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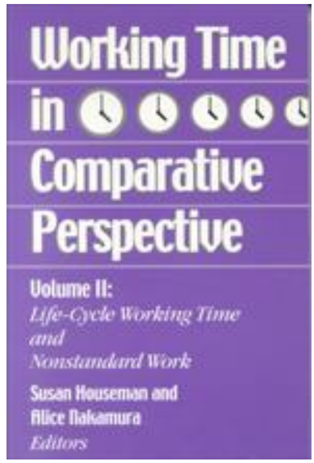
The Life Cycle of Working Time in the United States and Canada



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The Life Cycle of Working Time in the United States and Canada
Long-Term Evidence

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This chapter will discuss long-term changes in the life cycle of working time in the United States and Canada since 1920. The past 75 years have seen important changes in both weekly hours of work and in participation rates. These changes have been associated with equally remarkable movements in wages. This chapter will examine the relationship between these wage changes and the life cycle of labor supply in the two countries.

An international comparison can help us understand the extent to which labor supply developments in one's own country are unique or common to other nations. Nations differ in the structure of their economies, in labor market institutions, and, more generally, in their human relations climates; these factors can produce different labor market outcomes.

The next section offers an introduction to the economic analysis of life cycle variations in working time. The following section presents data on a number of age cross sections of labor supply as well as some cohort data, and discusses the implications for life cycle theory. The next sections present an empirical model of labor supply and provide the statistical results of testing this model, and the final section offers some conclusions. An appendix describes the data sources used for this study.

LIFE CYCLE THEORY AND LABOR SUPPLY

Economists have long been interested in why labor supply varies with age. The standard analysis is in terms of a choice between income and leisure, since diverting time from leisure to paid employment increases income. A higher price or opportunity cost of time is expected to discourage taking leisure; on the other hand, higher levels of income may yield a greater demand for leisure. Since the wage rate is both an approximate measure of the price of time and a principal determinant of the average person's income, changes in the wage rate, including those that occur over the life cycle, are expected to play an important role in determining the age distribution of labor supply.

In the simplest theory, labor supply at each age is determined by contemporary conditions, without regard to past or future concerns. For example, the labor supply of a 30-year-old in 1980 is determined by the wage rate available to him in that year, the wealth or nonlabor income that he might have, and other contemporary influences, but not by concerns about the future.

The effects of a high wage on labor supply at a given age are ambiguous in this simple theory since, as noted above, a higher opportunity cost of time discourages leisure while higher income is likely to increase it. We do know that over the past 150 years real hourly wages rose and the average level of male labor supply fell, yielding the famous backward sloping supply curve of labor. But these historical data on national aggregates may not give us a good prediction of how the number of hours worked will vary as an individual ages.

And indeed this simple theory does not explain life cycle variations very well. There are numerous empirical examples that are not consistent with a negative relation between age-specific wages and labor supply: new entrants into the labor force and those nearing retirement age typically earn less per hour yet supply fewer hours than those in the prime-age category, for example. More generally, we know that individuals do consider their likely futures when making decisions; for example, they save for their old age, when they expect to reduce their labor supply.

The life cycle theory of labor supply provides an alternative to this model.[1] Ghez and Becker (1975) pioneered in the development of this theory. In their model,[2] a young person's lifetime wealth is given by the initial stock of wealth he possesses plus the present value of all future income streams, including those from earnings. It is a perfect foresight model in which the individual can accurately predict these future events. On these assumptions, an individual's wealth does not vary over his lifetime; year-to-year changes in hourly wages only represent differences in the price of time.

Individuals maximize their lifetime utility, the present value of the utility gained in each year of adult life; the annual utility is a function of leisure and consumption in a given year. They can borrow as much as they like at a constant rate of interest and in any year work as many or as few hours as they like at the same hourly wage. The individual can then follow a utility-maximizing life plan for supplying labor, borrowing, and savings.

With wealth constant and higher wages in a given year simply representing a higher price of time, the individual will reduce the amount of leisure and increase labor supply when his wage is high, yielding a positive correlation of wages and labor supply.

The theory does not predict a perfect positive match between wages and hours over the life cycle, though. On the one hand, the market rate of interest encourages individuals to work hard and save when they are young; on the other hand, a common preference by individuals for present over future satisfactions provides an inducement to borrow and take leisure when young. If the rate of interest is high relative to the way the individual discounts the future, he is expected to have a peak in hours of work somewhat earlier than the peak in his hourly earnings.

The Ghez-Becker model makes some strong assumptions. Most people can not in fact readily predict how long-term trends in wages will affect their lives; even if they could, they face constraints in both credit and labor markets that would prevent them from taking full advantage of their predictions. Most of us cannot borrow as much as we might like at any interest rate, let alone a constant rate. In the labor market, part-time employment is often less well paid than full-time, while very long hours fatigue us, reducing our productivity and, often, the hourly return for our efforts. A temporary withdrawal from the labor force also imposes costs—lower earnings when the employee returns to seek new employment are common. Finally, the majority of full-time workers are employed at standard hours that constrain the ability of younger and older workers to have very different schedules.

Ghez and Becker did submit their theory to an empirical test, comparing the age distribution of hours per employed males with the age distribution of hourly wages, both for the year 1965. They found a very good fit: both hours and wages followed an inverted U path. Hours peaked before hourly wages, as their theory would predict if individuals faced a rate of interest that exceeded their personal rate of time preference.

This was not a satisfactory test of the theory, though; life cycle theory is a theory of the behavior of individuals, *not* age cross sections. The latter compares the labor supply of a number of cohorts at a moment of time; this need not trace out the experience of a single cohort.

EMPIRICAL DATA[3]

Age Cross Sections

Canadian and U.S. data on hours, labor force participation, employment, and earnings over the past 75 years provide us with a rich source of information. Long-term data on the age cross sections of male labor input (defined here as the proportion of the group employed times hours worked by those employed), reveal broadly similar patterns in Canada and the United States (Table 1). Data on child labor are not even collected, presumably because it has become so unusual. The labor of teenagers is reported and is relatively low.[4] Labor supply rises for those in their early twenties and is typically at a maximum for those in their late thirties. Those in the 45–64 age group work less, and those over 65 supply much less labor than those aged 45–64. We thus obtain an inverted U in each age cross section.

These inverted Us do change their shape over time. Earlier withdrawals from the labor force and later entry by young people, together with continued heavy participation by prime-age males, have yielded a more peaked distribution of labor supply in both countries.

Table 1 Hours of Labor Input, by Males

Canada						United States					
	Age group						Age group				
	15–19	20–24	25–44	45–64	65+		16–19	20–24	25–44	45–64	65+
1995	8.6	23.1	33.6	28.1	3.2	1995	11.7	28.8	38.9	33.6	4.9
1990	11.9	26.9	35.4	29.5	3.5	1990	12.7	29.7	39.7	33.4	5.0
1985	10.5	25.9	34.6	29.5	3.8	1986	12.2	29.8	39.1	32.6	4.7
1980	13.9	29.3	36.4	32.0	4.7	1983	11.3	27.1	37.2	32.1	4.8
1975	14.1	29.1	37.0	33.3	6.1	1980	14.2	29.4	39.0	33.7	5.7
1970	12.2	29.9	38.3	35.5	8.2	1977	14.7	30.2	39.9	34.7	5.8
1965	13.5	34.7	41.2	38.0	10.0	1970	13.1	30.7	41.1	37.4	8.7
1960	14.1	34.2	40.3	37.6	11.3	1965	13.3	34.2	42.8	39.0	9.6
1955	17.4	36.9	41.8	38.8	12.5	1960	14.0	34.0	41.1	38.1	11.5
1950	21.7	39.7	44.4	41.4	16.7	1955	17.4	35.2	42.2	39.0	14.9
1946	24.2	38.4	44.7	42.7	20.0	1950	19.1	33.7	40.9	38.2	17.8
1941	25.1	44.2	50.5	49.0	21.7	1940	14.7	33.0	40.4	37.1	17.7
1931	23.1	39.3	44.3	43.4	22.7	1930	20.0	37.6	44.8	42.0	25.4
1921	31.3	45.2	50.3	49.6	27.3	1920	28.7	43.5	50.2	47.0	29.2

The age cross sections of wages for males in the two countries are also peaked. Hourly wages typically are very low for teenagers, rise with age, then peak in the late forties (somewhat later than the peak in labor supply).

There is one important difference between labor supply trends in Canada and the United States: the increase in Canadian unemployment over the past 15 years has now introduced a persistent, significant wedge between labor force and employment rates. However, this has not greatly influenced the relative distribution of labor input in the cross section, since there has been a substantial increase in the rate of unemployment among prime-age Canadian males, as well as higher rates among other age groups. When labor supply data obtained by multiplying hours per employed person by the labor force participation rate are compared with data using hours and the employment rate, little difference is observed in the relative age distribution of labor inputs.[5]

Time Series

Over the past 75 years, labor input per capita fell in each age group. In the earlier years of this period, reduced hours per employed male were the principal factor reducing labor input; in more recent years, declining rates of labor force participation and, most recently in Canada, higher rates of unemployment have been much more important.

Hours reduction in Canada also took a somewhat different course than in the United States. There was a sharp reduction from 1850 to 1950 in the United States, but very little reduction since for prime-age males.[6,7] Hours reduction continued for a few years longer in Canada; for example, the standard workweek in Canadian manufacturing fell from 50.3 hours in 1921 to 43.2 hours in 1950, but then dropped to 40.2 hours in 1965. But household data show little if any reduction in the past 20 years.[8]

Male labor force participation rates fell significantly in both countries; there was a long-term downward trend in every age group. The largest declines are seen among teenagers and those over 55. These trends have accelerated in recent decades, in the very years in which hours decline was moderated or ceased.

Because of higher unemployment, in Canada the decline in male employment rates was significantly sharper than that in labor force participation. Among males 15 and older, only 65 percent were employed in 1995. Even in the prime-age group—35–44 years—only 85 percent were employed.

Cohort Analysis

As noted above, life cycle theory is *not* a theory of age cross sections, but of individuals as they age, better measured by cohort data.[9] In both countries, cohort data show that the labor supply of male workers declines more with age than is indicated in the cross sections (compare Table 2 with Table 1). The basic reason for this difference is the downward time trend in male labor supply. Consider how inaccurate it is to use a cross section of U.S. males in, say, 1965 to evaluate the life cycle of labor supply of a man who is 67 years old in that year. Census data indicate that a 22-year-old in 1920 actually was likely to put in as much as 10 more hours per week, on average, than a 22-year-old was in 1965. Hence, an age cross section that compares 22-year-olds in 1965 with 67-year-olds in that year significantly underestimates the decline in labor supply with age that cohort actually experienced.

This cohort cross section discrepancy is now modulated somewhat differently than in earlier years. In both countries there has been a sharp decline in the proportion of males employed over 55 years of age, while hours of work have recently been flat. One result is that the discrepancy between cohort and cross-sectional data has become much smaller for the middle-age groups than for older groups. A cross-sectional age distribution of labor input in 1920 not only greatly exaggerated the input that a contemporary 17-year-old would supply in the last years of his working life, it also yielded substantial overestimates of his labor input in his twenties, thirties, and forties (see Table 1). More recently, though, while a 17-year-old in the 1960s did experience much more decline in his old age than would be predicted from a 1960s cross section, the cross-sectional data did not yield a bad prediction of his labor input as a middle-age worker. With weekly hours remaining fairly stable, the labor inputs of workers in their thirties or early forties were not falling very much in, say, the 1960–1980 period. (The forecasting error would be somewhat larger for Canadian workers because of the much larger increase in Canadian unemployment among the prime-age group.)

The Relation between Labor Input and Earnings

The real hourly earnings of males quadrupled in both countries over the past 75 years. The steep upward time trend in real wages in the first part of this period, from 1920 to about 1970, introduced major differences between age cross section and cohort earnings data. When wages rise at almost 2.5 percent per year,[10] the average wage at the end of a 50-year working life will be about triple the average wage at the beginning. Absent any changes in the age distribution of wages, the real hourly wage of a man in a given age group will then be more than three times as high in 1970 as in 1920. This rising trend yields a much more rapid increase in wages with age for a cohort than we see in the cross section. While the cohort gains both from this trend and from the benefits of the group's lifetime of job training and other useful work experience, we see only these latter effects in the cross section.

This has important implications for the life cycle theory of labor supply set forth above. Labor supply has tended to decline with age, while real hourly wage in the 1920–1970 period increased with age. As a result, data for the cohort entering in 1920 demonstrate a weak relationship between labor supply and wage. (See Figures 1 and 3.)

A representative worker in this cohort might achieve a four- or fivefold increase in his real wage over the next 50 years (due in part to improvements in his own skills and experience, and in part to the upward national trend in real wages), yet his labor input would decline by about 80 percent. Even if we compare the earnings of a man in his early twenties in this period with those he might earn in late middle age (say, 30 years later), we see a similar, if more moderate, result: a decline in labor input despite a more than threefold increase in his wage. Such facts challenge a life cycle theory that predicts that a future of rapidly rising wages will induce a cohort to take leisure when young and defer working until late in life.

The dramatic change in real wage growth in the past 25 years, from rapid increase to stagnation, affords another opportunity to consider the empirical usefulness of this theory. The relationship between labor input and wage in the cohort data now differs less from that found in the recent cross sections (compare Figures 2 and 4 with Figures 1 and 3, respectively); the cohort relation is now more uniformly positive, and so more like that in the cross section. An observer who relied only on these recent data might conclude that the simple life cycle theory is approximately correct.

The life cycle theory predicts that this major change in real wage growth (and hence in the way in which wage varies with age for the average person) would have produced large-scale changes in the life cycle of labor supply; the elimination of the trend reduces the incentive to supply more labor later in life, and so forecasts a shift toward supplying labor at earlier ages. It is difficult to see this effect in the cohort data in Table 2.

Figure 1 Labor Input versus Wage, Canada, 1921–1971

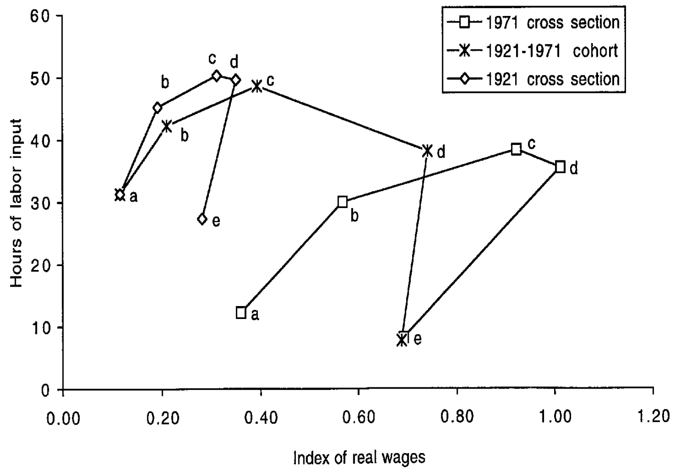
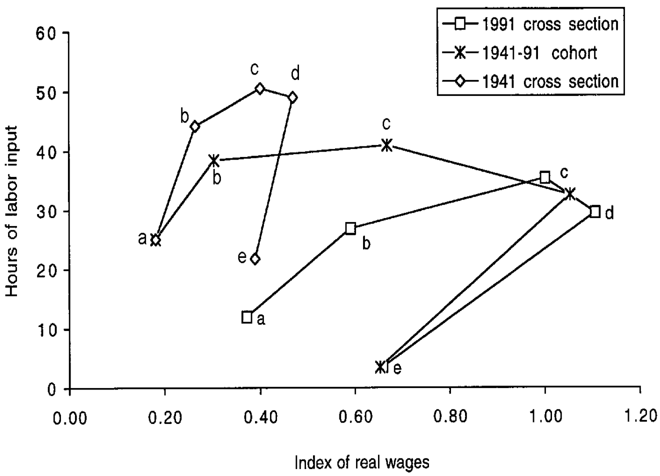


Figure 2 Labor Input versus Wage, Canada, 1941–1991



Key to Figure Legends

Legend	Age group (years)
a	Under 20
b	20–24
c	25–44
d	45–64
e	65 and older

Figure 3 Labor Input versus Wage, United States, 1920–1970

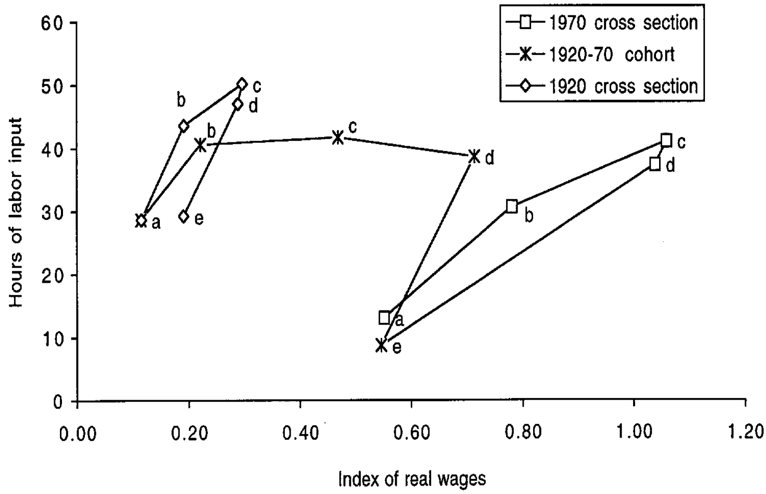


Figure 4 Labor Input versus Wage, United States, 1940–1990

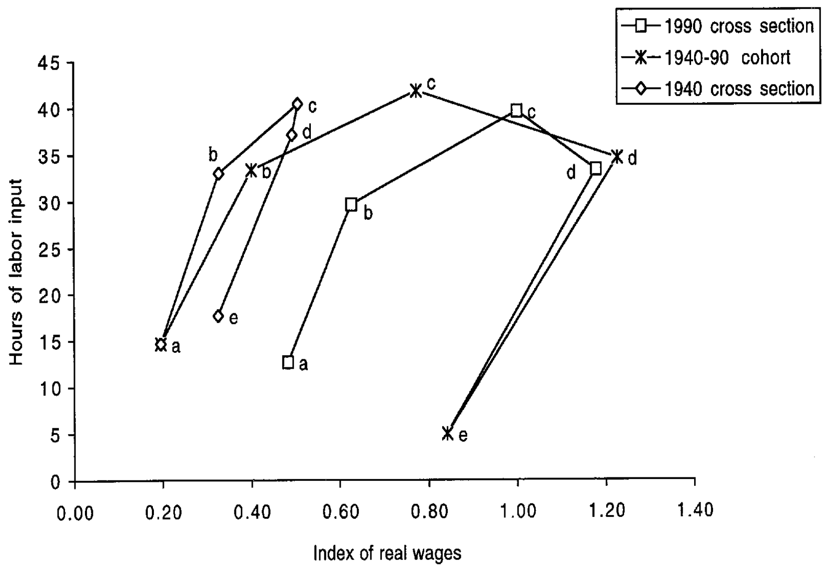


Table 2 Cohort Analysis of Hours of Labor Input

Canada						United States					
	Year cohort born						Year cohort born				
Age	1904	1914	1924	1934	1944	Age	1903	1913	1923	1933	1943
16–19	31.3	23.1	25.1	20.9	14.0	16–19	28.7	20.0	14.7	19.1	14.0
20–24	42.2	41.8	38.4	36.3	30.2	20–24	40.6	35.3	33.3	35.2	34.2
24–44	48.6	44.6	40.9	39.5	36.7	24–44	41.7	40.8	41.8	40.6	39.9
45–64	38.1	36.5	32.5	29.5	28.1	45–64	38.6	38.3	34.7	32.8	33.6
65+	7.7	4.5	3.4			65+	8.7	5.7	5.0		

AN EMPIRICAL MODEL

The Basic Cohort Model

Such questions can be explored more systematically in a statistical treatment that uses multivariate analysis. Following Ghez and Becker, the behavior of a single cohort can be modeled with the log of labor input (*I*) being a function of a constant term, age (*A*), and the log of wage (*W*) at each age, *i*:

(1) $$I_i = b_0^* + b_1 W_i + b_2 A_i$$

In the Ghez-Becker model, b_2 is the product of the difference between the rate of interest and an index of individual time preference, and a measure of the substitutability of present and future consumption experiences; b_1 is a weighted average of this substitution possibility and the extent to which goods and time are substitutes within a single period;[11] and b_0^* reflects the influence of the cohort's wage (the present value of its earnings over its lifetime) as well as a constant.

The present study uses data from a number of birth cohorts (see Table 2). A Ghez-Becker type model can be rewritten for more than one cohort as

(2) $$I_{ij} = b_0 + b_1\left(W_{ij} - W_j\right) + b_2 A_{ij} + b_3 W_j,$$

where i denotes age group, j denotes the jth birth cohort, and W_j is the log of cohort wage.[12] In this model, b_1 is expected to be positive, since the relative variation of wage over the lifetime of a given cohort is expected to increase labor supply. The constant b_2 will be negative if (as in the Ghez-Becker study) the market rate of interest exceeds the individual rate of time preference. The constant b_3 may be negative if there is a "backward sloping supply curve of labor," in the sense that those cohorts facing higher wages supply less labor over their lifetimes.

Eq. 2 can also be written as

(3) $$I_i = b_0 + b_1 W_{ij} + b_2 A_{ij} + (b_3 - b_2) W_j$$

The age (A_{ij}) and the log of current wage (W_{ij}) of a cohort can readily be measured. Measuring the cohort wage is not so easy. A perfect foresight model would assume that each individual knows his future wages and hence could calculate their present value—a measure that would be consistent with the Ghez-Becker model. However, we lack full working life information for many of the cohorts in our data. One might, moreover, wish to consider other hypotheses about wage expectations. Several alternative models of cohort wage were developed to deal with these concerns. The first, W_j^1, simply assumed that the cohort wage of each cohort surpassed that of a cohort born a year earlier by the same percentage, g, so that $W_j^1 = W_0 + jg$, where W_0 is the logarithm of the cohort wage in a base year 0, and j is the number of years from the birth year of the base cohort to that of the jth cohort. For convenience, the base birth year chosen here was 1903. The age of an age group was taken at its midpoint. For example, those 14–19 years old in 1920 (the youngest cohort in the earliest year for which we had data) were assumed to be 17 years old then, or born in 1903. Or, to take another example, those 25–44 years old in 1950 were assumed to be born in 1916. In the first example, j was equal to 0; in the second, to 13.

W_0 is invariant. Hence, substituting in Eq. 3, we can write

(4) $$\begin{aligned} I_{ij} &= b_0 + b_1 W_{ij} + b_2 A_{ij} + (b_3 - b_1)(W_0 + jg) \\ &= b_0' + b_1 W_{ij} + b_2 A_{ij} + (b_3 - b_1) jg. \end{aligned}$$

Here the constant term is $b_0' = b_0 + (b_3 - b_1)W_0$.

A stochastic equation was used to estimate labor input in this first model:

$$\textbf{(5)} \quad I_{ij} = \beta_0' + \beta_1 W_{ij} + \beta_2 A_{ij} + (\beta_3 - \beta_1)gj + u_{ij},$$

where u_{ij} is a random disturbance term.

Cohort and Unexpected Period Effects

The break in wage regimes noted above (rapid wage growth followed by wage stagnation) offers an opportunity to carry out simple, informal tests of the importance of cohort and unexpected period effects on the life cycle of labor supply. The data were first divided into two periods, "early," 1920–1970, and "late," 1975–1995. The model was estimated for each of these periods separately.[13]

To explore this period hypothesis further, a dummy variable L, equal to 1 if after 1970, zero otherwise, was introduced as an independent variable and as multiplying each of the regressors, in an estimation of the 1920–1995 period:

$$\textbf{(6)} \quad I_{ij} = \beta_0' + \beta_1 W_{ij} + \beta_2 A_{ij} + (\beta_3 - \beta_1)gj + \beta_0'^{*} L + \beta_1^{*} W_{ij} L + \beta_2^{*} A_{ij} L + (\beta_3^{*} - \beta_1)gjL + u_{ij},$$

where u_{ij} is a random disturbance term.

If the life cycle or cohort theory is correct, and the cohort wage is defined accurately, we should expect little change in the coefficients between the early and late periods. By the same reasoning, Eq. 6 should not afford a better fit to the data than Eq. 5.

A change in wage regimes may also affect expected cohort wage. To explore this possibility, four other measures of expected cohort wage were constructed and used in alternative estimations. These measures assumed that those cohorts that had left the labor force by 1970—while wages were still rising—did use the average rate of growth of wages before 1970 to predict the long-term trend in their earnings; the log of the cohort wage for this group ($j < 0$) was measured as $W_0 + jg$, where g is the growth rate in average wages in the early period.

The alternative measures assumed that the change in wage regimes altered expectations for younger cohorts. All four assumed that those who entered the labor force after 1970 expected no upward trend in their wages (i.e., that $g = 0$ if $j \geq 50$).

This leaves a third group containing those who entered before 1970 but reached retirement age after that date (i.e., $0 \leq j \leq 50$). The first alternative $\left(W_j^2\right)$ assumed constant cohort wage growth for those in this group up to 1970, but no growth after that date. The log of the cohort wage in this model, W_j^2, is then

if $j \leq 50$,

$$W_j^2 = W_0 + jg$$

(if $j \geq 50$,

$$W_j^2 = W_0 + 50g).$$ [14]

Variant 3 rejects the notion that the middle group didn't take future wage stagnation into account. The expected rate of growth of cohort wage for cohorts in this middle group is assumed instead to have declined linearly in the 1920–1970 period, from the growth rate expected by those entering in 1920 or earlier to the zero growth expected by those entering in 1970 or later. In this variant, the log of cohort wage for the middle group is

$$W_j^3 = W^0 + jg(1 - 0.01j).$$

This function is at a maximum at $j = 50$, and so predicts no further growth after 1970.[15]

The last variants $\left(W_j^4 \text{ and } W_j^5\right)$ explicitly recognize that if wage stagnation occurred later in life, it might have less impact on life cycle decision making for two reasons: fewer years would be affected by the change in growth rates, and later years may be weighed less heavily than earlier years. The present value of the future wage trend was used to measure expected cohort wage in these variants. (The wage trends used continued to be the observed trend in the 1920–1970 period, and zero growth from 1970 onward.) W_j^4 used a real rate of discount of 4 percent; W_j^5 used a zero rate of discount. In these models, the log of cohort wage for the middle group is

$$W_j = W_0 + \int_0^{50-j} e^{g(j+t)-rt} dt + \left(e^{g50}\right)\left(\int_{50-j}^{50} e^{-rt} dt\right),$$

using r to denote the rate of discount.[16]

Multicollinearity

Current wages and cohort wages display similar upward trends, as do their logs, W_{ij} and W_j. In an alternative regression, it was assumed that the trend in the dependent variable was due to changes in the cohort wage. $\Delta I/\Delta$yr was calculated for each period studied, and used to calculate an adjusted dependent variable $I'_{ij} = I_{ij} - j(\Delta I / \Delta \text{yr})$. I'_{ij} was then regressed against age (A_{ij}) and the log of current wage (W_{ij}).

Canadian Unemployment

As noted above, the persistently high level of unemployment in Canada calls into question the use of labor input—hours per worker times proportion employed—as a measure of labor supply. To deal with this problem, alternative regressions were run with Canadian labor supply measured using labor force participation rate instead of proportion of population employed.

EMPIRICAL RESULTS

Table 3 presents the results of statistical estimations of the log of labor input, I, using the basic model set forth in Eq. 5 and data for Canada and the United States for the past 75 years. Part A presents results using the first measure of cohort wage $\left(W_j^1\right)$; the third measure $\left(W_j^3\right)$ is employed in part B.[17] (Space limitations prevent presentation of results for W_j^2, W_j^4, and W_j^5.) In each country, estimates are given for the entire 1920–1995 period, for the "early" period (1920–1970), and the "late" (1975–1995) period. Table 3, part C presents the results of an alternative method for standardizing for the cohort wage effect, using the adjusted dependent variable, I'_{ij} (defined above as $I - j(\Delta I / \Delta \text{yr})$). (Note that the cohort wage effects in parentheses are based on the calculation used to obtain the adjusted dependent variable, not on a multi-

Table 3 Empirical Results[a]

A. Dependent variable: labor input
Cohort wage used: first (W^1_j)

	Canada			United States		
	1920–1995	1920–1970	1975–1995	1920–1995	1920–1970	1975–1995
Constant	7.3448	7.1733	5.3189	6.2422	6.5215	2.8810
	(31.750)	(29.024)	(9.251)	(18.933)	(30.496)	(4.782)
Wage	1.6480	1.4792	2.1984	1.2514	1.3803	2.7630
	(14.846)	(13.65)	(14.217)	(7.784)	(14.183)	(14.861)
Age	–0.0726	–0.0704	–0.0528	–0.0509	–0.0548	–0.0259
	(–18.064)	(–15.422)	(–7.101)	(–9.434)	(–14.481)	(–3.476)
Cohort wage	–2.4136	–1.8441	–3.9858	–1.8443	–1.6914	–3.1520
	(–17.231)	(–14.66)	(–1.928)	(–8.760)	(–14.694)	(2.730)
Cohort wage, adjusted coefficient	–0.7655	–0.3649	–1.7874	–0.5929	–0.3111	–0.3890
$\bar{R}^2$	0.829	0.844	0.915	0.544	0.856	0.888
N	70	45	25	75	40	35

B. Dependent variable: labor input
Cohort wage used: third (W^3_j)

	Canada			United States		
	1920–1995	1920–1970	1975–1995	1920–1995	1920–1970	1975–1995
Constant	7.3709	6.7760	5.5300	6.1160	6.2617	4.0160
	(25.726)	(22.982)	(9.206)	(19.914)	(22.572)	(5.796)

Wage	1.7747	1.3779	2.4380	1.4960	1.3716	2.5470
	(14.531)	(11.035)	(13.222)	(8.381)	(11.377)	(10.483)
Age	–0.0760	–0.0658	–0.0515	–0.0498	–0.0530	–0.0402
	(–18.522)	(–12.369)	(–8.421)	(–9.685)	(–11.386)	(–5.793)
Cohort wage	–3.0593	–2.2990	–1.6450	–2.0950	–2.1865	0.5358
	(–7.491)	(–7.503)	(–2.199)	(–9.050)	(–7.192)	(0.702)
Cohort wage, adjusted coefficient	–1.2846	–0.9211	0.7930	–0.5990	–0.8149	3.0828
$\bar{R}^2$	0.697	0.670	0.919	0.559	0.647	0.863
N	70	45	25	75	40	35

C. Dependent variable: I′ = labor input net of calculated cohort wage effect

	Canada			United States		
	1920–1995	1920–1970	1975–1995	1920–1995	1920–1970	1975–1995
Constant	17.4540	17.7910	17.0970	13.7850	15.2160	4.8710
	(90.909)	(84.245)	(142.258)	(80.700)	(83.764)	(37.594)
Wage	0.4166	0.4490	2.2020	0.3168	0.3624	2.6430
	(2.908)	(3.027)	(14.256)	(2.421)	(2.768)	(13.313)
Age	–0.0222	–0.0190	–0.0462	–0.0169	–0.0107	–0.0447
	(–5.543)	(–4.809)	(–15.663)	(–4.550)	(–2.917)	(–13.562)
Cohort wage (calculated effect)	[–0.39]	[–0.30]	[–1.96]	[0.29]	[–0.22]	[0.30]
N	70	45	25	75	40	35

(continued)

Table 3 (continued)

D. Dependent variable: labor supply = hours × labor force participation rate

	Canada		
	1920–1995	1920–1970	1975–1995
Constant	7.3360	7.1623	5.3820
	(31.267)	(31.209)	(9.002)
Wage	1.5932	1.4260	2.1332
t-ratio	(14.152)	(14.176)	(13.265)
Age	–0.0718	–0.0695	–0.0535
t-ratio	(–17.606)	(–16.387)	(–6.916)
Cohort wage	–0.0406	–0.0437	–0.0117
t-ratio	(–16.310)	(–15.437)	(–1.634)
Cohort wage,			
Adjusted coefficient	1.5526	1.3823	2.1215
$\bar{R}^2$	0.826	0.868	0.910
N	70	45	25

[a] *t*-ratios are in parentheses.

variate analysis.) Part D of Table 3 presents estimations of labor supply in Canada, with the dependent variable defined as hours × labor force participation rate.

In every regression, the current wage variable has a positive, statistically significant effect on labor input, and age has a negative, significant effect. These two effects are consistent with the empirical findings in the Ghez-Becker study.

In the regressions for the entire period and for the early period in Table 3, the age coefficients range from –5.5 to –7.6 percent over the five models (W_j^1 through W_j^5). These are larger than expected (inasmuch as they are designed to reflect the difference between the available rate of return and individual time preference) and are much larger than those found by Ghez and Becker. When a correction is made for multicollinearity in Table 3, part C, the age coefficients for these periods are considerably smaller—between –1.1 percent and –2.2 percent—though still larger than the very small coefficients found by Ghez and Becker. The results in the present study indicate that when young people are faced with rapidly rising real wages, they are restrained from taking full advantage of the upward trend and postponing effort to their later years by a discrepancy between the market rate of interest and their own rate of time preference, and by uncertainty and other factors constraining the young. It was argued earlier that uncertainty about the future is a major constraint on life cycle variations in labor supply. In an interesting paper on the life cycle of savings, Nagatani (1972) argues that, under reasonable assumptions, such uncertainty can be "translated into a risk premium which adds to the market rate of interest in discounting future income." On this reasoning, the relatively large coefficients on age found here can be interpreted as reflecting not only the market rate of interest, but also an uncertainty premium.[18]

The elasticities of labor input with respect to current wage obtained for the entire period and for the early period are also rather large, ranging from 1.2 to 1.7, suggesting a high degree of substitutability of labor input between ages. However, when the adjusted dependent variables are used (Table 3, part C), the estimated current wage elasticities for these periods are more plausible, ranging from just 0.3 to 0.5.

The estimations for the "late" period are more difficult to interpret. Since there has been very little change in average real hourly wages in recent years, we should be able to focus more clearly here on life cycle variations in wages. While we do find good fits to the data in this period, the age and current wage coefficients are implausibly large, and they remain so even when an attempt is made to correct for multicollinearity (Table 3, part C). This may be the result of unobserved variables. In the Ghez-Becker model, these age and wage coefficients generate an inverted U in the life cycle of labor supply. Conversely, an increase in the steepness of this U in data will likely yield higher levels of these coefficients in a regression. However, this increased kurtosis may also reflect the influence of other, unobserved variables rather than a true change in the substitution elasticities that the age and wage coefficients represent in this model.

The relationship between labor supply and cohort wage in this late period is ambiguous, especially in the United States, where we see a decline in labor input per capita accompanied by a decline in the real average wage, yielding a calculated *positive* elasticity of about 0.3 (see Table 3, part C). This may be a result of the very small changes in real wages and labor supply in this period, i.e., –0.6 percent and –0.2 percent per annum, respectively. When change is this small, measurement errors can dominate real movement. Some economists have argued that the consumer price index has been upward biased over the past 20 years, by as much as 1 or 2 percent a year. If the measurement error was, say, 1.2 percent per year, then real wages actually increased at an annual rate of 0.6 percent, and the elasticity of labor supply with respect to wages was –0.3! One cannot, then, rely on the estimates of cohort wage effects in this period.

These estimations also provide evidence of a shift in labor supply relationship over time. The goodness of fit improves when separate regressions are run for the two subperiods. The adjusted R^2 values (see part A of Table 3) show a gain from 0.829 for the entire period to 0.844 and 0.915 for the two subperiods in the Canadian data, while this measure rises from 0.544 to 0.856 and 0.888 when U.S. data are employed. Moreover, when the entire period is used, with a dummy variable, "late period," introduced for interaction with all variables (as in Eq. 6), the adjusted R^2 rises from 0.829 to 0.902 for the Canadian data and from 0.544 to 0.886 for the U.S. data (not shown).

The alternative models of cohort wage W_j^2, W_j^3, W_j^4, and W_j^5 are designed to help us see how individuals reacted to the major change in the wage regime that occurred around 1970—to determine whether what appear to be unexpected period effects might actually be explained in terms of rational life cycle planning in a perfect foresight model. In this context, the results are somewhat disappointing. While the regression coefficients are broadly similar to those in the first model, the alternative models of cohort wage typically yield poorer fits, especially in the early subperiod (see parts A and B of Table 3). Unlike the basic model, the alternative models assume that younger workers in the early period forecasted wage stagnation and adjusted their labor supply accordingly. The results do not support that hypothesis. (Using alternative models has little impact in the late period, presumably because wages were flat in that period.)

Finally, when the alternative measure of labor supply, hours × labor force participation rate, is used for Canadian data (in Table 3, part C), the results are very similar to those obtained in parts A and B, when hours × employment rate is used. The one exception is in the late period, when the coefficient of cohort wage is insignificant.

CONCLUSIONS

1) The life cycle of working time has been remarkably similar in Canada and the United States. There are, of course, some differences. Canadian unemployment has been higher in recent years, reducing labor input. There are also smaller differences, especially in the timing of change; for example, the earlier achievement in the United States of a 40-hour standard workweek.
2) The age distribution of male labor supply is an inverted U. Over time, the peak has become more pronounced, as participation for young and old workers declined relative to those in their prime.
3) The level of male labor supply has declined over time: in earlier years, it was largely a result of reductions in working hours; more recently, it has been due to declining labor force participation.

4) Cohort data are a more appropriate measure of the life cycle of individual behavior than are cross-sectional data, but the cohort data show less regularity—especially for the U.S. cohort whose working lives spanned the entire 1920–1970 period, when wages were growing rapidly.

5) A multivariate estimation of the life cycle model performs well in the 1920–1970 period. When a number of cohorts are combined in a multiperiod analysis, and estimates of cohort wage, current wage, and age are used as independent variables, about 85 percent of the variation in labor input is accounted for in both countries. The signs of the independent variables are consistent with the model and, when they are corrected for multicollinearity, are of a plausible magnitude. The age coefficients do suggest that in a period of rapid growth in real hourly wages, a high level of uncertainty about the future, and possibly other factors, constrain young people from taking full advantage of this trend.

6) The model fits the data even better in the later period. This is seen both in a simple figure charting the experience of one cohort and in a multivariate, multicohort analysis. However, the magnitudes of the coefficients are implausibly large.

7) When the two periods are combined, significantly better results are obtained when a dummy variable representing the change in period is interacted with the independent variables. There are important changes in the regression coefficients.

8) An attempt was made to determine whether workers whose lives overlapped the early period, characterized by wage growth, and the later period of wage stagnation foresaw the change and adjusted their labor supply accordingly. No support was found for this hypothesis.

Notes

1. I follow Ghez and Becker in using this term to refer to decision making over an entire life cycle, rather than to decisions over a shorter period of time, such as a business cycle. For interesting examples of the use of different life cycle analyses using Canadian data, see Altonji and Ham (1990); Reilly (1994); and Roble, Magee, and Burbridge (1992).

2. For a positive assessment of this approach, see Browning, Deaton, and Irish (1985) and Rios-Rull (1993).
3. Sources discussed in the Data Appendix to this chapter.
4. This group provides the most difficult measurement problems. Different age categories are used by censuses and surveys in different years; there is an important, though difficult to measure, long-term trend from full- to part-time employment as student enrollment increases, and the way in which government agencies have measured (or have not measured) the role of student employment has changed.
5. Published sources of data and interpretations include Benimadhu (1987); Denton and Ostry (1967); Gartley (1993); Gower (1992); Morisette and Sunter (1994); Podoluk (1968); Rashid (1993); Simard (1986); Conference Board of Canada (1974); as well as the Canadian Censuses of 1921, 1931, 1941, 1951, 1961, and 1971; Historical Statistics of Canada (1965 and 1983 editions); Historical Labor Force Statistics; historical supplements of the Canadian Economic Observer; and Hourly Data from the Survey of 1981 Work History.
6. As measured by household data, at least. The establishment data collected by the United States Bureau of Labor Statistics indicate a sharper decline than do their household data, partly because of increased moonlighting (measured in the latter but not the former series) but also because of likely greater inaccuracy in the household data. Similar gaps between household and establishment data are seen in the Canadian statistics. Unfortunately, data collected from establishments are not obtained in conjunction with questions on the age distribution of the establishment's employment.
7. Since persistent, long-term variations in unemployment are usually small (much less important than variations in hours or labor force participation rates), very long-term analyses of labor inputs typically do not emphasize them. The long-lived increase in Canadian unemployment does require discussion.
8. Again, for prime-age males. Moreover, while the average changed little, there was an increase in the dispersion of hours. See Morisette and Sunter (1994) for an interesting discussion.
9. The census and labor force survey data used here are only imperfect measures of cohort behavior. As they age, cohorts are reduced by death and emigration, increased in numbers by immigrants. If those who die, emigrate, or immigrate supply, on balance, more or less labor than those who remain of the original cohort, the results observed in these sources will only approximate actual cohort behavior.
10. A typical rate of change in that period.
11. See Ghez and Becker (1975, p. 16). In real terms, the coefficient of the current wage is given by $-[\sigma_f(1 - s) + \sigma_c s]$ and the coefficient of age is $\sigma_c(r - \rho)$, where σ_c is the intertemporal elasticity of substitution, σ_f is the contemporary elasticity of substitution between goods and time, r is the real rate of interest, and ρ is the individual's rate of time preference. $s = WL/(WL + X)$ where W is the real wage rate, L is consumption time, and X is consumption of goods and services.
12. A comparison of Eqs. 1 and 2 indicate that $b^*_0 = \mathrm{b}_0 + (b_3 - b_1)W_j$.

13. The data used were those for the years shown in Table 1, plus for the United States, 1993.
14. In estimating equations using the alternate measures of cohort wage, the constant term was interpreted in the same fashion as when the first measure of cohort wage was employed: in the third measure, for example, $\beta' = \beta_0 + (\beta_3 - \beta_1)W_0$ and the independent variable, cohort wage, in the regression was $W^3{}_j - W_0 = jg$ if $j \leq 0$; $= jg(1 - 0.01j)$ if $0 \leq j \leq 50$; and $= 25g$ if $j > 50$.
15. Note that $W_j^3 = jg$ at $j = 0$ (as in the earlier variants), and $25g$ at $j = 50$.
16. Regressions were also run that allowed for changed expectations within the late period. A sixth measure of cohort wage was employed here, $W_j^6 = W_j(1 - \alpha y)$, where y = current year – 1970 and α is an estimable parameter. These regressions were not successful.
17. The estimations using W_j^3 for the early period in Canada and the United States and for the entire period in Canada displayed significant autocorrelation. The results shown in Table 3 for these estimations were corrected for AR1 autocorrelation using the Cochran-Orcutt method.
18. The uncertainty premium here would be reflected in the lender's unwillingness to lend at a conventional rate of interest and the youth's unwillingness to borrow. The labor market constraints mentioned above would also contribute to large age constraints on individual behavior.

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Data Appendix

United States: U.S. data for the 1977–1995 period from the *Monthly Labor Review*, various issues; *Employment and Earnings*, various issues, and unpublished data from the United States Department of Labor. Data for 1920–1977 from Owen (1986). Data for the recent period were relatively easy to obtain. When there was a change in data series in recent years, the Bureau of Labor Statistics personnel were very helpful in providing unpublished data. I am especially grateful to Steve Hipple for his assistance in this work.

Canada: Canadian data were obtained from a number of published and unpublished sources. I am especially grateful to David Gower, Regine Lafnier, Rene Morisette, and Abdul Rashid, all of Statistics Canada for their help in supplying and interpreting data.

Labor input per capita: This series required data on the employment rate and hours of work, by age and sex, over a 75-year period.

Employment rate: 1975–1995. *Labour Force Surveys*. Various issues, Table 1.

1946–1975. An employment rate was constructed for these years, then linked at 1975 to the Labour Force Survey data. Employment rate was measured as (labor force participation rate) × (1 – unemployment rate).

Labor force participation rate: *Historical Statistics of Canada*. 1983. Series 205–222.

Unemployment rate: *Historical Statistics of Canada*. 1983. Series 223–235.

1921–1946. An employment rate was constructed for these years, then linked to the later series.

Employment rate was again measured as (labor force participation rate) × (1 – unemployment rate).

Labor force participation rates were constructed from data in *Historical Statistics of Canada*. 1967. Series D107–123, and Denton and Ostry (1967).

Unemployment rate: Gower (1992). These national unemployment rate data were linked at 1946 with age divided data.

Hours: 1975–1995. Unpublished data from the *Labour Force Survey*, obtained from Statistics Canada.

1921–1975. A series of average hours was constructed. The ratio of female to male hours in 1975 was assumed to persist in this period. This ratio was used in conjunction with data on the changing proportions of males and females in the work force and with the series on average hours to estimate the average male workweek. Within the male work force, the age distribution of hours was assumed to correspond to 1975 ratios.

Average hours, 1966–1975. Unpublished data from Statistics Canada; linked to 1975 data.

Average hours, 1926–1966. Ostry and Zaidi (1979), pp. 80–81. Nonagricultural workers hours series; linked to 1966 data.

Average hours, 1921–1926. Ostry and Zaidi (1979), Standard hours in manufacturing. Linked to later series.

Wages: A time series of male real wages was constructed. Ratios of the wages of the different age groups to the male average were then multiplied by this average series to obtain wages for each age group.

Average male wages: 1995. *Employment, Earnings, and Hours*, February, 1996, p. 38.

1969–1994. Real earnings of male full-time, full year workers were obtained from *Earnings of Men and Women*, 1994, Text Table 1. (Hours reductions were minimal in that period, so that this series is a fair approximation of changes in hourly earnings.) Linked to 1995.

1920–1969. General index of wages (Deflated by Canadian CPI). *Historical Statistics of Canada* (1983), Series E209–219 for 1961–1969; E198–208 for 1920–1961. (This series endeavors to measure hourly earnings.) Linked at 1969 to later index.

Wage ratios: 1994. *Earnings of Men and Women*. 1994. Table 4. Average earnings of earners, full-year, full-time workers.

1980, 1990. Average earnings of earners, full-year, full-time workers. Unpublished data for *Earnings of Men and Women* from Statistics Canada.

1941. "Earnings, Employment and Unemployment of Wage-Earners, 1941." *1941 Census of Canada*, Volume VI. 1946 had both annual earnings and weeks worked by age and sex. The latter were divided by the former to obtain weekly earnings by age and sex.

1931. *Earnings of Wage Earners, Dwellings, Households, Families, Blind and Deaf-Mutes 1931 Census of Canada*. Vol. V. 1931 had weekly earnings by age and sex.

These five years were used to obtain through interpolation the wage ratios for the remaining years used in the statistical work.

Working Time in Comparative Perspective

Volume II

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