Review of Income and Wealth
Series 56, Number 3, September 2010

LONG-RUN INEQUALITY AND SHORT-RUN INSTABILITY OF MEN'S AND WOMEN'S EARNINGS IN CANADA

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This paper examines the variability of workers' earnings in Canada over the period 1982–2006. We decompose the total variance of workers' earnings into a 'permanent' component between workers and a 'transitory' earnings instability component over time for given workers. We then investigate the statistical relationships between these components and indicators for the business cycle. The most marked change in earnings variances in Canada since 1982 is the general rise in total earnings variance, which is essentially driven by a quite dramatic rise in long-run earnings inequality. The patterns across age categories of the two variance components are almost opposite. Long-run earnings inequality generally rises with age, but earnings instability is seen to generally decline with age, so that earnings instability is markedly highest among entry age workers. Unemployment rate effects are positive on almost all variance measures, while higher unemployment is associated with widened long-run earnings differentials and greater short-run earnings instability.

1. Introduction

Canada's labor market since the early 1980s has been subject to major transformations such as increasing integration with the U.S. economy and shifting trade flows, the rapidly advancing state of information technology, shifting modes and organization of production such as 'outsourcing' and non-standard work patterns, fluctuating prices for natural resources, marked changes in the Canadian exchange rate, highly uneven regional growth rates, increasing competitive pressure in product markets, and high inflows of immigrants. On the macroeconomic level, the economy recovered slowly from the severe recession of the early 1990s, as the unemployment rate was persistently high until the late 1990s and then proceeded to decline to 30-year lows by the mid-2000s. These developments might well be expected to have an impact on the distribution of labor market earnings across workers.

Note: The Small Area and Administrative Data Division of Statistics Canada provided access to the LAD data upon which this study is based. Don McDougall, Roger Sceviour, and Steve McBride provided excellent computing assistance.

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This paper examines the variability of men's and women's earnings in Canada over the period 1982–2006 using a variance decomposition approach exploiting a large representative longitudinal database. Following Gottschalk and Moffitt (1994, 2009), we decompose the total longitudinal variance of workers' earnings over this period into a "permanent" or long-run component between workers and a transitory or year-to-year earnings instability component over time for given workers. A distinctive feature of the present paper is that this decomposition is applied to a five-year moving window of earnings, so that we can examine (graphically and through regression techniques) how total earnings variance and its two components have changed since the early 1980s in a quite flexible descriptive fashion. This is also a longer time span than in any previous Canadian study. We report results separately for men and women and for four separate age groups of workers. The flexible moving-window feature of our analysis also permits an examination of how the earnings variance components vary with macroeconomic indicators, namely the unemployment rate and the real GDP growth rate, over this period.

Understanding the patterns of long-run earnings inequality across workers and their year-to-year earnings instability is of economic and policy interest. Long-run earnings differentials across workers are related to lifetime earnings patterns and are affected by factors such as human capital attainment and skill levels, long-run labor force attachment and work patterns, evolving industry/occupational mix in the economy, shifting returns to skills, and cohort effects. These forces speak to issues involving skill level, job matching, access to training, and efficient usage of human capital. In contrast, year-to-year changes in earnings around long-run trends reflecting earnings instability are a result of more transitional factors, such as frictional or cyclical unemployment and workplace restructuring, contingent and non-standard employment relationships, volatile primary good prices, and volatility in firm performance. They focus policy attention more on issues such as social insurance, improving the flow and quality of labor market information, and macroeconomic stabilization policy. Decomposing overall longitudinal earnings variance into permanent and short-run components allows one to better interpret and test alternative explanations for observed outcomes, and sheds light on sources of changes in earnings mobility (Gottschalk and Moffitt, 2009). Better estimates of transitory earnings variance over the life-cycle also allow for better estimates of age-related bias and hence consistent estimation of the degree of intergenerational correlation of long-run earnings (Solon, 1992). More generally, empirical analyses that use current earnings as a proxy for long-run earnings status need to recognize the structure of the biases involved (Haider and Solon, 2006).

In terms of Canadian empirical analysis, Beach *et al*. (2003) followed a variance decomposition approach and showed the existence of a structural shift in the variance measures between the 1980s and 1990s. Beach *et al*. (2005) incorporated a regional dimension along with a temporal shift measured over two periods (1982–89 vs. 1990–97). The present paper extends the above analysis by incorporating a moving-average measure of permanent earnings within the Gottschalk–Moffitt decomposition approach. This feature allows one to calculate a time series of variance components and thus to analyze detailed year-to-year changes in these

variance measures both graphically and by regression techniques. Macroeconomic effects can thus be estimated directly rather than inferred indirectly from regional differences in macroeconomic performance. The current analysis also extends the interval of analysis up to 2006 and brings in the further richness of gender and age differences in the time series patterns.

2. Review of the Literature

There has been a burgeoning of interest in the underlying pattern of earnings dynamics behind the run-up of earnings inequality since the late 1970s. Attention has focused on (i) the structural modeling of the earnings dynamics involved, (ii) the bias adjustment that is required for short-run earnings instability in the estimation of intergenerational correlation of long-run earnings status, and (iii) the degree to which the marked run-up in earnings inequality since the early 1980s is driven by rising earnings instability versus widening long-run earnings differentials and returns to skill. The present paper fits into the latter strand of inquiry.

In the first of a series of influential papers Gottschalk and Moffitt (1994)—using standard random-effects variance decomposition formulas applied to U.S. Panel Study of Income Dynamics (PSID) data for white male workers—decomposed total earnings variance in longitudinal data into separate permanent and transitory variance components and found that *both* a growing instability of earnings and a widening dispersion of permanent earnings contributed about evenly to the increase in cross-sectional earnings inequality from the 1970s to the 1980s, although the latter component was about twice the size of the former. This approach was also used by Hacker (2006) and applied to family income volatility (Gottschalk and Moffitt, 2009) for both women and men. Haider (2001) and Moffitt and Gottschalk (2002) then presented more formal parametric models of the earnings dynamics, so that the transitory and permanent variance components depend upon the underlying parametric estimates. Both applied their analyses to the PSID data again for males. Haider (2001) found that the transitory component increased during the 1970s, while the variance in permanent earnings increased substantially during the severe recession of the early 1980s among U.S. males. He determined that the permanent variance is only mildly counter-cyclical, while earnings instability is strongly counter-cyclical. Moffitt and Gottschalk (2002) discerned a secular rise in the permanent component until 1996, and a rather dramatic increase in the transitory component during the 1980s, followed by a decline after 1991.

This work has been updated more recently in Shin and Solon (2008) and Moffitt and Gottschalk (2008), both using PSID data on male earners up to 2004, but using different modeling approaches. The latter, for example, found that transitory variance increased substantially in the 1980s and then remained fairly high through to the 2000s. The run-up in overall earnings inequality since the mid-1990s, however, reflects a corresponding rise in the permanent earnings variance.

Gustavsson (2008) provides estimates of persistent and transitory earnings variances for Swedish men over the period 1960–90 using a parametric modeling approach. He finds that the permanent variance decreased moderately over the

1980s, while the transitory variance showed a clear upward trend. Studies using the same parametric modeling approach applied to men's earnings have also appeared for other countries as well, including Dickens (2000) and Ramos (2003) for Great Britain and Cappellari (2004) for Italy.

The Canadian literature on earnings variability was fairly sparse until recently, and the only work is based on administrative data files.[1] Baker and Solon (2003) follow a parametric modeling approach to earnings variance decomposition and employ data from the Canada Customs and Revenue Agency's (CCRA's) T-4 tax files (submitted by employers) covering the period 1974–92. Their analysis includes male workers having above-minimum earnings for at least nine consecutive years. They find that the increase in Canadian earnings inequality over the 1976–92 period reflects an increase in both long-run inequality and earnings instability, with the former component having a somewhat larger role.

Morissette and Ostrovsky (2005) look at the instability of family earnings and total income over the separate periods 1986–91 and 1996–2001, and make use of the Canadian Longitudinal Administrative Database (or LAD) file that includes income from T-1 income tax forms filed by individuals. They find that permanent earnings inequality among families widened considerably between these two periods. Ostrovsky (2008) applies the Baker and Solon model to LAD data on immigrant males over the period 1982–2004 to see how their earnings experience differs from that of native-born men in Canada. Ostrovsky (2010) essentially updates Baker and Solon's analysis using LAD data for 1985–2005. He applies the latter's same parametric specification to an estimation sample of adult males having above-minimum earnings for *all years* for which they satisfy the age window of 25–59 years. He finds that Canadian males' earnings inequality increased substantially in the early 1990s recessionary period and continued to increase throughout the 1990s and into the 2000s. He also finds that both permanent and transitory variance components contributed to this growth of earnings inequality and grew at a similar pace since the mid-1990s.

The present paper follows on from the authors' earlier studies (Beach *et al.*, 2003, 2005) which make use of the Gottschalk and Moffitt (1994, 2009) non-parametric random-effects approach, again applied to the large LAD database. A similar methodology is used, for example, in a recent study by the U.S. Congressional Budget Office (2007) as well as in Moffitt and Gottschalk (2008). We also extend the analysis to women workers as well as men and separately for four age groups of workers between ages 20 and 64.

3. Empirical Approach and Estimation Samples

3.1. *Empirical Approach: Descriptive Decomposition*

The empirical approach used in this study follows Gottschalk and Moffitt (1994, p. 254) and is set out in the Appendix. It is essentially a traditional random-

[1]The Survey of Labor and Income Dynamics or SLID is a relatively recently available longitudinal database, but it has not been used as yet to address the issues covered in this paper. Its first cohorts date to 1993, and individuals are rotated out of the sample after six years.

effects or error components model (Johnston, 1984, p. 400). The permanent component of the variation in log-earnings is the "between (workers) component" of variation, and the transitory component term is the "within component" of variation (i.e., within the life-cycle for a given worker). Total variance in (log) earnings reflects both year-to-year variation in earnings across time for individual workers and also variation in earnings that persists between workers over the sample period. Transitory variance represents the average across workers of the intertemporal variance of annual (log) earnings from each worker's long-run average earnings. It thus reflects unstable employment and hours worked patterns from year to year. Permanent variance represents the variation in long-run average earnings across all workers in the sample. It captures persistent earnings differentials among workers relative to overall mean workers' earnings. It thus reflects more long-run or "permanent" wage rate or skill differentials across workers. So long as the time period covered for each worker is the same (i.e., a balanced sample), the transitory and permanent variance components sum to equal the total variance of (log) earnings.

In implementing these variance estimates, an individual's actual (log) earnings is replaced by life-cycle-adjusted (log) earnings, i.e., the residual between actual reported (log) earnings and log earnings predicted from an OLS regression equation of log-earnings on a quartic in age. Transitory variance, therefore, picks up year-to-year variation in a worker's (log) earnings about the worker's earnings trajectory. Permanent variance then captures the differences in average levels of life-cycle (log) earnings trajectories across workers. Since there is only one life-cycle (log) earnings regression estimated across all workers in each of our samples, high-skilled workers with high earnings trajectories will have a time series of large positive values, and low-skilled workers with low earnings trajectories will have a time series of large negative values. The transitory variance captures the volatility of earnings about individuals' life-cycle trajectories, while the permanent variance captures the more persistent and enduring differentials in log-earnings between workers as the average vertical differences between their life-cycle profiles (i.e. between workers of different skill levels).

3.2. *Data Construction: Data Source and Estimation Samples*

The data source for this study is Statistics Canada's Longitudinal Administrative Database (LAD). It is a 20 percent representative sample of all Canadian income tax filers drawn from CCRA's T-1 income tax files, containing over 3.0 million records per year. The measure of earnings used in the paper is total annual wage and salary income (henceforth "earnings"), as reported on individuals' tax forms.

The first stage of the estimation samples used in this analysis includes all paid workers aged 20 to 64 who were not full-time students during the tax year, who received at least $1000 (in 1997 constant dollars) of wage and salary income, whose earnings exceeded any net (declared) self-employment income, and who reported at least two years of above-minimum earnings (as just defined) on the LAD file. These omissions approximate Statistics Canada's concept of "all paid workers" while excluding those with only limited attachment to the

labor market.[2] Most of the exclusions stem from workers over age 64, the self-employed (most of whom had very low labor market earnings), and non-continuous participants in the labor market.[3,4] Since the original source of earnings data is the income tax files, no top-coding of earnings figures occurs.

The period covered by the study is 1982–2006. In order to capture inter-temporal changes in the variance components occurring over this period on a continual basis, a trade-off emerges between the length of the window over which the variance components are calculated and the frequency of the observations that we generate from those intervals. The longer the window for the calculation, the more degrees of freedom there are in order to identify the deviations from the mean and the better the mean represents long-term earnings. On the other hand, the longer this window, the lower the frequency of independent observations over the entire interval, and the fewer values one has in order to produce time-series graphs and undertake regression analysis. We choose a window length of five years as long enough to distinguish "permanent" or long-run earnings inequality from short-run or "transitory" earnings instability, but short enough to generate a sufficient number of time-series points to allow reasonable graphing of time-series patterns and statistical analysis of the effects of macroeconomic variables. As we seek to generate point estimates at an annual frequency, overlapping as opposed to disjoint windows are employed.[5]

In the second stage of the estimation samples, the entire 25-year estimation interval is divided into 21 contiguous rolling sampling windows of equal five-year length, each involving a balanced sample of workers whose earnings are positive for five consecutive years.[6] The initial sample, for instance, is comprised of all

[2]When compiling the LAD file, special procedures are employed in order to deal with individuals who have changed their SINs (social insurance numbers which serve as our identifier), who have multiple SINs, and other non-standard cases (see Finnie, 1997), which comprise on the order of 4 percent of the file in any given year. Full-time students are identified from tuition and education tax credit responses on T-1 forms.

[3]Discussion of the coverage and representativeness of the T1-tax file data is found in Frenette *et al*. (2007). They argue for the relatively better representativeness of the T1-tax file data over standard annual surveys in Canada—especially in the coverage of the two tails of the income distribution—since the later 1980s because of the advent of refundable tax credits that require tax filing in order to claim them. Ostrovsky (2010, p. 5) cites Statistics Canada's estimates that LAD coverage rates for men and women aged 25–59 in 2005 were between 88 and 96 percent, depending on age group. Coverage of these with positive wage and salary income is expected to be considerably higher.

[4]As a tax-based administrative data set, the LAD file does not have information on educational attainment or hours worked, so there are limitations on the economic modeling of earnings that can be undertaken.

[5]As a robustness check, analysis was also done for three-year windows and seven-year windows, and the graphs corresponding to Figures 1–3 are very similar and are available upon request. The only difference is that, in the case of the three-year window, the total variances flatten, and the transitory variances turn down at the very end of the interval.

[6]The restrictions on the estimation samples that individuals have positive earnings for all five years of the rolling window is not necessary for the variance estimations, although having a balanced sample is necessary to ensure that the variance decomposition goes through with exact equality. It can be viewed as an intermediate case between requiring positive earnings over a substantially longer period typically used in parametric estimation studies in order to better estimate the detailed earnings dynamics parameters (e.g. at least 9 years by Baker and Solon)—what may be called a narrow estimation sample—and the least restrictive case of at least 2 years of positive earnings—what may be called a broad estimation sample. The latter approach has broader coverage, particularly if women and non-prime-age workers are included in the analysis. For present purposes, we have chosen to focus on the intermediate case, fully recognizing that earnings instability results would be greater with a broad estimation sample.

individuals who reported positive earnings for each of the years 1982–86. The second sample is comprised of all individuals who reported positive earnings for each of the years 1983–87, and the 21st and final sample is comprised of all individuals who reported positive earnings for the years 2002–06. For each such five-year sample, the three variance measures are calculated. By construction, any two adjacent samples will share 4 years of data, any two samples that commence two years apart from each other will share 3 years of data, and any two samples that commence five or more years apart from each other will share no observations.[7] The statistics that are produced from this data-generating process of rolling samples—of which there are 21 annual observations—are analogous to a moving average process over five consecutive years. Despite the obviously high correlations that exist between statistics that are calculated from samples that are either one or two years apart from each other (only in the case of five or more years of time between the start dates will the calculated values be totally independent), it turns out that distinctive turning points can be discerned over the global interval from 1982 to 2006.

The estimation samples of this paper also involve breakdowns by age as well as gender. The four age groups are 'Entry' (age 20–24), 'Younger' (age 25–34), 'Prime' (age 35–54), and 'Older' (age 55–64) for each of women and men. This allows us to examine earnings variability patterns over different phases of workers' life-cycles. The sizes for the full set of 168 samples (four age groups for each gender over 21 cohorts) are available from the authors. The samples vary between 63,000 and over 1,000,000 data points and reflect the demographic shifts and labor market participation trends that occurred over this period. In particular, there is a diminishing proportion of younger workers and an increase in the proportion of women in the labor market. These patterns also reflect individuals' movements across age groups over the relevant sample period. For example, individuals exit the 'Entry' age groups and enter the 'Younger' groups as they age, and a similar dynamic operates across the entire age spectrum of workers.

For the graphical as well as for the regression analysis, we first estimate life-cycle adjusted earnings profiles based on log-earnings regressions. As mentioned above, the dependent variable is the log earnings for an individual in a given year, and the independent variables consist of a quartic in age for each of the male and the female estimation samples. For these (log) earnings equations, the four age groups are pooled together for a given gender. These regressions are estimated separately for each estimation window. This results in 42 such (log) earnings regressions (a male and a female regression for each of the 21 window samples).

4. Estimation Results: Basic Patterns of Earnings Variance Changes Since 1982

The empirical analysis of this paper proceeds in two stages. In the first stage—involving the actual microdata from our estimation samples—the three

[7]Note that no two samples will be composed of the exact same individuals. Over time, some new individuals will enter the sample as they meet our overall sampling criteria, and some individuals will leave the sample as they no longer meet these criteria. Subjects will also change age groups with the passage of time.

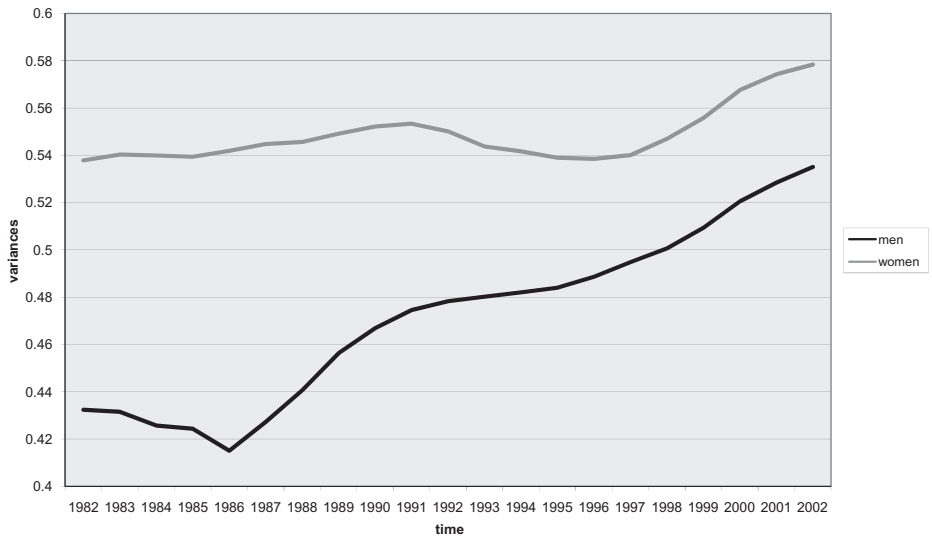

Figure 1. Total Variances by Gender

variance measures are calculated and examined descriptively in this section. The second stage of analysis involves running regressions with the variance measures as dependent variables; the results are presented in Section 5.

4.1. *Variance Components Over Time for Men and Women*

The three variance measures are illustrated over the 1982–2006 period in Figures 1–3, with Figure 1 for total earnings variance, Figure 2 for short-run earnings instability, and Figure 3 for long-run or permanent earnings inequality. The years on the base axis refer to the midpoints of each five-year moving window. There is a curve for each gender. Long-run inequality accounts for about three-quarters of total variance in earnings, while earnings instability accounts for only about one quarter. For women, the permanent inequality component has changed relatively little from 70 percent of total variance for 1982–86 to 71 percent by 2002–06. For men, though, the relative size of the permanent inequality component has risen from 69 to 76 percent over this period. All three variance measures are also higher for women than for men—by 8 percent in the case of total earnings variance, by 32 percent for earnings instability, but by less than 1 percent for permanent inequality, all for the most recent 2002–06 interval.

The most marked change in earnings variances in Canada over the full period is the general rise in total earnings variance for both men and women (Figure 1). This rising inequality is much more marked for men than for women. In the case of men, this is essentially driven by the dramatic rise in long-run earnings inequality (Figure 3), while for women both variance components have contributed to the rise (Figures 2 and 3). Between the 1985–89 window and the 2002–06 window, the total variance for women rose by 7.2 percent, and their long-run earnings inequality went up by 9.5 percent. For men, however, between 1986–90 and 2002–06, the

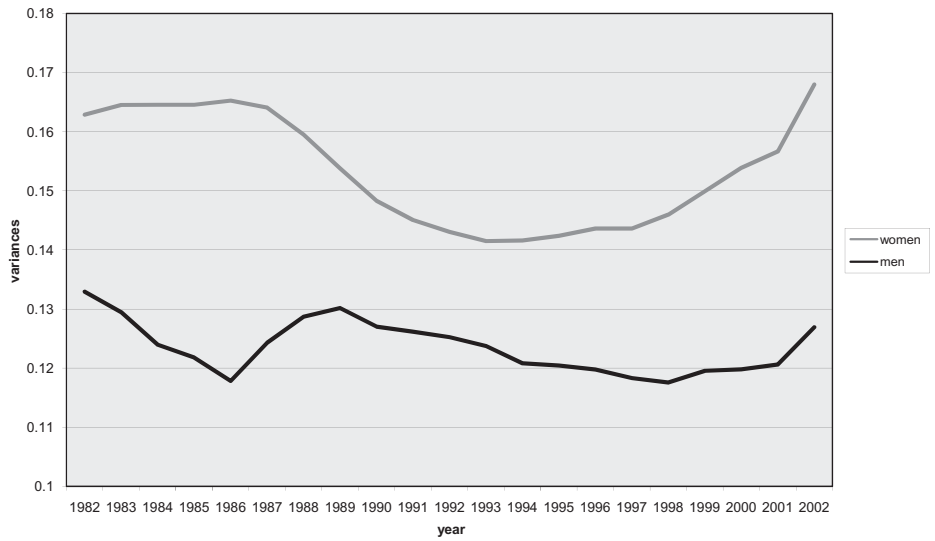

Figure 2. Transitory variance by gender

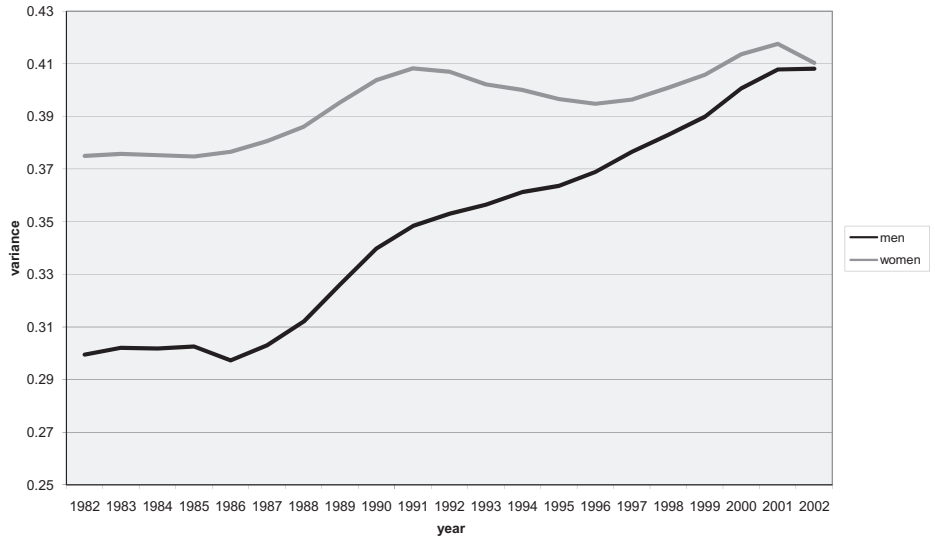

Figure 3. Permanent Variance by Gender

corresponding increases were by 28.9 percent and 37.3 percent, respectively. Indeed, since the late 1990s, all three variance measures have been rising for both men and women. Furthermore, since the total earnings variance and long-run earnings inequality are higher for women than for men, the dramatic rise in these measures for men has resulted in a marked convergence in these measures between women and men, particularly since the early 1990s. Back in 1982–86, for example,

the total variance for women was 24 percent higher than for men, and the long-run inequality measure was 25 percent higher—substantially greater than in 2002–06.

A second notable change over the period is the quite substantial run-up of short-run earnings instability since the mid-1990s for women and since the later 1990s for men, as seen in Figure 2. Since 1998–2002, men's earnings instability has gone up by 8.0 percent, while since 1993–97 women's earnings instability has risen by 18.8 percent. Again, since the later 1990s, the transitory variance component has been behaving similarly for men and women. Though in this case, the more rapid run-up in the component for women has resulted in a widening of the earnings instability difference between the genders.

One question worth asking is what portion of the increase in total earnings variance between the 1980s and 2000s is attributed to permanent or transitory components. Since total variance is the sum of these two components, it is straightforward to decompose its changes over time. For each of the selected periods 1982–86 to 1992–96, 1982–86 to 2002–06, 1986–90 to 2002–06, 1992–96 to 2002–06, and 1996–2000 to 2002–06, the percentage contributions arising from changes in long-run earnings inequality for men ranged between 85 and 100 percent. The run-up for men is therefore driven almost completely by increases in long-run earnings inequality. For women earners, again, the latter component is vastly dominant, except for the more recent periods since the middle 1990s, when the earnings instability share of change from 1992–96 to 2002–06 is 88 percent and from 1996–2000 to 2002–06 is 61 percent. For women, the run-up in earnings inequality is driven by permanent changes in the 1980s, by mixed patterns in the 1990s, and by mostly instability changes in the 2000s.

The present study shows some rather different results from those of Baker and Solon (2003) and Ostrovsky (2010). All three studies use Canadian income tax data, and all three studies show a substantial increase in the total earnings variance for men in the early 1990s recessionary period followed by a continuing increase throughout the 1990s and into the 2000s. The present study differs from the other two—which use the same earnings dynamics parameterization scheme—in using a non-parametric characterization of the two variance components and in incorporating a somewhat broader sample definition.[8] The differences in results show up in the estimated variance components. Baker and Solon (2003) and Ostrovsky (2010) find that the rise in total earnings variance stems from increases in both permanent and transitory components, while the present study finds that—at least for male earners—the former component accounts for virtually all of the increase.[9]

4.2. *Differences in Variance Components by Age*

Changes in the three variance measures over time by age group are summarized in Table 1.

[8]The present study covers ages 20–64 vs. ages 25–59 for Ostrovsky (2010) and Baker and Solon (2003), includes women rather than solely men, and the estimation samples include workers with five consecutive years of above-minimum earnings vs. at least 7 years (for Ostrovsky, 2010) or 9 years (for Baker and Solon, 2003) of above-minimum earnings.

[9]Since the time periods of coverage of Ostrovsky (2010) and the present paper are very similar—1985–05 for the former vs. 1982–06 for the latter—the difference in decomposition results is very likely due to the different methodologies used.

TABLE 1

EARNINGS VARIANCE MEASURES BY SEX AND AGE, 1982–86 AND 2002–06

	Entry	Younger	Prime Age	Older	All Ages
			(A) Men		
	(1) *Long-Run Earnings Inequality*				
8286–	0.2988	0.2710	0.3019	0.4134	0.2995
0206–	0.2741	0.3355	0.4252	0.6362	0.4081
	(2) *Earnings Instability*				
8286–	0.2094	0.1264	0.1044	0.1746	0.1330
0206–	0.2141	0.1288	0.1035	0.1914	0.1269
	(3) *Total Variance of Earnings*				
8286–	0.5082	0.3974	0.4063	0.5880	0.4325
0206–	0.4881	0.4643	0.5287	0.8276	0.5351
			(B) Women		
	(1) *Long-Run Earnings Inequality*				
8286–	0.2757	0.3635	0.4205	0.4326	0.3750
0206–	0.2298	0.3551	0.4431	0.5329	0.4104
	(2) *Earnings Instability*				
8286–	0.2261	0.1795	0.1274	0.1185	0.1629
0206–	0.3073	0.2533	0.1180	0.1440	0.1680
	(3) *Total Variance of Earnings*				
8286–	0.5019	0.5430	0.5479	0.5511	0.5379
0206–	0.5371	0.6084	0.5612	0.6769	0.5784

These results highlight the different patterns of change by age, but also allow one to localize better where the major patterns noted above are generated, so that possible explanations can be better targeted.

As can be seen from Table 1, the patterns across ages of the two variance components are almost opposite. Long-run earnings inequality generally rises with age, so that it is markedly highest among the older age group—for both men and women—much as one would expect from a standard on-the-job training (OJT) human capital model (as also found in Dickens, 2000, and Gustavsson, 2008). If one uses entry workers' permanent variance figure as a base of 1.0, then the most recent interval's (2002–06) long-run earnings inequality rises to 1.224 for younger workers, 1.551 for prime-age workers, and 2.321 for older workers among males, and 1.545 for younger workers, 1.928 for prime-age workers, and 2.319 for older workers among females. Earnings instability, however, is seen to generally decline with age, at least between entry and prime-age workers, so that instability is markedly highest among entry age workers, which is very much consistent with a career job-matching perspective. More generally, the results replicate the general finding in the literature of a U-shaped pattern of transitory earnings variance over the life-cycle (Baker and Solon, 2003; Mazumder, 2005). Again, if one uses the entry workers' transitory variance figure as a base of 1.0, then the most recent period's earnings instability levels decline to 0.602 for younger workers and to 0.483 for prime-age workers before rising back up to 0.894 for older workers in the case of males, and 0.824 for younger and 0.384 for prime-age workers, back up to 0.469 for older workers among females. With the variance components moving in opposite directions according to age, it should not be surprising that the relative

TABLE 2

Ratio of Long-Run Inequality to Earnings Instability Measures by Sex and Age, 1982–86 and 2002–06

	Entry	Younger	Prime Age	Older	All Ages
			(A) Men		
8286–	1.427	2.144	2.892	2.368	2.253
0206–	1.280	2.604	4.108	3.324	3.215
			(B) Women		
8286–	1.219	2.025	3.300	3.650	2.302
0206–	0.748	1.402	3.754	3.701	2.443

size of the variance components also varies markedly across age groups. Table 2 shows the ratio of long-run inequality to short-run instability of earnings across age groups. For both women and men, the ratio markedly rises with age, at least up to the prime-age group (for men) and beyond (for women). That is, instability of earnings markedly declines in importance across age groups compared to long-run earnings differences, at least up to prime age workers, while permanent earnings inequality becomes relatively more important.

The pattern of total earnings variance across ages basically reflects that of long-run earnings inequality, which is the larger source component of total variation, which results in total earnings variance being the highest among older workers. The outcome is that total earnings variance shows a deckchair pattern across ages for men and a chaise-longue pattern across age groups for women.

4.3. *Changes in Variance Components Over Time by Age Group*

The figures in Tables 1 and 2 show that the variance component patterns across age groups have changed fairly substantially over the sample period 1982–2006. The two rows of figures in each panel refer to the initial 1982–86 interval and the most recent 2002–06 sample interval. One can see that the increases in the permanent earnings variance were experienced most dramatically for older workers (and to some extent prime-age workers) since the mid 1980s, and particularly so for men. Between the 1986–90 and 2002–06 intervals, long-run earnings inequality went up by 7.9 percent and 23.2 percent, respectively, for prime-age and older female workers, but by 39.5 percent and 58.8 percent, respectively, among male workers. On the other hand, the increases in the transitory earnings variance were experienced most strongly by entry and younger female workers, particularly since the early-to-mid 1990s. For entry women workers, since the 1990–94 interval, earnings instability rose by 37.3 percent; while for younger women workers, since the 1993–97 interval, it rose by 48.5 percent. Over the period as a whole, the ratio of permanent to transitory variances fell for entry workers and also for younger female workers, but rose for prime-age workers and also for older male workers (see Table 2). The result is that the entire age profile of total earnings variance has shifted up quite strongly since the middle 1980s for both women and men, with the strongest upward shifts occurring among older workers of both genders and also for prime-age male workers. The general rise in overall long-run earnings inequal-

ity in Figure 3 thus reflects a corresponding rise in virtually all age groups (except for Entry workers) as well as the general aging of the workforce and maturing of the large Baby Boom cohort.

What factors can explain these two major patterns of change in the earnings variances in Canada over the 1982–2006 time period? First, why has there been a dramatic rise in long-run earnings inequality, particularly for older and prime-age male workers? This is consistent with and reinforcing of the broad annual cross-sectional evidence of strongly rising earnings inequality in Canada (and elsewhere) since the late 1970s, which has generated a massive literature discussing contributing factors and alternative explanations. Skill differentials—both by education and work experience—have been rising (Boudarbat *et al*., 2008), generating a huge literature on explanatory factors (e.g. Card and Lemieux, 2001). There has been an ongoing shift in the Canadian economy toward service-sector employment (where inequality is traditionally higher than in the primary and heavily unionized manufacturing sectors), and especially toward financial, business, and professional services (Statistics Canada, 2008). Higher-skilled workers have been putting in longer hours on the job (Picot, 1998) with the advent of flattening organizational structures, quicker responsiveness, and 24/7 electronic access. Since the later 1990s, median retirement age has been rising as more higher earners (particularly males) are choosing to retire later (Beach, 2009). Perhaps the most dramatic development has been the rapid rise of professional and managerial earnings at the very top end of the distribution, as Canadian employers compete with remuneration practices in the United States (Saez and Veall, 2005). The great majority of such beneficiaries of this competitive environment has been prime-age and older male workers who largely fill these positions.

Second, why has short-run instability or year-to-year changes of earnings increased so dramatically for women, and particularly for entry and younger workers, since the early 1990s (and more recently for entry and younger men)? These results are consistent with the increased use of more flexible non-standard work arrangements in the Canadian labor market, largely in the service sector and in sectors facing downward competitive pressures (Vosko *et al*., 2003; Statistics Canada, 2009). There has also been a substantial rise in the proportion of young people attending colleges and universities full time (and hence get excluded from our samples), so that those young workers who are included in our samples consist increasingly of lower-skilled workers. Furthermore, the last decade has seen very significant growth in the construction, energy, and primary sectors, largely in the western provinces of Alberta, British Columbia, and Saskatchewan (Statistics Canada, 2008), and in the major urban centers of Toronto, Calgary, and Vancouver, and these jobs (with their relatively unstable employment patterns) have been predominantly filled by younger men.

4.4. *Cross-National Comparisons*

How do the major results of this paper compare to those of other countries? Inter-country comparisons are not straightforward because of different methodologies, different estimation samples, different control variables used, and differences in labor market institutions and policies. We focus on the period from the

mid-1980s through to the early 2000s, as this is the coverage of the current paper. Gottschalk and Moffitt (2009)—to the authors' awareness—provided the only other earnings variance decomposition results for women. They use the same variance decomposition methodology as the present paper, but apply it to actual earnings rather than to age- or life-cycle-adjusted earnings residuals. For both Canada and the United States, cross-sectional earnings inequality for women has shown considerably less of an increase since the late 1970s than for men. Obviously, the pattern of change is complicated by the increased labor market involvement of women, particularly in the 1980s. But, while the transitory variance for women in the U.S. showed no major evidence of an overall trend over the 1990s, the present study for Canada finds a broad decline in transitory variance over the 1990s followed by a marked increase in the 2000s.

Three papers that provide a direct comparison with men's experience in the United States are Haider (2001), Moffitt and Gottschalk (2008), and Gottschalk and Moffitt (2009). All three use PSID data and show that total cross-sectional earnings inequality for men has broadly risen since the mid-1970s. Moffitt and Gottschalk (2008) show that the biggest increases occurred in the early-to-mid 1980s and the late 1990s and early 2000s—both periods of major recessions in the labor market. The late 1980s and early 1990s and the late 1990s and early 2000s saw the most rapid run-up of total earnings inequality for Canada as well (see Figure 1). Haider (2001) used a parametric modeling approach applied to residuals from a preliminary regression on potential experience. Moffitt and Gottschalk (2008) use both a parametric modeling approach and the same random-effects approach of the present paper applied to residuals from a preliminary regression on age, education, and race, and Gottschalk and Moffitt (2009) follow the same random-effects approach of this paper but applied simply to raw earnings data. They all find that permanent earnings inequality for men in the U.S. increased substantially over the 1980s, and the latter two papers find that the permanent inequality stabilized at this higher level over most of the 1990s and then moved up strongly again in the later 1990s and early 2000s. After 1990, about two-thirds of the rise in cross-sectional inequality was due to the increase in permanent earnings inequality. In the present paper, we find a strong rise in permanent inequality for Canada throughout the 1990s and into the early 2000s, which completely drives the observed run-up in cross-sectional earnings inequality over this period (see Figure 3). The U.S. studies find mixed results for men's earnings instability over the 1980s. Gottschalk and Moffitt (2009) and Moffitt and Gottschalk (2008) report rising earnings instability over the 1980s, stabilized levels over the 1990s, and a sharp rise again from the late 1990s into the 2000s, so that transitory variance accounted for only about a third of the increase in cross-sectional inequality since about 1990. For Canada, we find a downward trend in earnings instability over the 1990s and a beginning upward trend only in the 2000s (see Figure 2).

The comparable studies outside North America all use the parametric modeling approach of Moffitt and Gottschalk (2008), and again all refer to males. Dickens (2000) and Ramos (2003) both look at Great Britain. The former uses the New Earnings Survey Panel over 1975–95, and the latter the British Household Panel Study data for 1991–99. Both look at full-time males and the main results in both are based on actual earnings (rather than age-adjusted residuals), but the

dependent variable for Ramos is usual monthly earnings, while that in Dickens is average hourly wage or weekly earnings. They both point out the very major rise in cross-sectional earnings inequality in Great Britain over the entire period. Dickens (2000) finds that from 1980 on, both permanent and transitory variance components rose sharply, with each accounting for about half of the rise in cross-sectional earnings inequality. Ramos (2003) obtains consistent results, with the permanent component playing a relatively larger role at the beginning of the 1990s, and the transitory variance becoming more important in the later part of the decade. The more recent rise of the importance of the transitory variance (or earnings instability) is also found in the present paper for Canada, though increases in permanent earnings inequality as the dominant source of rising cross-sectional inequality since the 1980s appears to be a quite different result for Canada.

The studies by Cappellari (2004) and Gustavsson (2008) look at Italy and Sweden, respectively. Cappellari (2004) uses an Italian administrative database covering the period 1979–95 and focuses on full-time male earners aged 25–58. Gustavsson (2008) uses a large longitudinal database for Sweden over the lengthy period 1960–90 and focuses on males born in Sweden aged 26–54. Both studies use annual earnings as their dependent variable not adjusted for age or other factors in a preliminary regression. In both countries, cross-sectional earnings inequality increased noticeably from the early 1980s through 1990, and in Italy continued to rise markedly in the mid-1990s. But while Gustavsson (2008) found that the persistent variance displayed a strong downward trend over the 1980s in Sweden, Cappellari (2004) found a strong rise in the permanent variance component in Italy over this period—similar to the finding in this paper and for the U.S. and U.K. On the other hand, Gustavsson (2008) found that the transitory variance for Sweden was stable over the first half of the 1980s and then rose strongly over the second half of the 1980s, so the rise in cross-sectional inequality after 1983 was largely due to the increased transitory earnings fluctuations. Cappellari (2004), however, found a declining role for the earnings instability component throughout the period 1979–95 in Italy, so that between 1985 and 1990, about two-thirds of the rise in total earnings variance was accounted for by the run-up of permanent earnings inequality, and over the period 1990–95, the latter accounted entirely for the increase in earnings inequality—again a result very similar to the present paper for Canada, with both countries showing a stronger contribution for permanent earnings inequality than in the U.S. or U.K.

5. Underlying Trends and Macroeconomic Effects: Descriptive Regression Results

In order to assess the empirical relationship between the alternative variance measures on the one hand and underlying trends and major macroeconomic effects on the other, we estimate a series of multiple regressions of the annual time series of observations of the variance measures as dependent variables. There are a total of 21 time-series observations for each of the three variance measures, starting with the 1982–86 sample window and ending with the 2002–06 sample window. Following Haider's (2001) parsimonious specifications, the macroeconomic effects as

independent variables are represented by the aggregate unemployment rate and the real GDP growth rate. For each of the five-year windows, the unemployment rate regressor assumes the average annual value over the five-year window (expressed as a percentage). The real GDP growth variable is calculated as the compound growth rate over the five-year window (expressed as a decimal). The three variance measures are treated as separate dependent variables in the regression analysis for all men excluding women, all women excluding men, and for each of the eight age–sex groups under analysis. The general form of the regression equations estimated is:

$$Y_t = \beta_0 + \beta_1 T + \beta_2 GR_t + \beta_3 UR_t + \varepsilon_t$$

where Y_t is one of the three variance measures, T is a linear time trend, GR_t is the average annual GDP growth rate, UR_t is the average annual unemployment rate, and ε_t is a regression error term. The net trend effect is picked up by the β_1 coefficient.[10] The inclusion of the time trend also has the effect of de-trending both of the remaining independent variables.

Because of the way that the variables are calculated in terms of rolling overlapping windows, the error terms in the regressions are likely to be highly serially correlated. To address this issue, we specify an error structure that follows a fourth-order moving average process. Although for many of the regression equations, some of the four MA estimated coefficients turn out to be insignificant, we include them in all specifications. The equations were estimated by maximum likelihood techniques (the AUTO command in the SHAZAM regression program).

5.1. *Net Trend Effects*

Estimates of the β_1 trend coefficient from the above equation appear in Table 3, first for women and men as a whole (Panel A) and then broken down by age group (Panel B). The principal finding is that, across the board for women and men as a whole, and for all age groups, there is a consistent positive trend in long-run earnings inequality. This net trend effect reflects the positive observed trend in Figure 3 (in the univariate context) and is again consistent with underlying widening of skill differentials and widening cross-sectional earnings inequality that has been widely documented in the literature over this period. The upward trend is also two to three times stronger (both absolutely and relative to their variance size) among men than among women workers. In the top panel, the trend coefficient for men is 2.33 times that for women. Across the four age groups, the increasing trend in long-run earnings inequality rises markedly with age for both men and women, though much more strongly for male workers. The relative size of the trend coefficients across ages for men (compared to the overall male trend coefficient in Panel A) rises from 0.259 for entry age workers to 0.694 for younger workers, to 1.112 for prime age workers, and up to 2.021 for older workers. The pattern for women is similar.

[10]Note that an artifact of the construction of the dependent variables is that there is likely to be a significant time trend.

TABLE 3

Regression Estimates of Net Trend Effects on Earnings, Variance Measures for Men and Women, 1982–2006

	LR Inequality	Earnings Instability	Total Variance
	(A) Men and Women		
Men	0.00663**	–0.00024	0.00663**
Women	0.00285**	–0.00105	0.00143*
	(B) Men and Women by Age		
Men:			
Entry	0.00173**	0.00051*	0.00269**
Younger	0.00462**	0.00017	0.00503**
Prime	0.00737**	0.00052**	0.00784**
Older	0.01302**	0.00148**	0.01454**
Women:			
Entry	0.00006	0.00330	0.00198**
Younger	0.00010	0.00089	0.00051
Prime	0.00211**	–0.00159**	0.00062
Older	0.00576**	0.00094	0.00697**

Note: ** (*) Indicates statistical significance at the 1 (5) percent level.

The second main finding to come out of Table 3 is that there is a much weaker (often non-significant) and mixed set of trend results estimated for short-run earnings instability. Indeed, the earnings instability trend coefficients turn out slightly negative in Panel A of the table. This is perhaps not surprising in light of the non-monotonic patterns of change in transitory variance shown in Figure 2 (in the univariate context) and the declining degree of earnings instability across most age groups.[11] For men, underlying within-age-group earnings instability is rising slightly. But the results do not point to a significant underlying positive trend in earnings instability for entry and younger female workers. Again, this may reflect that the increases noted in Table 1 have occurred only since the mid-1990s for women. In general, the estimated net trend effects for earnings instability are an order of magnitude smaller than those for long-run inequality of earnings. Not surprisingly, then, the across-the-board positive trend in total earnings variance for men and women and for all ages is basically driven by the corresponding pattern in long-run earnings variance. Again, these results are consistent with the rising earnings variance shown in Figure 1.

5.2. *Macroeconomic Effects*

Macroeconomic effects are captured by two variables: the (aggregate) unemployment rate and real GDP growth rate. The regression results for the former appear in Table 4 and for the latter in Table 5. The unemployment rate is an indicator of labor market tightness. Reduced unemployment rates and thus tighter labor markets, according to conventional economic theory, would be expected to disproportionately benefit the earnings of low-skilled, lower-wage workers, so that

[11]Note that the regression results reported in Panel A incorporate both within-age-group net trends as well as the demographic shift of an aging workforce. Thus if earnings instability declines with age (at least between entry and prime-age workers), the maturing of the large Baby Boom cohort will put increasing weight on the lower earnings instability values.

TABLE 4

Regression Estimates of Unemployment Rate Effects on Earnings, Variance Measures for Men and Women, 1982–2006

	LR Inequality	Earnings Instability	Total Variance
	(A) Men and Women		
Men	0.00451*	0.00142	0.00685*
Women	0.00645**	–0.00459	–0.00068
	(B) Men and Women by Age		
Men:			
Entry	0.0139**	0.00563**	0.0211**
Younger	0.00679**	0.00241*	0.0101**
Prime	0.00586**	0.00303**	0.00745**
Older	0.00474	0.00338*	0.00848
Women:			
Entry	0.0102**	0.00040	0.00395
Younger	0.00432**	–0.00719	–0.00667
Prime	0.00732**	–0.00517**	0.00234
Older	0.00544*	–0.00402	0.00615**

Note: ** (*) Indicates statistical significance at the 1 (5) percent level.

TABLE 5

Regression Estimates of GDP Growth Rate Effects on Earnings, Variance Measures for Men and Women, 1982–2006

	LR Inequality	Earnings Instability	Total Variance
	(A) Men and Women		
Men	0.0446	–0.0186	0.0147
Women	–0.0664**	0.0044	–0.0218
	(B) Men and Women by Age		
Men:			
Entry	–0.0718*	–0.0240	–0.1082**
Younger	0.0081	–0.0466*	–0.0266
Prime	0.0350	–0.0335**	–0.0018
Older	0.2918**	0.0592**	0.3517**
Women:			
Entry	–0.1648**	0.0185	–0.1054**
Younger	–0.0689**	0.0125	–0.0269
Prime	–0.0234	0.0022	–0.0293
Older	–0.0469	0.0353	–0.0646**

Note: ** (*) Indicates statistical significance at the 1 (5) percent level.

earnings inequality should attenuate and earnings instability be reduced; higher unemployment rates should have the opposite effect. We would therefore expect positive unemployment rate effects on all three variance measures. Since male workers are traditionally more concentrated in primary and manufacturing/construction/transportation sectors, which have greater cyclicality than service sector employment where women are more concentrated, one would also expect stronger unemployment rate effects for men than for women.

The results in Table 4 are largely consistent with the first expectation, but not the second. Almost all of the coefficients in Table 4 are positive, indicating that higher unemployment is largely associated with higher earnings variances. But

while the unemployment rate coefficients on earnings instability and total earnings variance are indeed higher for men than for women, this does not hold for the long-run inequality of earnings. Once again, the effects on long-run earnings inequality come through most strongly, with consistent across-the-board and statistically significant effects of higher unemployment increasing long-run earnings inequality, and slightly more strongly among women than for men, though all effects are highly inelastic. The unemployment rate effects for men also decrease monotonically with age, so that entry-age workers (for both men and women) face the strongest cyclical effects on their long-run earnings inequality.

The unemployment rate effects on short-run earnings instability, however, are more mixed in sign and often not statistically significant. Though they are generally smaller than the effects on long-run earnings inequality, proportional to the size of transitory variance, they are much stronger than the long-run effects for prime-age and older workers. The effects are generally positive for men and negative for women, so the effects are higher for men than for women. Consequently, the unemployment rate effects on total earnings variance are largely driven by those on long-run earnings inequality, with almost all the coefficients positive, and indeed all the coefficients for men higher than those for women. Over the sample period covered, only two—though very severe—recessions occurred, in the early 1980s and early 1990s. Both were characterized by a great deal of permanent dislocation, dying out of rust-belt industries, industrial reorganization, and changed modes of merchandizing. Such widespread restructuring at these times may be the source of the strong long-run earnings inequality effects of unemployment, especially among male workers in older-line industries.

The GDP growth rate variable is an indicator of growing labor income and increased employment experience in the labor market; hence it picks up a different facet of the business cycle. Greater (real) GDP growth rates and hence faster-growing economies, according to conventional economic theory, would be expected to have an effect on earnings variance measures through four related but conceptually distinct channels, given that we are controlling for aggregate unemployment rates. The first channel operates through the labor force participation rate and hence the employment rate: higher economic growth and real wage rates generally increase participation rates through an upward-sloping labor supply curve—likely more so for women than for men, and more strongly among lower-skilled workers less permanently attached to the labor market. The second channel operates through hours worked: again an upward-sloping labor supply effect induces longer hours worked (conditional on being employed), and again likely more strongly for women than men and among lower-skilled workers with less than regular or normal hours of work. The third channel is the so-called trickle-down effect on hourly wages. Higher growth and tighter labor markets are likely to bid up disproportionately the wages and employment opportunities of relatively low-skilled workers and recent arrivals to the Canadian labor market, particularly in more cyclically sensitive sectors, such as primary and manufacturing/construction/transportation, where men are more concentrated.[12] They also tend

[12]Unfortunately, since the analysis uses administrative data, we cannot observe the amount of working time, so we cannot separate out these distinct channels in our regression estimates.

to open up opportunities for upward advancement. The fourth channel operates through worker displacement from the middle and lower-middle ranges of the earnings distribution, where ongoing economic growth is associated with capital investment and reorganization of production which moves some long-time workers down toward the lower end of the distribution. This would also likely occur more in manufacturing than services, and hence affect men, and unionized, less-educated and older workers more adversely than women, younger and more-educated workers. All four channels are expected to operate principally through the long-run earnings inequality term.

Higher economic growth can thus have mixed effects on earnings variances in this analysis. If it disproportionately advances the earnings levels of workers who are already at the lower end of the earnings distribution, this will have the effect of reducing the estimated variances (i.e., a negative "advancement effect"). On the other hand, if it draws workers into the earnings distribution toward its lower end, this will increase the estimated variances (i.e., a positive "polarization effect"). From the results in Table 5, it appears that the polarization effect dominates for men while the advancement effect dominates for women. From the results in the lower panel of the table, it also appears that the polarization effect operates most strongly among older men, while the advancement effect works most strongly among entry-age women. The growth rate effects for men also weaken very noticeably with age, so that entry-age workers show a significant advancement effect, younger workers essentially show no effect, while older workers show a strong polarization effect. Economic growth also largely reduces earnings instability for men, while showing no significant effect for women.

A summary of cyclical regression effects from Tables 4 and 5 is presented in Table 6. The entry "C" designates counter-cyclical findings (i.e., poor economic times result in higher earnings variances), while entry "P" indicates pro-cyclical effects (i.e., good economic times result in higher variances). As found by Haider (2001), counter-cyclical effects clearly dominate, with greater economic growth and lower unemployment generally reducing earnings variances.

Broadly speaking, three phenomena have been identified in the literature and argued to have huge effects on relative wages and employment patterns and on economic restructuring and reorganization in the workplace (e.g. Katz and Autor,

TABLE 6

Summary of Cyclical Regression Effects on Earnings Variance Measures

	LR Inequality	Earnings Instability	Total Variance
Unemployment rate:			
Men	C*	C	C*
Women	C**	P	C
Growth rate:			
Men	P	C	P
Women	C**	P	C

C = Counter-cyclical P = Pro-cyclical

Notes: P or C designations based on Panel A of Tables 4 and 5.

** (*) indicates statistical significance at the 1 (5) percent level based on Panel A of Tables 4 and 5.

1999) since the 1980s, especially for lower-skilled males and unionized workers. The first involves institutional and labor supply effects. Overall levels of Canadian immigration shifted up in the mid-to-late 1980s and continued at a much higher level in the 1990s and beyond than in the 1960s and 1970s. The 1990s also saw a marked downsizing of the public sector, a decline in the overall unionization rate in the private sector, and steps toward deregulation in selective and formerly protected industries such as airlines, transportation, and telecommunications. At the same time, major reforms were made to unemployment insurance and welfare programs which had the effect of encouraging labor market participation among low-wage workers.

The second phenomenon involves growing globalization, outsourcing, and international competitiveness. The Canada–U.S. Free Trade Agreement took effect in 1989, and the North American Free Trade Agreement took effect in 1994. The results, as Courchene and Telmer (1998) and others have argued, have been a massive reorganization of Canadian production and trade patterns away from an east–west axis to a north–south axis. There has been a corresponding rationalization of production lines and increase in the competitiveness of output markets, and hence increased cost awareness, restructuring of workplace arrangements, and greater use of outsourcing and more flexible non-standard work arrangements.

The third phenomenon involves the advent of skill-biased technological change based on chip-based recent information technology (e.g. Murphy *et al.*, 1998). The huge literature on this topic has emphasized widening skill differentials, growing within-group earnings inequality, and flattening organizational structures as IT-based production technologies displace many formerly well-paid workers—especially in manufacturing, assembly-line, and repetitive jobs—who then have painful adjustments to typically much lower-paying jobs with less secure employment.

All three of these phenomena are "permanent" or long-run in nature, and provide some explanation for the dominant rise in men's permanent variance of earnings, and are consistent with the finding of a polarization effect of economic growth over the period on long-run earnings inequality.

6. Review and Conclusions

This study has examined the variance of workers' earnings in Canada over the period 1982–2006 using the large Longitudinal Administrative Database of income-tax files for Canada. The total longitudinal variance in earnings across workers and over time is decomposed, using a non-parametric methodology employed by Gottschalk and Moffitt (1994), into a permanent or long-run inequality component between workers and a year-to-year earnings instability component among workers over time. There are three key features of the paper. (i) The study reports results for both women and men and for four separate age groups of workers so that one can better identify in which segments of the labor force major changes are occurring. (ii) This decomposition is applied to a five-year moving window of earnings, so that the analysis can examine how total earnings variance and its two components have changed over the 1980s and 1990s in a quite flexible, descriptive fashion. This approach readily lends itself to graphical description and

regression analysis linking these measures to macroeconomic indicators. (iii) The empirical analysis has a much longer time-span coverage for Canada (including up to the mid 2000s), which helps identify long-run and recent patterns of earnings changes.

Several major results have been found. First, the most marked change in earnings variances in Canada since 1982 is the general rise in total earnings variance (for both men and women), which is essentially driven by a quite dramatic rise in long-run earnings inequality. This rise in inequality is also much more marked for men than for women and shows up as well as a net underlying time trend effect when controlling for macroeconomic fluctuations over the period. Indeed, since the late 1990s, all three variance measures have been rising for both men and women. Because of the strong run-up in long-run earnings inequality for men, the ratio of long-run inequality to earnings instability has risen steadily throughout the sample period. Also, since the total earnings variance and long-run earnings inequality are higher for women than for men, the dramatic rise in these measures for men has resulted in a marked convergence in these measures between women and men, particularly since the early 1990s. A second notable change over the period is a quite substantial run up in short-run earnings instability since the mid-1990s for women and since the later 1990s for men.

Second, the patterns across ages of the two variance components are almost opposite. Long-run earnings inequality generally rises with age, so that it is markedly highest among the older age group—for both men and women—much as one would expect from a standard OJT human capital model. Earnings instability, however, is seen to generally decline with age, at least between entry and prime-age workers, so that earnings instability is markedly highest among entry age workers, which is very much consistent with a career job-matching prospective. The results also show that increases in the permanent earnings variance were experienced most dramatically for older workers (and to some extent prime-age workers) since the mid 1980s, and particularly so for men. On the other hand, the increases in the transitory earnings variance were experienced most strongly by entry and younger female workers, particularly since the early-to-mid 1990s.

Third, unemployment rates have statistically significant net regression effects on all the earnings variance measures. Unemployment rate effects are positive on almost all variance measures, which is consistent with conventional expectations that tighter labor markets reduce earnings variances, while higher unemployment is associated with widened long-run earnings differentials and greater short-run earnings instability. Once again, the effects on long-run earnings inequality come through most strongly, with consistent and statistically significant effects of higher unemployment increasing long-run earnings inequality. The unemployment rate effects for men decrease monotonically with age, so that entry age workers (for both men and women) face the strongest cyclical effects on their long-run earnings inequality.

Fourth, the GDP growth rate variable can be expected to have mixed effects on earnings variances. If higher growth moves up the earnings of lower-skilled workers, it is said to have an advancement effect. However, if it draws workers into the lower end of the earnings distribution, it can be said to have a polarization effect. The regression results for economic growth—though weaker than for unem-

ployment rates—show that the polarization effect dominates over this period for men, while the advancement effect dominates for women. It also appears that the polarization effect operates strongest among older men, while the advancement effect works strongest among entry-age women.

Appendix on the Variance Components

This paper adopts the methodology employed by Gottschalk and Moffitt (1994, p. 254), which involves a random-effects variance decomposition procedure using longitudinal data. The common starting point is the variance of a worker's (log) earnings averaged across all sample observations over time. Consider the following variables:

y_{it} = log earnings for person i in year t
T_i = number of years of earnings data observed for person i, $i = 1, \ldots, N$

and $K = \sum_{i=1}^{N} T_i = N \cdot \bar{T}$,

where an over-bar indicates a sample average. $\bar{T}$ is thus the average number of years of earnings data for the sample of N workers. It follows that $\bar{y}_i = \left(\frac{1}{T_i}\right)\sum_{t=1}^{T_i} y_{it}$ is average (log) earnings over the earnings-reported years of worker i, and $\bar{\bar{y}} = \left(\frac{1}{K}\right)\sum_{i=1}^{N}\sum_{t=1}^{T_i} y_{it}$ is the global, or overall, average level of (log) earnings averaged across all sample observations for all N workers. The measure of total earnings variation used is then the unbiased estimate for the global variance:

$$\text{Var}_{\text{Total}} = \left(\frac{1}{K-1}\right)\sum_{i=1}^{N}\sum_{t=1}^{T_i}\left(y_{it} - \bar{\bar{y}}\right)^2. \tag{1}$$

This expression reflects both variation in earnings across time for individual workers and also variation in earnings between workers over the sample period.

Now define a measure of transitory variance or temporary earnings instability as:

$\text{Var}_{\text{Transitory}}$ = Average over workers of [individual worker's variance of earnings deviations over time relative to the worker's long-run earnings level $\bar{y}_i$]

$$= \left(\frac{1}{N}\right)\sum_{i=1}^{N}\left[\left(\frac{1}{T_i - 1}\right)\sum_{t=1}^{T_i}(y_{it} - \bar{y}_i)^2\right]. \tag{2}$$
$$= \hat{\sigma}^2_{trans}.$$

The above quantity represents the average across workers of the intertemporal variance of (log) earnings from each worker's long-run average earnings. The measure appearing in square brackets is an (unbiased) estimate of the year-to-year volatility or instability of the (log) earnings about their mean of a worker i. Then define a measure of persistent or permanent earnings variance as:

$$\text{Var}_{\text{Permament}} = \left(\frac{1}{N-1}\right)\sum_{i=1}^{N}\left(\bar{y}_i - \bar{\bar{y}}\right)^2 - \left(\hat{\sigma}^2_{trans}/T\right). \tag{3}$$

The term on the left captures the variation in long-run average earnings across all workers in the sample. So it captures long-run earnings differentials among workers relative to overall or global mean workers' earnings. The second term in this expression—which is small compared to the first term—is an adjustment factor to insure an unbiased estimate of the variance of permanent earnings differences across workers. It can then be shown that the total variance equals the sum of the transitory variance and the permanent variance:

$$\text{Var}_{\text{Total}} = \text{Var}_{\text{Transitory}} + \text{Var}_{\text{Permanent}} \tag{4}$$

provided that $T_i = T$ for all i.

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