the population sample; it amounts to multiply the weight of each observation by the coefficient since

$$\hat{N}_{s,\hat{t} \geq 01/1990} = \eta N_{s,\hat{t} \geq 01/1990} = \eta \sum_{i \in s} \mu_{i,\hat{t} \geq 01/1990} = \sum_{i \in s} \eta \mu_{i,\hat{t} \geq 01/1990}$$

When dealing with average hours worked, there is no need to make the adjustment. As seen in appendix A, the formula used to compute average weekly hours is:

$$h_{s,\hat{t}} = \frac{\sum_{i \in s} \mu_{i,\hat{t}} h_{i,\hat{t}}}{\sum_{i \in s} \mu_{i,\hat{t}}}$$

The adjustment made to employment was equivalent to make an adjustment on the weight given to each observation, while applying the same transformation



coefficient homogeneously across individual observations. As mentioned above, we could rewrite the adjusted values for employment post January 1990 as:

$$\hat{N}_{s,\hat{t} \geq 01/1990} = \sum_{i \in s, \hat{t} \geq 01/1990} \eta \mu_{i,\hat{t} \geq 1990}$$

Applying these weights to average hours, because they are applied homogeneously, would have no effect on the final result since the coefficients would cancel each other:

$$h_{s,t} = \frac{\sum_{i \in s} \eta \mu_{i,\hat{t}} h_{i,\hat{t}}}{\sum_{i \in s} \eta \mu_{i,\hat{t}}} = \frac{\sum_{i \in s} \mu_{i,\hat{t}} h_{i,\hat{t}}}{\sum_{i \in s} \mu_{i,\hat{t}}}$$

2- 1997 changes in the definition of “usual weekly hours of work”.

Similarly to the “skilled employment” time series that displayed discontinuity through time due to changes in the questionnaire, the “usual weekly hours of work” series also suffered a major break due to changes in the definition of the variable. That break took place in 1997:1.

Prior to January 1997, usual weekly hours were the number of hours usually worked by the respondent in a typical week, regardless of whether they were paid. Beginning January 1997, usual hours of employees refer to their normal paid or contract hours, nor counting any overtime<sup>6</sup>. This change led to a clear break in the series, especially for skilled workers, as shown in Figure 8.

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<sup>6</sup> Background information for this section was found in the “Labor Force Survey utilization guide”.

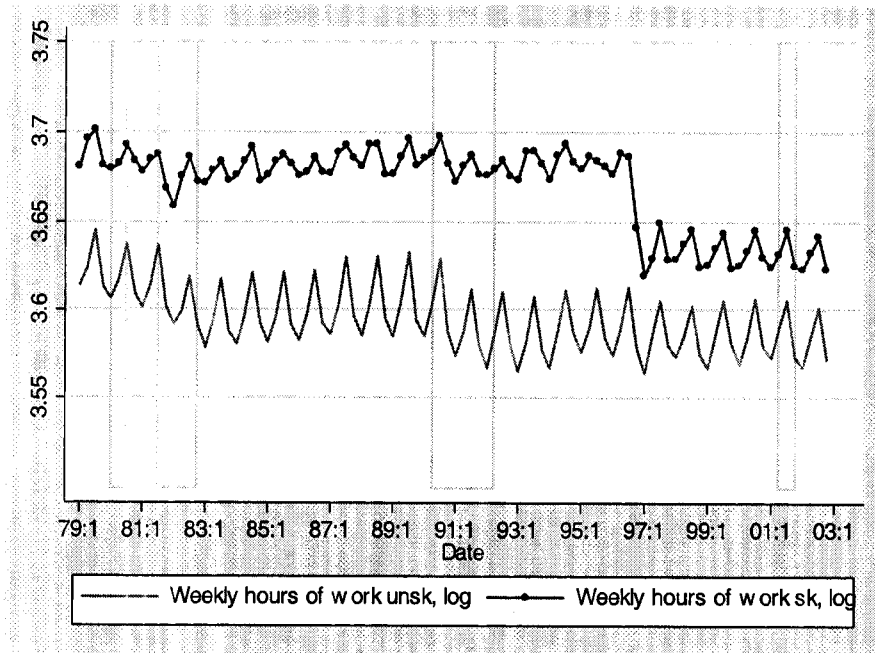


Figure 9: Unadjusted usual weekly hours of work per skill group.

The serie for skilled workers was the only one affected by this change since higher skilled individuals are not typically paid by the hour. Before 1997, even hours that were not paid were reported in “usual hours” of work. In January 1997, only paid hours prescribed by contracts were reported and therefore unpaid overtime hours that typically entered the series were dropped. The typical extra hours that a manager might do to meet a higher temporary demand are not “paid” hours in the strict sense of the word. This type of hours was excluded of the calculation of “usual hours” starting in 1997 which explains the major 1997:1 drop.

Unskilled individuals are believed to have more flexible contracts and are more often paid by the hour. Since contracts are often adjusted monthly or weekly and all hours of worked are paid, we do not see a major drop in the usual number of hours worked.

To deal with the discontinuity, we made a linear adjustment similar to the one made for the series of skilled workers due to changes in the educational question.

Specifically, we levelled the series so the drop of skilled weekly hours worked that takes place between the 9<sup>th</sup> month of 1996 and the 1<sup>st</sup> month of 1997 (which can be seen in Figure 8) would be of the same magnitude as the average of all the other drops experienced between September and January of the other years in the 1979-1999 period.

Between August and January for each year of the 1979-1996 time period, skilled usual hours on average decreased by 2.06 % due to seasonality:

$$\frac{1}{16} \sum_{t=0}^{t=16} \frac{h_{s,8/1979+t} - h_{s,01/1980+t}}{h_{s,8/1979+t}} = 2.06\%$$

Because of the change in definition, we witness a 7.04% decrease between August 1996 and January 1997.

$$\frac{h_{s,8/1996} - h_{s,01/1997}}{h_{s,8/1996}} = 7.04\%$$

We want to obtain an adjusted value for usual hours worked in January 1997,  $\hat{h}_{s,t=01/1997}$  so that

$$\frac{h_{s,8/1996} - \hat{h}_{s,01/1997}}{h_{s,8/1996}} = 2.06\%$$

The coefficient is 1.0525. Therefore, we have:

$$\frac{h_{s,8/1996} - 1.0525 * h_{s,01/1997}}{h_{s,8/1996}} = 2.06\%$$

To level the serie, we apply the same coefficient to all months post January 1997.

We also ensure that the reported drop in between each month of the August 1996-January 1997 period is proportionate to the drop observed in the non-adjusted serie. This procedure ensures a time-consistent time series as seen in Figure 9.

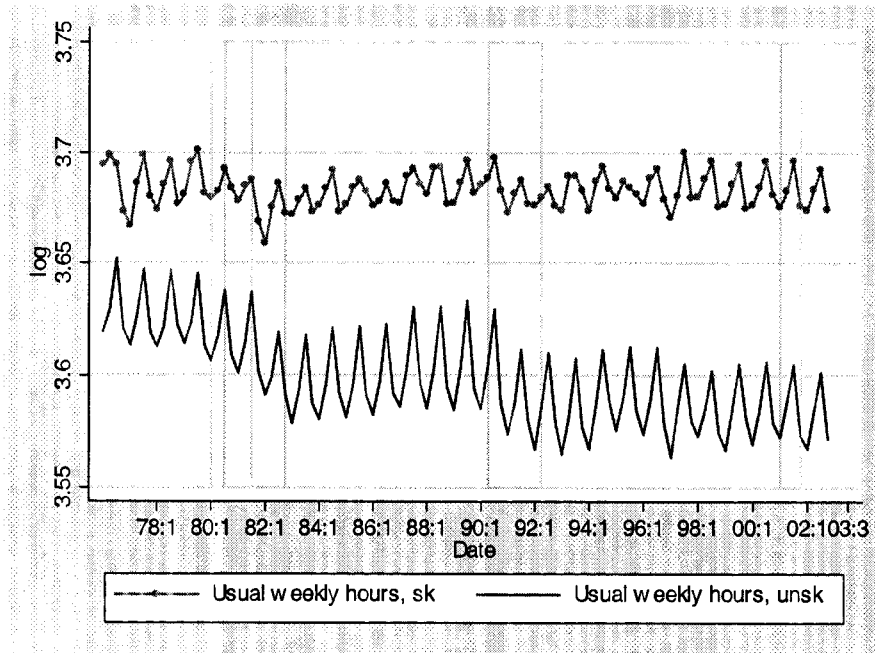


Figure 10: Adjusted usual weekly hours of work per skill group.

### Appendix C: Construction of the aggregates using a different series for weekly hours worked.

The LFS questionnaire asked the respondent its “usual” and “actual” number of weekly hours worked. As a benchmark for this paper, we used the “usual” number of weekly hours worked to construct our aggregated series, as Castro and Pirani did for their U.S. analysis. However, as shown in this appendix, using “actual” hours rather does not alter the results in a significant way. In what follows we show similar graphs as those presented in the main section of this paper, but using “actual hours weekly hours” as the alternative series for the number of weekly hours worked.

The recorded statistics for those figures are reported in table 3 below:

Variable	Volatility			Comovement		
	skilled	unskilled	aggregate	skilled	unskilled	aggregate
<i>1978:1-1986:4</i>						
Total hours: Efficiency Units	1.17	1.04	0.98	0.46	0.88	0.87
Total hours: Unweighted hours	1.17	1.19	1.11	0.41	0.88	0.87
Employment	0.93	1.03	0.96	0.27	0.76	0.74
Weekly hours of work (usual)	0.76	0.58	0.60	0.31	0.45	0.42
<i>1987:1-2002:4</i>						
Total hours: Efficiency Units	2.15	1.41	1.47	0.81	0.68	0.79
Total hours: Unweighted hours	2.11	1.44	1.48	0.83	0.72	0.79
Employment	1.81	0.84	0.94	0.77	0.74	0.86
Weekly hours of work (usual)	0.92	0.83	0.84	0.39	0.51	0.50

Table 3: Volatility and co-movement using an alternative measure of actual weekly hours worked.

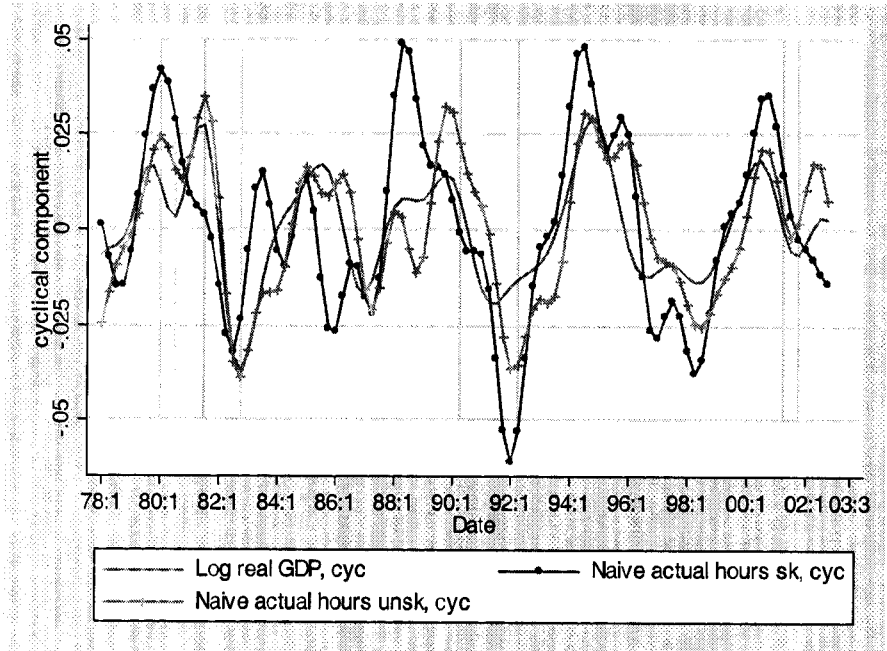


Figure 11: Unweighted (Naïve) hours per skill group (Actual hours).

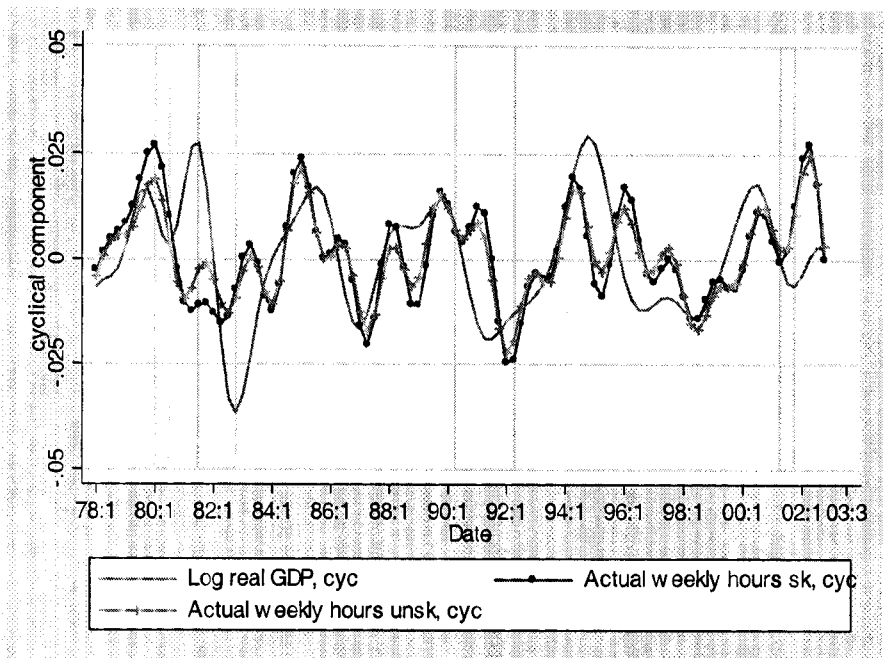


Figure 12: Average Weekly Hours per skill group (Actual hours)

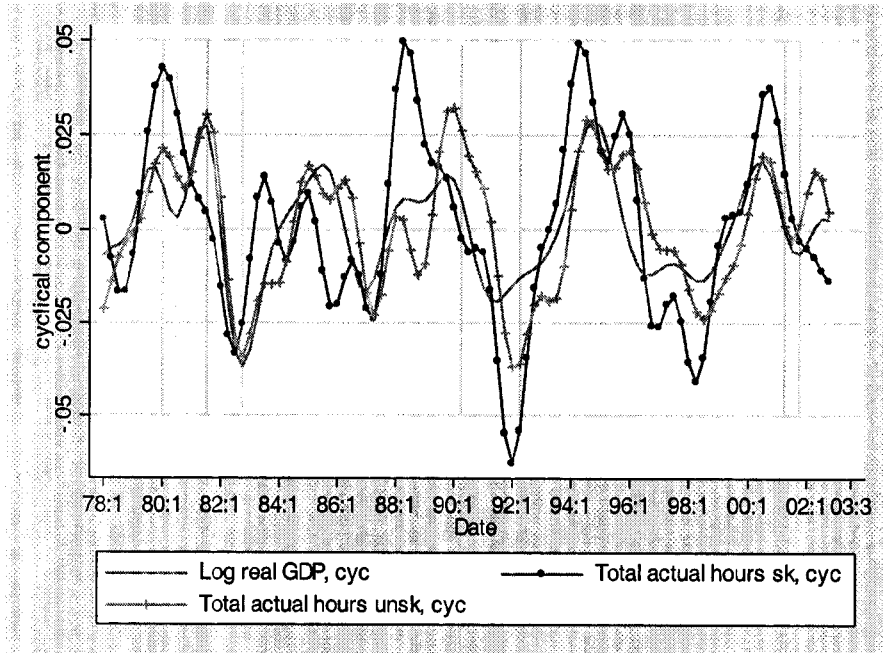


Figure 13: Total hours worked per skill group (Actual hours).

## Appendix D: Using an alternative date to define the two sub periods.

The partition between the two sub periods was somewhat subjective and we show in this section that choosing a different "split" date does not alter the results in any significant ways. We decided to compute the same statistics as the ones presented early but to split the period at 1985:1.

Variable	Volatility			Comovement		
	skilled	unskilled	aggregate	skilled	unskilled	aggregate
<i>1978:1-1984:4</i> Total hours: Efficiency Units	1.00	1.06	0.99	0.57	0.83	0.84
Total hours: Unweighted hours	0.93	1.21	1.13	0.56	0.86	0.86
Employment	0.81	1.08	1.03	0.51	0.83	0.81
Weekly hours of work (usual)	0.27	0.16	0.15	0.37	0.91	0.89
<i>1985:1-2002:4</i> Total hours: Efficiency Units	1.85	0.97	1.03	0.67	0.68	0.79
Total hours: Unweighted hours	1.83	1.03	1.06	0.67	0.72	0.79
Employment	1.77	0.81	0.89	0.64	0.69	0.80
Weekly hours of work (usual)	0.21	0.28	0.26	0.51	0.65	0.68

Table 5: Volatility and co-movement using an alternative date to divide the two sub periods.

Variable	Volatility			Comovement		
	skilled	unskilled	aggregate	skilled	unskilled	aggregate
<i>1978:1-1984:4</i> Total hours: Efficiency Units	1.17	1.07	1.02	0.56	0.91	0.90
Total hours: Unweighted hours	1.12	1.23	1.17	0.54	0.91	0.91
Employment	0.81	1.08	1.03	0.51	0.83	0.81
Weekly hours of work (actual)	0.75	0.55	0.57	0.26	0.41	0.38
<i>1985:1-2002:4</i> Total hours: Efficiency Units	2.06	1.35	1.4	0.74	0.68	0.77
Total hours: Unweighted hours	2.04	1.39	1.42	0.74	0.71	0.77
Employment	1.77	0.81	0.89	0.64	0.69	0.80
Weekly hours of work (actual)	0.91	0.82	0.83	0.42	0.52	0.51

Table 5: Volatility and co-movement using an alternative date to divide the two sub periods (Actual hours)

## Appendix E: Statistics and graphs for the entire period (including 1976-78).



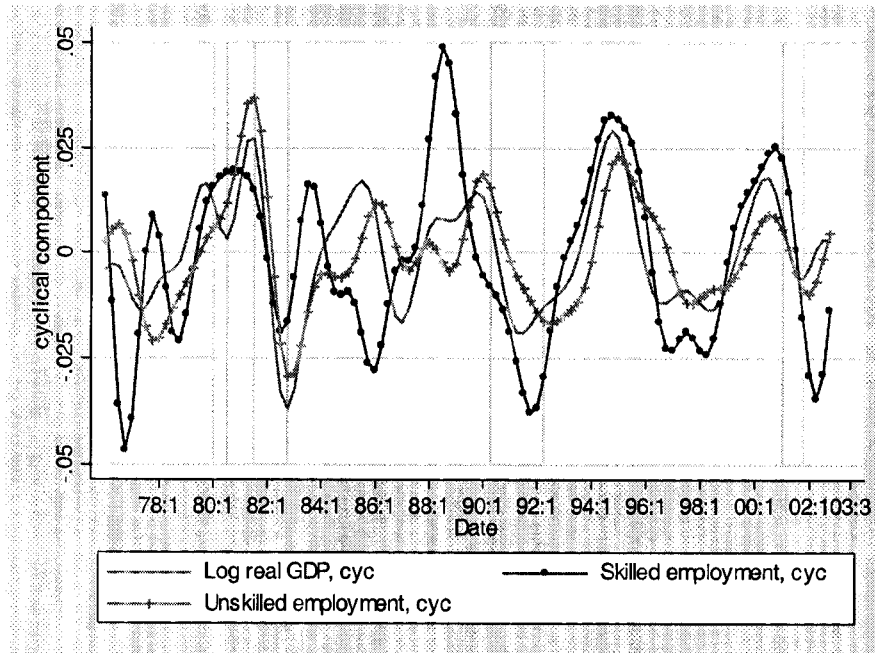


Figure 14: Employment per skill group for the entire period (including 1976-78).

Variable	Volatility			Comovement		
	skilled	unskilled	aggregate	skilled	unskilled	aggregate
<i>1976:1-1986:4</i>						
Total hours: Efficiency Units	1.41	1.01	0.93	0.36	0.77	0.78
Total hours: Unweighted hours	1.32	1.16	1.07	0.33	0.78	0.78
Employment	1.14	1.04	0.97	0.28	0.75	0.74
Weekly hours of work (actual)	0.32	0.17	0.16	0.41	0.74	0.75
<i>1987:1-2002:4</i>						
Total hours: Efficiency Units	1.91	1.02	1.09	0.79	0.72	0.85
Total hours: Unweighted hours	1.87	1.08	1.13	0.80	0.76	0.85
Employment	1.81	0.84	0.94	0.77	0.74	0.86
Weekly hours of work (actual)	0.21	0.30	0.27	0.50	0.68	0.72

Table 7: Volatility and co-movement for the entire period (including 1976-78).

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