

Age and earnings

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As people age and gain work experience, their earnings might be expected to continue to rise or at least remain stable until retirement. However, this appears not to be the case with traditional age-earnings profiles (Chart A). These show increases in earnings in the early years, a peak around middle age, and a decline thereafter. This inverted U-shaped pattern between age and earnings, based on the average earnings by age for all workers at a given time, is found in a wide range of data. For example, cross-sectional census data show that the earnings of men employed full time, full year declined after their mid-forties (Saint-Pierre 1996). The same pattern is found in cross-sectional data from the Survey of Labour and Income Dynamics (SLID).

The age-earnings profile is commonly used to describe the growth of earnings over the life cycle (Thornton et al. 1997). It is also widely used by forensic economists in the projection of future earnings when calculating earnings loss in personal litigations. The age-earnings profile also helps explain why older workers have a more difficult time adjusting to job loss since their higher earnings often reflect firm-specific skills.

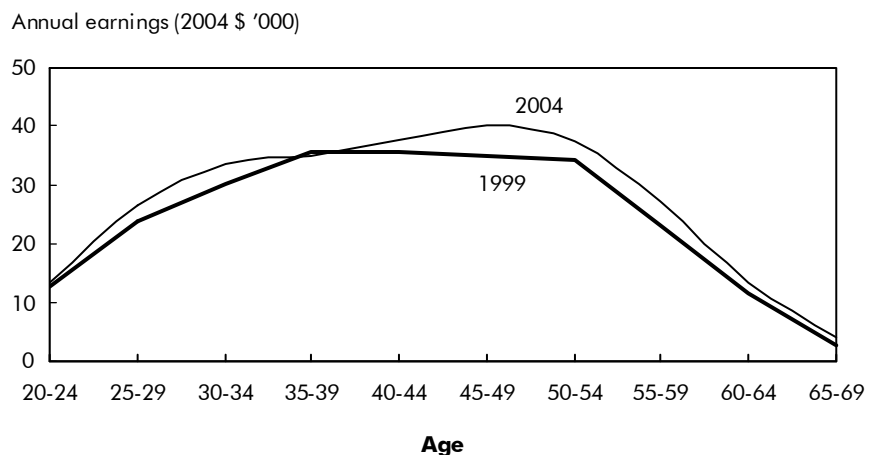
However, the traditional age-earnings profile has many problems, including the use and interpretation of cross-sectional data, selection problems, bias from voluntary changes in hours, and occupations of working retirees. This article addresses these problems in more detail and estimates a 'pure' age effect. Using the 1999 to 2004 SLID panel, the study re-examines the age effect on hourly rather than annual earnings in order to control

for changes in hours worked (see *Data source*). In addition, it uses multivariate analysis to test whether aging by itself results in lower hourly earnings when other related factors are controlled for.

Problems with traditional age-earnings profiles

One issue with the traditional age-earnings profile is that the effect attributed to age may also capture

Chart A Conventional cross-sectional profiles show annual earnings declines after age 50



Source: Statistics Canada, Survey of Labour and Income Dynamics.

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Data source

The **Survey of Labour and Income Dynamics** (SLID) covers roughly 97% of the Canadian population, excluding those in the territories, in institutions, on First Nations reserves or in military barracks. Each panel of respondents, approximately 15,000 households and 30,000 adults, is surveyed for six consecutive years. A new panel is introduced every three years, so two panels always overlap. This study used the third panel of SLID, which followed respondents from 1999 to 2004. The longitudinal nature of the survey allows for the tracking of hourly and annual earnings of individuals over a maximum of six consecutive years.

Since this study examines the age-earnings profile before retirement, the sample was restricted to individuals age 45 and over. As SLID does not collect labour-related information from individuals age 70 and over, the sample consists of individuals age 45 to 69.

Exploratory analysis with separate models for men and women indicated that differences between the sexes could easily be modelled as interactions in a single model for the pooled sample.

In order to overcome the issue of selection effect where older workers with higher earnings may be more likely to leave the labour market, only full-year, full-time workers

were included in the sample, which allowed for a fairly consistent cohort. Individuals were excluded when they began receiving pension benefits (from an employer-sponsored plan or the Canada/Quebec Pension Plan¹), since receipt of such benefits tends to occur after individuals have retired from their career job and the focus of this study was to understand earnings prior to retirement. In fact, the limitation of the sample to non-pensioners is crucial. Working pensioners are different from workers in their career job in that pensioners who return to the labour market typically work at a reduced capacity and these jobs are also, on average, lower in pay (Hébert and Luong 2008). However, since they are also receiving pension payouts, their total income may be equal to or exceed its pre-retirement level.²

The final sample consisted of 2,102 respondents for a total of 9,556 observations. The panel is unbalanced as the number of observations varied across respondents.

Nominal earnings were converted to 2004 dollars. For variables where information was missing for a large number of respondents, a distinct category for missing values was added to prevent these respondents from being dropped from the multivariate analysis.

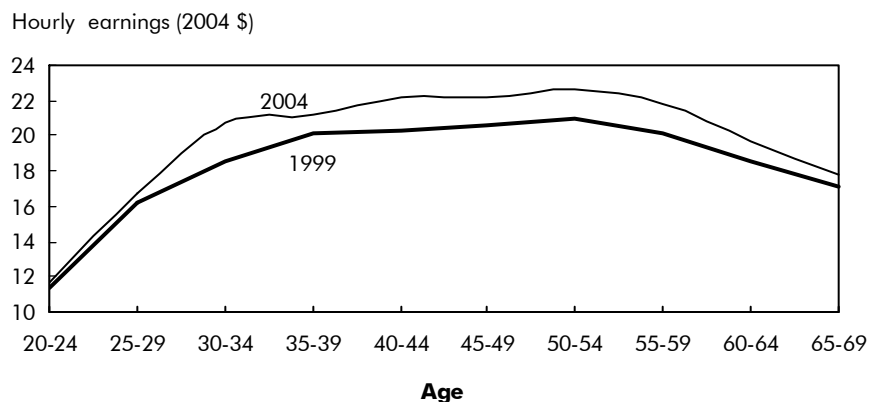
the effects of other factors related to, but distinct from, age. The original human capital earnings function was used to explain the decline in earnings at older ages as reflecting declines in productivity due to deterioration in human capital (Mincer 1974). However, conclusions based on cross-sectional data may be confounding differences between individuals at different points in their lives and differences within persons over time. Detailed longitudinal data and quantitative methods measuring within-person differences are required in order to determine whether individuals' earnings rise or fall over time.

The second issue is the correlation between age and work experience—the older the individual, the more years of work experience likely gained. While age is not irrelevant and often is accompanied by health issues which depreciate human capital stock, work experience remains a dominant factor in earnings. However, early estimates of the age-earnings profile had to derive work experience by subtracting years of schooling from age since work experience was not available. Furthermore, the effects of age and work experience on earnings were estimated separately rather than within the same model (Mincer 1974). Indeed, age has commonly been used as a proxy for years of

work experience since information on work experience is typically unavailable in both longitudinal administrative data and cross-sectional survey data. In order to estimate the 'pure' age effect on earnings, work experience must be controlled for. In addition, the majority of research on the age-earnings profile controls only for education and sex. However, other personal and job characteristics may also be at play.

Thirdly, studies often do not consider that some workers may have started transitioning into retirement. For example, older workers may voluntarily reduce their work hours to gradually phase into retirement. In fact, between 1999 and 2004, 60% of workers age 45 to 69 who experienced a fall in their annual earnings had reduced their work hours. On the other hand, 44% of older workers with a rise in their annual earnings had increased their hours.³ Previous findings of lower annual earnings for older workers may thus reflect decreased work hours. Indeed, individuals' hourly earnings may remain stable or even rise over time and therefore provide a more accurate measure of true earnings potential. Even with cross-sectional data, the age-earnings profile shows a less pronounced slope at older ages using hourly figures (Chart B).

Chart B Conventional cross-sectional profiles based on hourly earnings show more moderate declines after age 50



Source: Statistics Canada, Survey of Labour and Income Dynamics.

Another issue pertaining to the transition to retirement and its effect on earnings involves working pensioners. With pension benefits, these older workers can afford to either reduce their hours of work or take up a new job paying less than their pre-retirement one. Indeed, a study based on longitudinal data and a fixed-effects model found that hourly earnings declines begin only after age 60 and are attributable to pension benefits—that is, individuals receiving pension benefits but continuing to work would reduce their earnings in part by switching from full-time to part-time jobs (Johnson and Neumark 1996). Estimates for workers not receiving pension benefits reveal even weaker evidence of earnings declines at older ages.

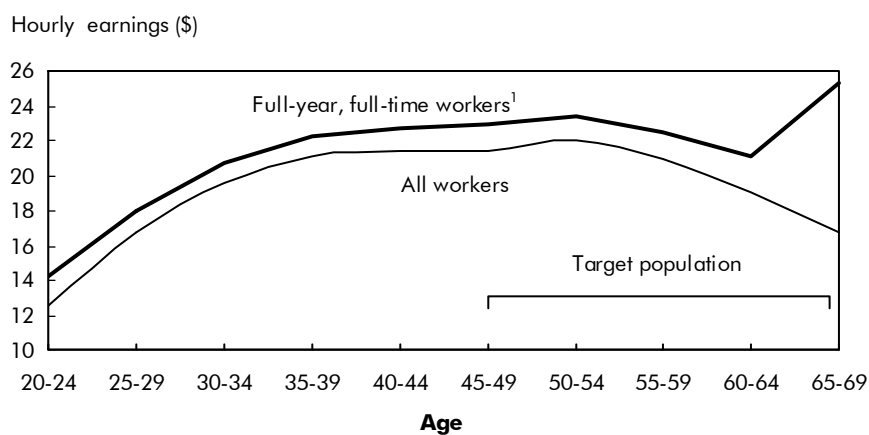
This study excludes workers from the sample when they began receiving pension benefits from an employer-sponsored plan or the Canada/Quebec Pension Plan (C/QPP). Benefits from Old Age Security (OAS) and the Guaranteed

Income Supplement (GIS) are not taken into account. While a sample of non-retired workers likely reduces the biases induced by working pensioners, some selection

effect may well remain since the C/QPP provides reduced benefits starting at age 60, full benefits at 65, and increased benefits up to age 70.

The selection effect involves the movement into and out of employment and changes in the cohort composition of older workers. Indeed, one longitudinal study (Myck 2007) suggested that the propensity of those with higher earnings to leave employment earlier contributes to the inverted U-shaped age-earnings profile. In order to account for this type of selection effect, the model was estimated for older adults working full year, full time to restrict the sample to a fairly consistent cohort (Chart C). Full-year full-time workers have higher hourly earnings on average than all workers, and the highest is for those age 65 to 69⁴ (due to the small number of observations in this age category, however, that average should be used with

Chart C Longitudinal profiles show only a modest drop in hourly earnings for older workers with no pension benefits



1. Excluding working retirees.

Source: Statistics Canada, Survey of Labour and Income Dynamics, 2004.

caution). Nevertheless, the data suggest that the lower earnings found for older workers in the traditional age-earnings profiles are likely a result of older workers retiring from their career job, activating their pension, and continuing to work at lower pay, which ultimately drags down the average for older workers. Older workers continuing uninterrupted work will, on average, maintain high earnings according to the sample used.

A new approach using multivariate analysis

In order to account for the many personal, job, and demographic factors that may affect earnings, a random-effects model (Frees 2004) was used to estimate the age-earnings relationship. As suggested by other studies (Robinson 2003, and Murphy and Welch 1990), the model included different functions to test for linear or non-linear relationships between age and earnings (see *Statistical model*).

Overall, coefficients for age and its powers were close to zero (Table). While the coefficients for age squared and age to the fourth were statistically significant on their own, the age variables, when tested as a whole, were not statistically different from zero, which indicates that when other personal and job-related characteristics are taken into account, a worker's age does not appear to be related to earnings. This is in contrast to many studies that used cross-sectional data to illustrate declining earnings for older workers prior to retirement. This difference arises in part because older workers are excluded from the longitudinal sample as soon as they start to receive a pension, contrary to previous studies.⁵ Another contributing factor is the use of longitudinal data.

While the results suggest that age is not significantly related to hourly earnings, they indicate that work experience, defined as years working full time for at least six months, is important in explaining variations. Indeed, the results show that, compared with workers having 30 to 34 years of work experience, those with 0 to 4 years earned almost 15% less, those with 5 to 14 years, 10% less, and those with 15 to 24 years, 5% less.⁶ However, contrary to previous research that indicated decreasing earnings for those with the most experience, this study showed that workers with either 25 to 29, or 35 and more years of experience were not statistically different from those with 30 to 34 years of work experience, which suggests that hourly earnings stabilize after more than 25 years of experience.

Statistical Model

SLID panel data for the years 1999 to 2004 were used to estimate variants of the random-effects model

$$\ln(y_{it}) = \beta_0 + \beta_1 \text{Age}_{it} + \beta_2 \text{Age}_{it}^2 + \beta_3 \text{Age}_{it}^3 + \beta_4 \text{Age}_{it}^4 + \gamma' x_{it} + T_t + v_i + \varepsilon_{it}$$

where y_{it} is the composite hourly earnings of individual i in year t , Age is the individual's age (centred at age 55), β_1 to β_4 are coefficients affecting Age and its powers, x_{it} is a vector of personal and employment characteristics (including work experience) that may or may not vary over time, and γ is a vector of regression coefficients. A series of dummy variables (T_t) is used to account for year-specific effects. Individual-specific effects are accounted for by the time-constant v_i , and ε_{it} is the error term. Standard errors for parameter estimates were calculated with the bootstrap method.

Other possible models for longitudinal or panel data include fixed-effects, random-coefficients, and population-averaged models. The fixed-effects model was not ideal for this study as it cannot estimate the effect of time-constant variables. Using generalized estimating equations, the population-averaged model roughly corresponding to the random-effects specification above yielded very similar results. A fully specified random-coefficients model proved difficult to estimate, but results from models including limited subsets of variables were in agreement with the results from the random-effects and population-averaged models. Also, an ordinary least squares (OLS) regression using 2004 data only was estimated for comparison purposes. Overall, the results from the OLS model were in agreement with the results from the random-effects and population-averaged models.

Overall, the results suggest that work experience is a better predictor of hourly earnings than age. This is plausible, since work experience, rather than age, is more directly tied to accomplishments, which are typically assessed when determining promotions and job offers.

Similar to other research, this study found sex and education to be significantly related to earnings. Results of the random-effects model suggest that men with university degrees earned 36% more than those with a non-university postsecondary certificate. On the other hand, men who completed high school did not have significantly different hourly earnings than men with non-university postsecondary education, but men with less than high school earned 11% less per hour. An earnings gap between men and women was also apparent. Women of all educational levels earned less than their male counterparts. For example, women with a non-university postsecondary certificate earned 15% less than their male counterparts.

Table Results of log-linear random effects

	Random effects model	
	Coefficient	Exponential coefficient
Age		%
Age squared	-0.005	-0.5
Age cubed	-0.002**	-0.2
Age to the fourth power	0.000	0.0
	0.000**	0.0
Sex and education (ref. men, non-university postsecondary)		
Men, less than high school	-0.116***	-10.9
Men, high school	0.048	5.0
Men, university	0.310***	36.3
Women, less than high school	-0.403***	-33.2
Women, high school	-0.278***	-24.3
Women, non-university postsecondary	-0.162***	-14.9
Women, university	0.048	4.9
Work experience (ref. 30 to 34 years)		
0 to 4 years	-0.158***	-14.7
5 to 14 years	-0.107***	-10.2
15 to 24 years	-0.047**	-4.5
25 to 29 years	-0.011	-1.1
35 or more years	-0.006	-0.6
Immigrant status (ref. non-immigrant)		
Immigrant	-0.018	-1.7
Visible minority status (ref. non-visible minority)		
Visible minority	-0.231***	-20.6
Disability status (ref. no disability reported)		
Disability reported	0.002	0.2
Job status (ref. permanent)		
Non-permanent job	0.004	0.4

** statistically significant or significantly different from the reference group (ref.) at 0.05

*** significantly different from the reference group (ref.) at 0.01

Note: Some variables had missing values. Other variables used, but not shown, comprise occupation, industry, region, area of residence size and year effects.

Source: Statistics Canada, Survey of Labour and Income Dynamics, 1999 to 2004.

Job permanency is another indicator of job quality. However, the results indicate that older workers with non-permanent jobs (i.e. seasonal, temporary, term or contract, casual, or through a temporary help agency) did not have significantly different earnings than older workers with permanent jobs. While permanent jobs

in theory are more likely to be unionized, which typically leads to better pay, the non-significant finding here likely resulted from restricting the sample to full-year, full-time workers. In fact, only about 4% of the sample had non-permanent positions.

Immigrants and visible minorities may also earn less due to different starting levels and growth rates for reasons such as language barriers, lack of social networks, lack of recognition of credentials by employers, and discrimination. However, immigrants' earnings were not statistically different than earnings of non-immigrants. While existing research indicates a gap in earnings between *recent* immigrants and non-immigrants (Statistics Canada 2008, and Frenette and Morissette 2003), the sample also included immigrants who had arrived earlier and perhaps from different countries. However, earnings of visible minority individuals were estimated to be almost 21% less than for other workers.⁷

As individuals age, they have a higher likelihood of developing disabilities that may affect their ability to continue working in their job. They may then choose to reduce their hours of work, change jobs, or withdraw from the labour force, which would likely have a negative impact on their earnings. However, the results in the sample used here do not support this hypothesis, which could be related to a selection effect. For example, workers with a disability may have switched to another job or they may have withdrawn from the labour market (Pyper 2006). Therefore, only those whose disability did not affect job performance may have remained. Since SLID does not have detailed information on the type and severity of a disability,⁸ those in the sample who reported having a disability may have had minor or less limiting disabilities.

Conclusion

Age-earnings profiles have been important in the understanding of individuals' earnings over the life cycle. However, they are often created using cross-sectional data that compare earnings of workers at different ages rather than following the earnings trajectory of workers over time. Since this method does not examine the year-to-year earnings of older workers, its capacity for assessing whether earnings fall as workers age is limited. Rather, the interpretation can suggest at best that older workers of a certain age earn less, on average, than workers in their 40s.

This study builds on previous work by using longitudinal data, which allows for the examination of earnings over time while controlling for differences in educational, personal, demographic, and job characteristics. In addition, hourly instead of annual earnings were used in order to account for changes in work hours over time, which would affect annual but not hourly earnings. In general, the findings show that age had no significant effect on hourly earnings after controlling for other factors. This result is attributable to the exclusion of working pensioners in combination with the use of longitudinal data. The results are mostly in line with those of an earlier study which found a very weak relationship between age and earnings after pensioners had been excluded (Johnson and Neumark 1996).

The results show that hourly earnings increase with work experience, reaching a maximum for those with 25 to 29 years of experience and essentially plateauing after that. Therefore, experience-hourly-earnings profiles would be more accurate in estimating the earnings trajectory of individuals over the life cycle.

Perspectives

Notes

1. Although Old Age Security is also considered a public pension, it is received by all Canadians regardless of whether they had ever entered the labour force. Excluding OAS recipients would exclude almost everyone over 65 from the sample.
 2. Using data from SLID, the average hourly earnings of working pensioners were not statistically different from the previous year (while they were still in career employment). However, their annual earnings fell from \$46,500 to \$38,400 while their total annual income increased from \$47,300 to \$57,500 during the survey period. These differences in annual earnings and total income were statistically significant at the 5% level.
 3. Survey of Labour and Income Dynamics, panel 3, 1999 to 2004.
 4. The average hourly earnings for full-year, full-time workers age 65 to 69, excluding working pensioners, were statistically different from those age 60 to 64.
 5. The OLS model yielded similar results when working pensioners were excluded from the sample. When working pensioners were included in the sample, the age effect was not significant in the random effects model but was in the OLS model using 2004 cross-sectional data,
- suggesting that the combination of the presence of working pensioners in the sample and the use of longitudinal data results in a negative relationship between age and hourly earnings.
6. Differences in percentage terms were obtained by exponentiating the coefficients.
 7. While it would be interesting to explore an interaction between immigrant and visible minority status, it was not possible due to inadequate sample size in each of the cells.
 8. In SLID, respondents are flagged as having a disability if they answer positively to at least one of a series of questions inquiring about difficulty carrying out activities related to daily living, or about having physical or mental conditions or health problems that reduce the amount or kind of activity they can do in any of a few different types of situations (e.g. at home or at work).

References

- Frees, Edward W. 2004. *Longitudinal and Panel Data: Analysis and Applications in the Social Sciences*. New York: Cambridge University Press.
- Frenette, Marc and René Morissette. 2003. *Will They ever Converge? Earnings of Immigrant and Canadian-born Workers over the Last Two Decades*. Statistics Canada Catalogue no. 11F0019MIE – No. 215. Analytical Studies Branch Research Paper Series. Ottawa. 20 p.
<http://www.statcan.gc.ca/pub/11f0019m/11f0019m2003215-eng.pdf> (accessed December 23, 2008).
- Hébert, Benoît-Paul and May Luong. 2008. "Bridge employment." *Perspectives on Labour and Income*. Vol. 9, no. 11. November. Statistics Canada Catalogue no. 75-001-XIE. p. 5-12.
<http://www.statcan.gc.ca/pub/75-001-x/2008111/pdf/10719-eng.pdf> (accessed December 22, 2008).
- Johnson, Richard W. and David Neumark. 1996. "Wage declines among older men." *The Review of Economics and Statistics*. Vol. 78, no. 4. November. p. 740-748.
<http://www.jstor.org/stable/2109961?seq=9> (accessed December 22, 2008).
- Mincer, Jacob A. 1974. *Schooling, Experience, and Earnings*. National Bureau of Economic Research. New York and London. Cambridge University Press.
- Murphy, Kevin M. and Finis Welch. 1990. "Empirical age-earnings profiles." *Journal of Labor Economics*. Vol. 8, no. 2. p. 202-229.
<http://www.jstor.org/stable/pdfplus/2535096.pdf> (accessed January 5, 2009).

- Myck, Michal. 2007. *Wages and Ageing: Is There Evidence for the "Inverse-U" Profile?* IZA Discussion Paper Series No. 2983. Bonn, Germany. Institute for the Study of Labor. 28 p.
- Pyper, Wendy. 2006. "Aging, health and work." *Perspectives on Labour and Income*. Vol. 7, no. 2. February. Statistics Canada Catalogue no. 75-001-XIE. p. 5-15. <http://www.statcan.gc.ca/pub/75-001-x/10206/9095-eng.pdf> (accessed January 5, 2009).
- Robinson, Helen. 2003. "Are you experienced? British evidence on age-earnings profiles." *Applied Economics*. Vol. 35, no. 9. p. 1101-1115.
- Saint-Pierre, Yves. 1996. "Do earnings rise until retirement?" *Perspectives on Labour and Income*. Vol. 8, no. 2. Summer. Statistics Canada Catalogue no. 75-001-XPE. p. 32-36. <http://www.statcan.gc.ca/studies-etudes/75-001/archive/e-pdf/2890-eng.pdf> (accessed December 23, 2008).
- Statistics Canada. 2008. *Earnings and Incomes of Canadians over the Past Quarter Century, 2006 Census: Census Year 2006*. Statistics Canada Catalogue no. 97-563-XIE, no. 1. Ottawa. 51 p. <http://www12.statcan.ca/english/census06/analysis/income/pdf/97-563-XIE2006001.pdf> (accessed December 23, 2008).
- Thornton, Robert J., James D. Rodgers and Michael L. Brookshire. 1997. "On the interpretation of age-earnings profiles." *Journal of Labor Research*. Vol. 18, no. 2. Spring. p. 351-365.