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THE QUANTITY AND PRICING OF HUMAN CAPITAL IN CANADA AND THE UNITED STATES

Audra Bowlus*, Haoming Liu and Chris Robinson***

*University of Western Ontario

**National University of Singapore

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*Chris Robinson is the CIBC Chair in Human Capital and Productivity and Audra Bowlus is CIBC Fellow in Human Capital and Productivity, both at the University of Western Ontario. This research is supported by the Canadian Imperial Bank of Commerce Project.

1 Introduction

Human capital theory has been the basis of a huge literature studying the determination of earnings since the seminal work of Becker (1964), Ben Porath (1967), Mincer (1974) and many others.[1] There is by now quite general agreement that human capital plays a major role in (the determination of earnings). In the original Ben Porath model, human capital is assumed to be homogeneous and many authors have followed. The literature has, however, many discussions of heterogeneous human capital. In fact, as early as Becker (1964) a dichotomy has been made between firm specific and general capital. This initial focus on firm specific capital led to attempts to measure the relative importance of specific capital by examining the effects of firm tenure on earnings profiles. This literature produced conflicting evidence on the magnitude of tenure effects.[2] More recently, the whole issue of the source of the specificity has been reexamined.[3] A common feature, however, is that general human capital is always estimated to be a very large amount of the total. Recent work suggests that for the U.S. at least general skills are dominant.[4]

The homogeneous human capital assumption is a very powerful tool for examining a variety of important questions, especially those involving aggregate issues such as determining the amount of human capital and pricing of human capital in an economy, the contribution of a post-secondary education system to a country's stock of human capital, or human capital and education system comparisons across economies. Since human capital is not directly measurable, a variety of approaches to measurement have been taken in the literature. Most of these are based on what in the original human capital models are more appropriately interpreted as inputs into the

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[1] See Willis (1986) for a survey.

[2] See, for example, Abraham and Farber (1987); Altonji and Shakotko (1987); Topel (1991); Altonji and Williams (1992); Abowd, Kramarz, and Margolis (1999).

[3] See Neal (1995), Parent (2000), Kambourov & Manovski (2002), Poletaev & Robinson(2002,2003)

[4] See Gould (2002).

human capital production function rather than the output. A common measure of general human capital is years of schooling; a refinement to this takes into account work experience - usually in the form of some measure of total accumulated time at work. For international comparisons, often the best that could be done was to compare the fraction of the relevant populations with various levels of education. For example, the OECD report comparisons of a such a measure, designated A1, which the publication characterizes as "traditionally used to proxy the stock of human capital"[5] Comparing features of the educational attainment distributions across countries presents a variety of problems if the aim is to measure the relative stocks of human capital.

At the most basic level, the there is the problem of adding different levels of education. This is often avoided by choosing a measure such as the fraction of the population who have graduated high school (for comparison across developing countries) or the fraction of the population with post-secondary education (for comparison across developed countries). However, this can result in misleading conclusions. According to the latter measure, Canada has higher per capita human capital than the United States. However, the US has a higher fraction of the population with a university degree. If this measure was used instead of the fraction with post-secondary education the ranking would be reversed. In addition, simple relative wage-based weighting of the university and non-university forms of post-secondary would also reverse the ranking. For a variety of important contexts, a better measure of human capital is needed. A better measure is also needed to answer some of the most important questions in the current literature on wages, productivity and growth.

In this paper we propose a new approach that retains the assumption of homogeneous human capital, but incorporates both a human capital production function that can be subject to technological change. Within this framework we develop a new measure, using the assumption that an efficiency units approach, modified to permit technological change in human capital production and endogenous human capital choices, provides a very good approximation for the purpose of addressing many of the important questions. In an earlier paper, Bowlus, Liu and Robinson (2002), we presented evidence of the usefulness of the efficiency units approach to the

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[5]*Education at a Glance - OECD Indicators,* OECD 1998, p. 7.

issue of wage cyclicality. Central to this literature was the appropriate way to measure an aggregate wage and an aggregate unit of labour input. The efficiency units approach solves the problem in an elegant way that permits comparison of alternative approaches in the literature within a single framework. In this paper this approach is refined and expanded to permit the construction of secular series on efficiency units of labour input and the price of an efficiency unit for Canada and the United States and to answer a variety of important wage and education related questions.

The outline of the paper is as follows. In section 2 the basic structure of the approach is presented, together with some discussion of identification and estimation issues. In section 3 estimates of human capital inputs and prices for the U.S. and Canada are presented and the patterns are discussed. Section 4 examines technology changes in human capital production in more detail via a cohort analysis suggested by the new framework. In Section 5 estimates of the contribution of the post-secondary education systems to total human capital stocks in Canada and the United States are presented. Section 6 has some conclusions and an outline of future work.

2 The Price and Quantity of the Human Capital Input

The benefits of a homogeneous human capital model are simplicity and ease of aggregation. The assumption has been used in a variety of contexts with fruitful results. In recent years, especially in the literature on widening skill differentials in the U.S. and the debate over skill biased technical change, the assumption has been maintained within a “skill” or “sector” category but abandoned across such categories, in part on the grounds that it is inconsistent with observed features of the wage structure such as changing “skill differentials”. In fact, a homogeneous human capital model is completely consistent with these facts, provided technological change in the human capital production function and/or individual heterogeneity and endogenous education choice are permitted. Since technological change is taken for granted in almost all other production functions it would seem an extreme assumption to rule it out for human capital. In addition, the essence of human capital theory is that human capital investment is chosen optimally with individual heterogeneity having long been recognised as important in this context. The question then arises as to whether a homogeneous human capital model with these features, which retains the major advantage of simple aggregation, can explain the important wage patterns as well or better than alternative approaches.

In practice, neither approach is expected to be an exact reflection of reality. In heterogeneous human capital models, skill definitions are quite arbitrary and are usually based on a simple count of the number of years of schooling. Above and below some cutoff, efficiency units prevail. Wages are proportional to the amount of "human capital" within the skill, but the relation between observables such as schooling and human capital is assumed to be fixed. Across the cutoff, the factors are heterogeneous; relative wages across the cutoff depend on demand and supply. In homogeneous models there is no arbitrary skill cutoff and wages are proportional to human capital, but due to technological change and/or changing selection effects, the relation between observables, such as schooling, and human capital can change over time.

The essential features of an efficiency units model for labour follow from assuming that the production function can be written:

$$Y = F(K_1, K_2, \ldots, N) \tag{1}$$

where N is the total number of efficiency units of labour and K_1, K_2,... are the other factors. Competitive firms rent homogeneous human capital from workers and pay a rental rate λ. The wage rate received by individual i at time t is given by:

$$w_{it} = \lambda_t \, E_{it} \tag{2}$$

where E_{it} is the number of efficiency units per hour supplied to the firm by the worker, and λ_t is the rental rate paid for renting a unit of human capital, or the price of an efficiency unit. Given a competitive market, the assumption of homogeneous human capital ensures that there is a single price faced by all workers and paid by all firms for an efficiency unit. Wage variation across workers is induced by variation in the efficiency units they supply, not by variation in the price of efficiency units.[6]

For the purposes of pricing human capital according to an efficiency units model, the required assumption is not that in all production processes human capital is homogeneous, only that in a sufficient number of firms using these processes to make these the marginal firms - i.e. to set the relative prices. That is, if there are two types or workers whose human capital is homogeneous for the production function for these firms, but heterogeneous for the production function for other firms, the pricing of the inputs will be set by the first set of firms at the ratio of the efficiency units in their process who will be indifferent across types of workers. The remaining firms will then hire the two types such that the ratio of their marginal products in the "heterogeneous" production function is equated to the ratio of the prices.

The homogeneous input demanded by firms is efficiency units, *E.* The total amount of this input demanded (and supplied) in period *t* is $N_t = \sum_i E_{it} h_{it}$ and its price is λ_t, where h_{it} are the hours worked by individual *i* in period *t.* Equivalently, the stock can be written:

$$N_t = \sum_i (w_{it}/\lambda_t)\, h_{it} \qquad = (1/\lambda_t)\sum_i w_{it}\, h_{it}$$

i.e. the stock is proportional to total earnings, where the factor of proportionality is the inverse of the rental rate.

For a heterogeneous human capital model this specification applies within a human capital "type" - usually distinguished by years or schooling - e.g. college or high school. There is no single input price or input quantity. The focus of attention is usually on relative wages across the skill groups. In principle this depends on both relative prices, λ^c and λ^h, the efficiency units prices within college and high school type human capital, respectively, and relative per capita, per hour quantities of the human capital types. In practice, however, the quantities are implicitly

[6]The number of efficiency units supplied to the firm does not have to equal the human capital stock of the worker since the worker may be investing some human capital to augment his stock. This is discussed in more detail in Section 3 below.

assumed constant and normalized to one in both cases, hence the price ratio *is* the wage ratio and no distinction is made between the two.

Identification

Earnings or wage rates are observed; the price and quantity of human capital purchased are not. The primary identification issue is the appropriate decomposition of wages or earnings into the product of a quantity and price of human capital. The observation that relative wages have changed between workers distinguished by whether they are college or high school graduates implies in a homogeneous human capital model that the relative quantities of human capital supplied by these workers has changed since, by definition, they have the same price per unit. In a heterogeneous model relative prices and/or quantities may have changed. Both models are consistent with the observation of a change in relative wages. In practice, the literature on the "college premium" implicitly assumes no change in quantity and thus identifies the price change with the wage change. Homogeneous human capital models imply a change in relative quantities of human capital supplied by college and high school graduates to be consistent with relative wage changes. In this paper we interpret these changes in part as technological changes in the human capital production function or changes in the selection and level of (optimal) investment of people into the various levels of observed schooling that accompanied, for example, the increased enrolment in colleges and universities.

Technical change is considered a standard and important feature of production functions in general. Indeed it is typically the major source of growth and is often modelled as occurring continuously. However, this feature is seldom, if ever, explicitly investigated in the production function for human capital. The closest approach is the discussion of schooling quality. In heterogeneous human capital models, the amount of human capital associated with a particular observed worker characteristic, such as college or high school graduation, is typically taken as fixed. Implicitly this assumes zero technical change, which is a strong assumption given the ubiquitous nature of technical change in other production contexts, and zero selection or optimal investment changes, despite the large changes in college and university enrolment. Conversely, a homogeneous human capital or efficiency units approach requires a change in the amount of human capital associated with a particular observed worker characteristic for consistency with changes in relative wages across groups of workers distinguished by these characteristics.

The change in the amount of human capital associated with a particular observed work characteristic such as a university degree will, in our framework, reflect technological change in human capital production and selection effects due to endogenous schooling. This will appear as "vintage" effects in the sense that individuals who acquire their capital at university at different times will in general have produced different amounts and/or have different levels of initial endowment. The vintage effect in this framework does not require the human capital acquired in one year to be a different factor of production from that acquired in the next year, only a different amount. It has the important implication, however, that changes in the relative wages of university graduates would be age specific. In particular, if a technical improvement in human capital production at universities in some period increased the amount of human capital associated with individuals who graduated in that period, the relative wage of university graduates from that period would increase, but that of previous cohorts of university graduates would not. This feature does not occur in standard heterogeneous human capital models where relative prices are determined by relative supplies and demands of the two types of factor and all factors of a given type - e.g. university graduate - receive the same price. [7]

Since only wages (or earnings) are observed to identify a price and quantity product, the price and quantity are obviously unidentified. Zero change in the quantity for all groups of workers characterized by their years of schooling is one identification strategy which we associate with heterogeneous human capital approaches to wage patterns. The alternative followed here is to allow change in a restricted way that will still permit identification of the

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[7]Card & Lemieux (2001) note that "virtually the entire rise in the U.S. college premium is attributable to changes in the relative earnings of younger college educated workers" (p.705). This fact is inconsistent with the standard heterogeneous human capital model. To avoid this inconsistency, Card & Lemieux amend the standard heterogeneous human capital model by assuming a further heterogeneity between college graduates in different years. Individuals who graduate from college in different years are assumed to be different factors of production.

price and quantity separately. It might be argued that this approach requires a highly unlikely coincidence of relative quantity changes across observed groups happening in magnitudes that exactly match the observed relative wage changes. In fact, there would be no unlikely coincidence: the observed wage difference magnitude would simply be the consequence of the quantity change, not a coincidence either likely or unlikely. By analogy, suppose we observed a commodity being sold in a foreign market in two different container sizes, large and small. Suppose that unknown to us this market used an imperial system of weights and that what we characterize as "large" and "small" are in fact- 1lb and 1oz containers and that consumers have no preference for the containers and regard the commodity as homogeneous so that the market price ratio is 16:1. Over time the country moves to a decimal system and the containers become 500 grams and 25 grams. We still see large and small containers but now the price ratio is 20:1. By construction it would be a mistake for the observer to conclude that there were two heterogeneous commodities. This outcome is a consequence of the change in the relative container sizes and the fact that the relative quantity change exactly mirrors the relative price change is not a coincidence, likely or unlikely, but a consequence of the fact that the commodity is homogeneous.

The assumption of zero technical change, or more generally, no change in the quantity of human capital associated with an observed worker characteristic that provides identification in much of the literature on wage patterns is abandoned in this paper. However, since our approach permits quantities to change, prices and quantities will not be identified without some replacement assumption. In principle the working assumptions are two: that human capital is homogeneous and that initial endowments of human capital are constant, at least over the periods we deal with. Technological change in human capital production, or the other mechanisms that change the quantity of human capital associated with an observed worker characteristic, are left unrestricted. In essence, the second assumption identifies the price of human capital and the first identifies the relative quantities associated with any observed worker characteristics.

Implementation

E_{it} is assumed to be the sum of an initial endowment of human capital and human capital produced through schooling and on-the-job training. For simplicity assume that there is a single observed characteristic - an indicator of whether an individual went to university - that can be regarded as an exogenous input in human capital production and let efficiency units be given by an unobserved endowment plus produced human capital according to:

$$\ln E_{it} = \beta_{0t} + \beta_t Dit + \epsilon_{it} \qquad (3)$$

where β_{0t} is the mean unobserved endowment in the population, D_{it} (= 1 if the individual graduated from university; zero otherwise) is the input in human capital production; β_t is the production function parameter and ϵ_{it} is the idiosyncratic deviation in the unmeasured endowment so that $E\epsilon_{it} = 0$.

From (1) and (3),

$$\ln w_{it} - (\beta_{0t} + \beta_t D_{it}) = \ln\lambda_t + \epsilon_{it}$$

or

$$\ln w_{it} - (b_{0t} + b_t D_{it}) = \ln\lambda_t + \epsilon_{it} + s_{it}$$

where $s_{it} = -\{(b_{0t} - \beta_{0t}) + (b_t - \beta_t)D_{it}\}$ is the term that compensates for difference in substituting unbiased estimates, b_{0t} and b_t, for their true parameter counterparts, due to sampling error. The left-hand-side thus constitutes an estimator for $\ln\lambda_t$ from data on a single individual that differs from the true value by $\epsilon_{it} + s_{it}$ which will have a zero expectation if (i) the sample of ϵ_{it} is a random sample from the population in any period t, and (ii) $Cov(D,\epsilon) = 0$. Clearly a better estimator will follow from averaging over individuals:

$$\ln\lambda_t^* = (1/n_t)\sum[\ln w_{it} - (b_{0t} + b_t D_{it}) = \ln\lambda_t + (1/n_t)\sum\epsilon_{it} + (1/n_t)\sum s_{it} \qquad (4)$$

with

$$\text{plim } \ln\lambda_t^* = \ln\lambda_t$$

since plim $(1/n_t)\sum\epsilon_{it} = 0$ and plim $(1/n_t)\sum s_{it} = -\{\text{plim}(b_{0t} - \beta_{0t}) + \text{plim}(b_t - \beta_t)F_t\} = 0$

where F_t is the fraction of university graduates in the population.

Given observations on wages and the fraction of university graduates, all that is required to implement the estimator is to obtain the unbiased estimators, b_{0t} and b_t. Since λ is unobserved, the β's are not in general identified - i.e. in particular, the mean unobserved endowment β_{0t} is indistinguishable from $\ln\lambda_t$ in any cross section. Consider two identification strategies.

Constant* β*'s

First, suppose that both the mean endowment and the human capital production function are constant over time: $\beta_{0t} = \beta_0$, and $\beta_t = \beta$. Pooling the cross-sections over time yields:

$$\begin{aligned}\ln w_j = {} & (\ln\lambda_1 + \beta_{01}) + [(\ln\lambda_2 + \beta_{02}) - (\ln\lambda_1 + \beta_{01})]Y2_j \\ & + [(\ln\lambda_3 + \beta_{03}) - (\ln\lambda_1 + \beta_{01})]Y3_j + ...+ [(\ln\lambda_T + \beta_{0T}) - (\ln\lambda_1 + \beta_{01})]YT_j \\ & + \beta_1 D_j + (\beta_2 - \beta_1)D_jY2_j + (\beta_3 - \beta_1)D_jY3_j + ... + (\beta_T - \beta_1)D_jYT_j + v_j \\ & j = 1, 2, ..., (n_1 + n_2 + ... + n_T)\end{aligned} \tag{5}$$

where $Y2_j = 1$ if the observation j is from year 2, and Y3 = 1 if the observation j is from year 3, etc. and v_j is the error term for observation j. Imposing the assumption of constant β's and normalizing the first period price to one reduces this to:

$$\ln w_j = \beta_0 + [\ln\lambda_2 - \ln\lambda 1]Y2_j + [\ln\lambda_3 - \ln\lambda_1]Y3_j + ...+ [\ln\lambda_T - \ln\lambda_1]YT_j + \beta_1 D_j + v_j \tag{6}$$

Given the previous assumption on the error terms, OLS applied to this equation will provide consistent estimates for both the constant β's and the log prices in one step.

Technological Change in Human Capital Production: Variable β*'s*

The assumption of constant β's is a strong restriction since it implies that there is no technical change in the human capital production function. It is however commonly implicitly assumed in the standard literature examining relative wages over time. In fact, it is necessary in that literature for identification. Since the efficiency units framework imposes a common price, it is no longer necessary to rule out technical change in human capital production. All that is needed for identification is that the mean unobserved endowment β_{0t} is constant. All time varying (or constant) slopes are identified within each cross section so no restrictions across time are necessary. Imposing only time invariant constant terms gives the following:

$$\ln w_j = \beta_0 + [\ln\lambda_2 - \ln\lambda 1]Y2_j + [\ln\lambda_3 - \ln\lambda_1]Y3_j + ... + [\ln\lambda_T - \ln\lambda_1]YT_j$$

$$+ \beta_1 D_j + (\beta_2 - \beta_1)D_jY2_j + (\beta_3 - \beta_1)D_jY3_j + ... + (\beta_T - \beta_1)D_jYT_j + v_j \quad (7)$$

Again, given the current assumption on the error term, OLS applied to this equation will provide consistent estimates for the log prices, the time invariant constant term and the time varying slopes. The time varying slopes will reflect changes over time in the technology of human capital production and/or selection effects. However, the effects will be a compound of technology changes and cohort effects. Each cohort will be influenced by the human capital production function technology in place at the time the cohort produced the capital. The varying β's will capture the compound of these technology changes and the relative shares of the different cohorts in different calender years.[8]

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[8]An alternative strategy might to use information on AFQT scores for the omitted category to get a series on the beta zeros so that constancy could be relaxed. That is, it is only necessary to know the change in the "endowment" of the reference group. In terms of production function interpretations we have viewed the efficiency units as composed of two parts - an initial endowment and units subsequently produced by schooling. Technical change in the production function changes the schooled groups relative to those with only the basic endowment. However, given endogenous schooling and heterogeneous endowments, things would be complicated by

Endogenous Human Capital and Selection Effects

The assumptions (i) and (ii) are not innocuous. Violation of assumption (i) presents a problem for the wage cyclicality literature that is in essence a composition bias problem due to changing unobservables over the cycle. This is analyzed in detail in Bowlus, Liu & Robinson (2002). A more important problem for the analysis of secular trends is the violation of assumption (ii). Thus far it has been assumed that schooling can be treated as an endowment rather than a variable of choice and that it is uncorrelated with the unobserved part of the total endowment - the assumption Cov(D,ϵ) = 0 has been maintained. If we relax this approach and allow college to be a matter of choice this may result in a violation of the zero covariance assumption.

Suppose there are two sources of (log) efficiency units of human capital, an initial endowment and additional units produced by schooling (college). The endowment is unobserved. Rewrite equation (3) as:

$$\ln E_{it} = \beta_t D_{it} + u_{it} = \beta_{0t} + \beta_t D_{it} + \epsilon_{it} \qquad (3')$$

where u_{it} is the endowment of individual i at time t. In this case $\beta_{0t} = Eu_{it}$ and $\epsilon_{it} = (u_{it} - Eu_{it})$ so that β_{0t} measures the mean in the total population of the endowment. ϵ_{it} is the individual's deviation from this which has zero unconditional expectation for a random sample by construction. In the previous section it was generally assumed that in any period the sample observed in the market would be a random sample of the ϵ_{it} (so the expected value in any sample would be zero) and would have Cov(D,ϵ) = 0. If the fraction of college workers changed between periods it would do so in a way that maintained the zero covariance.

An alternative possibility is that the sample of the ϵ_{it} is not random - the expected value in a sample from boom periods may be lower than for bust periods if the usual composition bias

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schooling choice which could affect the average endowment of the reference group over time.

direction holds for unobservables as well as observables. If this happens in such a way that $Cov(D,\epsilon) = 0$ is not violated in any period, the estimated series will suffer from simple composition bias due to the cyclical effect on the cross section intercepts ($\ln\lambda_t + \beta_{0t}$). The true β_{0t} are the endowment means for the working populations in the relevant years; if these in fact vary over the cycle, the imposition of time invariant β_0 in (6) will cause a composition bias in the prices estimated by the coefficients on the year dummy variables, i.e. these year dummies will pick up the cyclical variation in the endowment means as well as the price variation. The slopes will remain unbiased so a series on the college stock relative to the period 1 mean endowment could still be calculated. Thus, if the working population endowments simply vary cyclically around a fixed total population endowment, secular efficiency units prices and quantity series can still be consistently estimated, but the cyclical series will be inconsistent.[9]

More seriously for an analysis of longer term secular trends, assumption (ii) $Cov(D,\epsilon) = 0$, may be violated even in a random sample from the total population due to the choice process for college. If suitable instruments for college choice were available it would be possible to follow a modified version of BLR. However, the literature on college choice suggests that such instruments are not easy to find. Instead, suppose that for year t, $Cov(D,\epsilon)= k_t$.

[Incomplete]

Having obtained a series on the efficiency units price, a series on the quantity of efficiency units follows simply from dividing total wages by this price. Let total efficiency units in period t be denoted N_t, then

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[9]See Bowlus, Liu & Robinson (2002) for further discussion.

$$N_t = \sum E_{it}h_{it} = \sum w_{it}h_{it}/\lambda_t \qquad (8)$$

where h_{it} is the hours of work of worker i in period t.[10]

3 Estimates of Human Capital Prices for the United States and Canada

The initial estimates of human capital prices abstract from a variety of complications to be considered later. They are computed using the baseline framework outlined in Section 2. The data sources were the 1976-2002 March files of the Current Population Survey (MCPS) for the U.S. and the 1982-1998 Survey of Consumer Finances files (SCF) for Canada. The equations to be estimated are (6) and (7) amended to include a richer list of observed human capital production function “inputs” available in the MCPS and SCF than the single dummy variable to denote a university graduate. For ease of comparison with other literature the primary specification adopted includes as inputs the usual regressors in standard earnings functions, years of schooling and experience. The issue of what regressors should be included and how they should be interpreted is discussed in detail in the Appendix.

United States

The March CPS (MCPS) annual labour incomes are for the year preceding the survey. Prior to the 1976 survey (1975 earnings) reported working hours in the survey could not be related to the previous year’s earnings. The CPS only asks wage and salary incomes for non-self-

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[10] In Bowlus, Liu and Robinson (2001) the concern was to estimate λ_t and N_t free of composition bias over the cycle. Suppose the fraction of non-college workers in the market went up when there was a boom and declined in the bust: if assumption (i) holds, so that the expectation of the mean in the sample of the unobservable endowment deviations from the population mean was always zero, there is only a problem of composition bias in the observed inputs in the human capital production function that is solved by the inclusion of an unbiased estimate of the the $(1/n_t)\sum(b_{0t} + b_tD_{it})$ term in (3), which is done simultaneously for all prices via OLS applied to equations (5) or (6). There may, however, also be a cyclical pattern to the unobserved inputs, violating assumption (i), thus causing a composition bias problem from that source. BLR discuss alternative methods to address this problem for cyclical analysis. We assume here that it is not a major problem for the analysis of long run trends.

employed workers. In the MCPS data, hourly wages can be constructed as the ratio of annual labour income to annual working hours. Annual working hours can be constructed as the product of weeks worked per year and usual hours worked per week for the 1976 survey onward. Prior to this survey year, usual weekly working hours were not recorded and weeks worked were reported in grouped categories. An imputation procedure (Liu, 1999, pp. 54-56) could be used to create a series back to the 1969 survey, but this is not done here. Details on how the data set was constructed are described in the Data Appendix.

In principle, any sub-sample of individuals in the data could be used to estimate (6) and (7), provided it satisfied the assumptions of the baseline framework. Restrictions on the sample were made primarily on the basis of the availability of wage observations and considerations of possible measurement error in these observations. Accordingly the sample was restricted to employees aged 17-65. It also excluded workers who worked less than 50 hours in the year. This restriction drops 17754 out of 1827940 observations - less than 1%.

In Section 2, it was noted that two assumptions are used for identification once technical change and endogenous human capital are permitted. The first is the homogeneous human capital assumption that identifies relative efficiency units across workers; the second is the constancy of the "initial endowment". In practice, there is an issue of identifying individuals possessing only the initial endowment. In theory the individuals with zero schooling might appear to be the obvious choice. However, the compulsory schooling laws make this choice infeasible.[11] In theory the choice should be made on the basis of the group for whom their production of human capital is least affected by technical change in the production function. In practice, we also require that the group is not too small.[12] The approach we have adopted for Canada and the United States is to examine a variety of specifications using zero or low levels of experience and low levels of schooling as the benchmark group.

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[11]Even if there were individuals with zero schooling in the data set, they would be very few, possibly very selected, and would make the estimates very sensitive to the inclusion or exclusion of small numbers of individuals.

[12]See footnote 9. Selection issues, discussed below, may be more of a problem in a group that has a level of schooling that is at the extreme end of the distribution.

The first estimates of prices for the 1975-2001 period are obtained from a constant β's specification for the identification and use a variety of functional forms and regressor lists. They are presented in Table 1. Plots of the price series are given in Figure 1. For all columns the regressors include education, experience and a dummy variable for female. In columns (1) & (2) experience is entered as a quadratic and education is entered in two continuous forms; in column (3) education is represented by a dummy variable set, but experience is still quadratic, and in column (4) experience is also represented by a dummy variable set. Finally, columns (5) & (6) include education-experience interactions, either with a quadratic specification for experience (5) or with dummy variables (6). It is apparent from Table 1 that the estimated price series under the constant β's assumption is insensitive to the functional form variations explored.[13] The time pattern of the price is shown in Figure 1. There is a decline to 1993 and then a partial recovery. The pattern is insensitive to specification. The Table numbers show the efficiency units price declining from 1975 to 1993 by 17-18% . Thereafter there is a partial recovery in the price, but by 2001 it is still 8-10% below the 1975 level.

The constant β's specification is more restrictive than necessary and does not allow for technical change in human capital production or changing selection effects. Table 2 presents the estimates for the price series when this restriction is relaxed. Figure 2 plots the time path. Again a variety of specifications were used. As Figure 2 shows, the time pattern is very similar to the previous estimates. The pattern is insensitive to a variety of specifications.[14] The data in Table 2 show, as in Table 1, a trough in 1993; however, in Table 2 this represents a decline of 20-23% since 1975 compared to the slightly smaller 17-18% for Table 1. Again, there is a partial recovery in the price, so that the decline is reduced to 10-13% by 2001, compared to 8-10% for Table 1. An overall comparison is plotted in Figure 3. The pattern is similar, but freeing up the coefficients over time clearly produce a more dramatic decline during the period of falling price and a faster recovery during the increase in price at the end of the period. Both sets of estimates

[13] In fact many more variations were examined with the same results.

[14] A large variety of specifications were examined. Those presented in Table 2 are typical. All show the same pattern though some specifications - especially involving only a partial freeing up of the coefficients - show a more or less exaggerated form of the pattern.

reflect increases after the recessions in the early 1980s and early 1990s, but also show a strong secular pattern of decline until 1993.

Overall, the estimates strongly suggest a substantial decline in the efficiency units price through most of the period. By itself, this decline in the price would lower wages for workers whose efficiency units stayed the same over the period by the same percentage. Table 3 presents the time path of the actual average hourly wage (column 1), the efficiency units price and the average quantity of efficiency units per worker-hour based on the constant β's specification (columns 2 & 3) and the efficiency units price and the average quantity of efficiency units per worker-hour based on the variable β's specification (columns 4 & 5). The hourly wage declined from \$9.22 in 1975 to lows in the 1981-84 period about \$1.00 lower. Thereafter there is a recovery, and though there was some decline in the early 1990s, the wage had reached \$9.98 by 2001 - an increase of 8.0% over the entire period. The efficiency units price under either specification shows a decline in the price of the labour input over most of the period and a lower price in 2001 than 1975. The hourly wage increase therefore reflects an increase in the number of efficiency units per worker-hour. The increases are apparent in columns 3 & 5. Efficiency units per worker-hour show a small decline to the early 1980s but then increase throughout the period. By 2001 efficiency units per worker-hour were 20% higher than in 1975. Of course, much of this increase would be expected because of increasing average educational attainment. The following Tables examine the changes over time *within* educational attainment groups.

Table 4 shows the efficiency units per worker- hour compared to the hourly wage rate for four schooling groups: 0-11 years, 12 years, 13-15 years, and 16 or more years. For the lowest schooling group, 0-11, hourly wages show the familiar decline, reaching a low of \$5.21 in 1993 compared to \$6.93 in 1975. Thereafter hourly wages increase modestly, but only reach \$5.74 by 2001 - a level that is still 17% below what it was in 1975. Throughout much of the period this decline in wages was due primarily to the decline in the efficiency units price. As late as 1996 the per worker-hour efficiency units were comparable to what they were in 1975.[15] Thereafter, a

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[15]The lowest schooling group, although assumed to be the category with no change in efficiency units produced by their schooling can still experience change in efficiency units because of the other

small decline in efficiency units prevented the wages for this group from rising as fast as the price of efficiency units. The high school graduates fared somewhat better. Wages declined by 15% from \$8.41 in 1975 to a trough of \$7.17 in 1993; the wage thereafter increased to \$7.82 so that by 2001 the level was only 7% less than in 1975. The better wage path is reflected in the efficiency units per worker-hour for this group which increased over the period, though not by enough to offset the negative effect of the declining price.

The post-secondary groups fared better, though it was college graduates that showed a really significant difference. The group with schooling 13-15 had a declining pattern in the wage rate similar to the other groups and also troughed in 1993, but overall fared somewhat better than high school graduates, reaching a level in 2001 that was only 4% below the 1975 level. Again this is reflected in average efficiency units for this group which increased by 7% over the period. The highest schooling group - the college graduates, as is well known, did much better. They also experienced a fairly sharp decline for much of the period, though they reached a trough much earlier than the other groups, and by 2001 this group had an hourly wage of \$15.31 which was 4% above the 1975 level. In particular in the period following the early 1990s recession, the highest schooling group did much better than the others. From 1993 to 2001 the wage growth for this group was 24% compared to only 9% for high school graduates.

The sources of the relative patterns are the movements in efficiency units quantities for the three groups since they all receive the same price per unit by assumption. All groups were affected by the secular decline in the price for the period 1975-1993. This dominated changes in the average efficiency units in each group which actually increased approximately 10% for all but the lowest schooling group. When the price rose after 1993, however, this was augmented by a 7.7% increase in average efficiency units supplied per hour by the highest schooling group, but was partially offset by declines in average efficiency units for the other groups.

In the specification of equation (7) , the unrestricted β_t capture all changes in the relationship between an observed worker characteristic and the number of efficiency units

determinants, including post-school investments.

associated with that characteristic. The changes may have a variety of sources. If all the change in the relationship between observed schooling and average efficiency units in a group was due to technical change in human capital production, the patterns in Table 2 suggest overall technological progress, but faster at higher levels of education in the later period. In fact, the particular pattern of change is probably due to several sources, including selection into the groups. There was a rapid increase in university enrolment in the 1960s and 1970s. If the correlation between initial endowments and university enrolments is positive and "marginal" students were drawn into university during the expansion in enrolment, the schooling coefficient would pick up this selection effect and would decline over the period if it was not outweighed by technological improvement in human capital production. Once the cohort had been absorbed and the selection process stabilized at a new relation between the endowment and university graduation, the effect of the technological change would take over. The pattern for the highest schooling group in Table 2 shows a decline in efficiency units per worker for the university group from the mid 1970s to the early 1980s, followed by an increase. This would be consistent with a dilution of the average quality of university graduates via selection in the early period outweighing the technical change, with consistently positive technological change throughout. This explanation will be examined later for consistency with the Canadian data where the time path and magnitudes of university enrolment have been different from the U.S.

The shares of the schooling groups in both employment and total efficiency units are given in Table 5. The employment shares of the lowest two schooling groups declined while the post secondary groups increased. The changes are substantial. The post secondary group now accounts for over 70% of the total efficiency units in the economy compared to 46% in 1975. with 45% coming from university graduates alone.

For a full explanation of the time path of the labour input price and quantity the demand and supply sides of the market would have to be fully modelled. In Table 6, estimates are presented of the actual prices and quantities under the fixed and variable β's assumptions. Good estimates of the prices and quantities are essential for a full analysis of the behaviour of wages and employment over time. The time paths and magnitudes, however, are also interesting in themselves. A strong quantity increase over the 1975-1993 period is accompanied by a significant price decline. Shifts in the supply curve have therefore been stronger than shifts in demand. The source of the increased supply is in part an increase in the number of workers by 34%, but a very important part is the increase in the number of efficiency units per worker, which was more than 25% over the period. In the 1993-2001 period when the labour price was increasing, the quantity is still increasing, indicating that the supply shifts have weakened relative to demand. Examination of the sources of the supply increase in this period show that the contribution of efficiency units per worker is less important than before. It increases over the period by 7% but this is only about one half of the percentage increase in the number of workers compared to nearly three quarters in the earlier period.

Canada

The Survey of Consumer Finances (SCF) was held every year from 1982 to 1998 except 1984. It is the closest Canadian match to the MCPS. Hourly wages are constructed in the same manner as for the U.S. as the ratio of annual wages and salaries to the product of weeks worked last year and total hours usually worked. While weeks worked last year refers to the same period as wages and salaries, total hours usually worked unfortunately refers to the survey reference week - not to the previous year. This creates some problems for the Canadian data that do not occur in the MCPS. The Canadian data also suffer from comparability problems over time in the education variables. Both these problems and the solutions adopted are discussed in detail in the data appendix.

Table 7 presents the estimates of the efficiency units price for Canada for the period 1981-1997 obtained from a constant β's specification for the identification and using a variety of functional forms and regressor lists. These series are equivalent to those in Table 1 for the U.S. The results show that the price estimates are not very sensitive to the functional form assumptions under the constant β's specification. The time pattern is shown in Figure 5. All the estimated paths are close to one another. They show a strong downward trend to 1985 followed by a short recovery to 1989 and then a further downward trend throughout the 1990s. The pattern is similar to the U.S. up to 1993, but diverges thereafter with U.S. price rising through the rest of the 1990s quite strongly but the Canadian price falling over the same period. In terms of magnitudes, the Canadian price fall is a substantial 12-13% over the 1981-1997 period which is double the fall in the U.S. price over the same period. During the 1993-1997 period when the U.S. price rose by 10%, the Canadian price continued a downward trend.

Table 8 presents the estimates for the cases when technical change in human capital production and changes in selection effects are permitted (time varying β's). These are equivalent to the U.S. series in Table 2. The data in Table are plotted in Figure 6. They show a similar overall pattern to the previous estimates. There is a strong downward trend to 1985 followed by a recovery and then a further downward trend to the end of the period. The effect of freeing up the β's is more apparent in Figure 7 that compares representative estimates from the two specifications (equivalent to Figure 3 for the U.S.). As in the U.S. case, the decline in the early 1980s in the time varying β's specification is more pronounced and the price generally stays lower thereafter than the constant β's specification. However, whereas in the U.S. there is a price recovery in the 1990s during which the two estimated price paths converge, in the Canadian case the price continues to decline and there is no convergence.

Overall, as in the U.S. case there is evidence of cyclical price decline in recessions, but also strong secular trends. In the U.S. case this was downward until the early 1990s followed by a substantial increasing trend. For Canada the secular trend is downward for the whole period. This price decline would, by itself imply lower wages for workers whose efficiency units stayed the same over the period, and indeed, Canadian workers did suffer a decline in wages over the period. In the following Tables this decline is decomposed into the effects due to price and those due to changes in average efficiency units.

Table 9 presents the time path of the actual average hourly wage (column 1), the efficiency units price and the average quantity of efficiency units per worker-hour based on the constant β's specification (columns 2 & 3) and the efficiency units price and the average quantity of efficiency units per worker-hour based on the variable β's specification (columns 4 & 5). The hourly wage was relatively unchanged over the period 1981-1997, declining slightly from \$11.50 in 1981 to \$11.39 in 1997. The efficiency units price under all specifications declined substantially. Under the constant β's specification the price falls by 13%; with the time varying β's specification the price falls by 18%. The relatively flat average hourly wage therefore reflects an increase in average efficiency units per worker. In columns 3 & 5, the average efficiency units per worker-hour are reported under the constant and time varying β's specifications, respectively. Since educational attainment was rising, this increase is not surprising. Of more interest are the implied patterns of efficiency units per worker within educational attainment groups.

Table 10 reports the efficiency units per worker-hour compared to the hourly wage rate for the four schooling groups: less than high school, high school graduates, non-university-post-secondary and university. For all groups there is a real wage decline. The three lowest groups declined by 6.2 - 7.8%. Unlike the U.S., the highest education group also declined, and in fact this group had the largest decline of 9.3%. The reason for this difference is two-fold. The increase in efficiency units per worker-hour for the university graduate group rose relatively slowly in Canada compared to the U.S. - 10% vs. 30%. In addition, the price decline in Canada was stronger than the price decline in the U.S. - 18% vs. 9%.

Relative wages in Canada also show a different pattern from the U.S. As is well known, the large widening of the gap between university graduates and high school graduates observed in the U.S. did not occur in Canada. The estimates in Tables 4 and 10 indicate that this was due to the much smaller increase in efficiency units per worker-hour for the university graduate group in Canada compared to the U.S. A cohort analysis may shed light on the reasons for this difference.

4 A Further Examination of Technical Change and Endogenous

Schooling.

The varying β's specification provides indirect estimates of technical change in human capital production and the effects of endogenous schooling, but the precise effects are complicated by cohort effects in the standard repeated cross section analysis of Section 3. This is not an important issue for identifying prices and quantities of efficiency units, but is an important issue for identifying the precise nature of the technology changes and/or selection effects. This is examined further by re-estimating the price series using a cohort approach. In this approach, the time varying β's specification for the education variables reduces to fixed β's for each cohort, but varying β's across cohorts.

[Incomplete]

5 The Contribution of Post-Secondary Education Systems to the Stocks of Human Capital in Canada and the United States

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6 Conclusions and Future Work

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REFERENCES

[Incomplete]

Table 1: Price of Efficiency Units of Labour (Restrictive Specification); U.S. 1975-2001.

Year	(1)	(2)	(3)	(4)	(5)	(6)
1975	1	1	1	1	1	1
1976	1.01	1.012	1.012	1.012	1.012	1.012
1977	1.012	1.013	1.014	1.014	1.014	1.015
1978	1.003	1.005	1.006	1.007	1.006	1.008
1979	.982	.984	.986	.987	.986	.987
1980	.937	.939	.94	.943	.94	.943
1981	.91	.911	.913	.916	.913	.916
1982	.891	.891	.893	.896	.893	.896
1983	.884	.884	.886	.889	.885	.89
1984	.875	.876	.877	.881	.877	.882
1985	.883	.883	.885	.889	.885	.89
1986	.895	.896	.898	.902	.898	.904
1987	.891	.891	.893	.896	.892	.898
1988	.891	.89	.892	.896	.892	.897
1989	.885	.884	.886	.891	.886	.892
1990	.866	.865	.866	.871	.866	.873
1991	.848	.85	.85	.855	.85	.857
1992	.836	.837	.837	.843	.837	.845
1993	.824	.824	.824	.831	.824	.832
1994	.833	.833	.833	.841	.833	.842
1995	.826	.826	.826	.834	.827	.836
1996	.832	.834	.833	.841	.834	.843
1997	.849	.85	.85	.858	.85	.86
1998	.872	.874	.873	.882	.874	.885
1999	.883	.884	.884	.893	.886	.896
2000	.901	.901	.901	.91	.903	.913
2001	.905	.904	.904	.914	.907	.917

Table 2: Price of Efficiency Units of Labour (Time Varying Coefficients); U.S. 1975-2001.

Year	(1)	(2)	(3)	(4)
1975	1	1	1	1
1976	1.012	1.013	1.013	1.013
1977	1.014	1.015	1.015	1.016
1978	1.043	1.04	1.041	1.035
1979	1.022	1.019	1.021	1.015
1980	.976	.975	.975	.971
1981	.913	.919	.911	.902
1982	.895	.901	.893	.884
1983	.887	.895	.886	.878
1984	.831	.843	.819	.819
1985	.838	.85	.826	.826
1986	.851	.863	.838	.839
1987	.849	.848	.84	.824
1988	.848	.848	.84	.824
1989	.842	.843	.834	.819
1990	.827	.825	.838	.811
1991	.811	.809	.821	.796
1992	.799	.798	.809	.785
1993	.78	.772	.799	.765
1994	.788	.78	.807	.774
1995	.782	.774	.8	.768
1996	.81	.793	.826	.786
1997	.826	.808	.843	.802
1998	.849	.831	.866	.824
1999	.879	.856	.895	.854
2000	.896	.873	.912	.87
2001	.899	.876	.916	.874

Table 3: Hourly Wages, Efficiency Units Price and Efficiency Units per Worker Hour; U.S. 1975-2001.

Year	Wage	Price(F)	Units(F)	Price(V)	Units(V)
1975	9.221	1	9.221	1	9.221
1976	9.261	1.01	9.17	1.012	9.152
1977	9.237	1.012	9.128	1.014	9.11
1978	9.217	1.003	9.19	1.043	8.837
1979	8.966	.982	9.13	1.022	8.773
1980	8.465	.937	9.034	.976	8.673
1981	8.211	.91	9.023	.913	8.993
1982	8.208	.891	9.212	.895	9.171
1983	8.26	.884	9.344	.887	9.312
1984	8.205	.875	9.377	.831	9.874
1985	8.374	.883	9.483	.838	9.992
1986	8.6	.895	9.609	.851	10.106
1987	8.608	.891	9.661	.849	10.139
1988	8.574	.891	9.623	.848	10.111
1989	8.601	.885	9.719	.842	10.215
1990	8.484	.866	9.796	.827	10.258
1991	8.407	.848	9.914	.811	10.366
1992	8.374	.836	10.017	.799	10.481
1993	8.368	.824	10.156	.78	10.728
1994	8.549	.833	10.262	.788	10.848
1995	8.796	.826	10.648	.782	11.248
1996	8.847	.832	10.633	.81	10.922
1997	9.11	.849	10.731	.826	11.03
1998	9.375	.872	10.752	.849	11.043
1999	9.477	.883	10.733	.879	10.782
2000	9.841	.901	10.923	.896	10.984
2001	9.976	.905	11.024	.899	11.097

Table 4: Hourly Wages, Efficiency Units Price and Efficiency Units per Worker-Hour by Education: U.S. 1975-2001

Year	Price	ED < 12		ED = 12		12 < ED <16		ED = 16+	
		Wage	Units	Wage	Units	Wage	Units	Wage	Units
1975	1	6.931	6.931	8.409	8.409	9.483	9.483	14.743	14.743
1976	1.012	7.068	6.984	8.431	8.331	9.359	9.248	14.666	14.492
1977	1.014	6.921	6.826	8.529	8.411	9.282	9.153	14.481	14.281
1978	1.043	6.888	6.604	8.521	8.17	9.259	8.878	14.024	13.446
1979	1.022	6.792	6.646	8.263	8.085	9.027	8.832	13.404	13.115
1980	.976	6.396	6.554	7.834	8.027	8.614	8.826	12.314	12.617
1981	.913	6.238	6.832	7.603	8.328	8.337	9.132	11.684	12.798
1982	.895	6.048	6.757	7.572	8.46	8.175	9.134	11.676	13.046
1983	.887	6.044	6.814	7.486	8.44	8.165	9.205	12.003	13.532
1984	.831	5.924	7.128	7.467	8.986	8.102	9.75	11.854	14.265
1985	.838	5.911	7.053	7.475	8.92	8.314	9.922	12.28	14.654
1986	.851	5.988	7.037	7.618	8.952	8.511	10.002	12.688	14.91
1987	.849	5.913	6.964	7.629	8.986	8.555	10.077	12.65	14.9
1988	.848	5.881	6.936	7.597	8.958	8.517	10.044	12.419	14.645
1989	.842	5.729	6.804	7.546	8.962	8.558	10.164	12.601	14.966
1990	.827	5.615	6.789	7.334	8.868	8.396	10.152	12.58	15.212
1991	.811	5.533	6.822	7.283	8.98	8.198	10.109	12.303	15.17
1992	.799	5.422	6.786	7.233	9.052	8.046	10.07	12.227	15.303
1993	.78	5.213	6.684	7.169	9.191	8.022	10.284	12.343	15.824
1994	.788	5.36	6.802	7.228	9.173	8.052	10.218	12.722	16.145
1995	.782	5.359	6.853	7.277	9.306	8.309	10.626	13.293	16.999
1996	.81	5.574	6.882	7.415	9.154	8.372	10.336	13.154	16.24
1997	.826	5.566	6.739	7.579	9.176	8.483	10.27	13.755	16.653
1998	.849	5.6	6.596	7.702	9.072	8.767	10.327	14.107	16.616
1999	.879	5.579	6.347	7.782	8.853	8.9	10.125	14.141	16.088
2000	.896	5.623	6.276	7.729	8.626	8.992	10.036	15.323	17.102
2001	.899	5.742	6.388	7.818	8.696	9.109	10.133	15.311	17.031

Table 5: Fraction of Total Efficiency Units and Employment by Education: U.S. 1975-2001

Year	ED < 12		ED = 12		12 < ED < 16		ED = 16+	
	Workers	Units	Workers	Units	Workers	Units	Workers	Units
1975	.261	.1778	.4074	.365	.1718	.168	.1599	.2891
1976	.2574	.1793	.404	.3634	.1751	.1681	.1634	.2891
1977	.2504	.1699	.404	.3702	.1819	.1749	.1637	.2849
1978	.2335	.158	.407	.3718	.189	.1834	.1705	.2868
1979	.2261	.155	.4101	.3745	.1907	.1869	.1732	.2837
1980	.214	.1442	.4184	.3811	.1914	.1899	.1762	.2848
1981	.2066	.1394	.418	.3837	.192	.1882	.1835	.2887
1982	.1915	.1237	.4112	.3717	.2007	.192	.1966	.3126
1983	.1854	.1184	.4134	.3688	.2009	.1933	.2003	.3195
1984	.1812	.114	.4098	.3677	.2072	.1971	.2019	.3213
1985	.1726	.1052	.4113	.3596	.2095	.2029	.2066	.3323
1986	.1709	.1022	.4056	.3501	.2123	.2045	.2112	.3432
1987	.1702	.1007	.4044	.3519	.2111	.2043	.2143	.3431
1988	.165	.0968	.4012	.3497	.213	.2064	.2207	.347
1989	.1595	.0897	.4006	.3463	.2172	.2118	.2226	.3522
1990	.1532	.0873	.3996	.3424	.2229	.217	.2243	.3534
1991	.1438	.0786	.3561	.3059	.2764	.2608	.2237	.3547
1992	.136	.0721	.3451	.2932	.288	.2684	.2309	.3663
1993	.1351	.0695	.3339	.2792	.2972	.2761	.2339	.3753
1994	.1341	.0688	.3273	.2737	.2972	.2714	.2413	.3861
1995	.136	.068	.3231	.2659	.2959	.2696	.245	.3966
1996	.1349	.0684	.3291	.2681	.2919	.2674	.2441	.3961
1997	.1347	.0682	.3254	.2616	.2906	.2632	.2493	.407
1998	.1319	.0641	.3211	.2549	.2909	.261	.2561	.42
1999	.1301	.0615	.314	.2477	.2962	.2696	.2596	.4211
2000	.1283	.0596	.3109	.2416	.2964	.263	.2644	.4358
2001	.1282	.0611	.3054	.2328	.2935	.2576	.273	.4485

Table 7: Estimates of the Price of Efficiency Units of Labour: Canada 1981-1997

Year	(1)	(2)	(3)	(4)	(5)	(6)
1981	1	1	1	1	1	1
1982	.963	.962	.962	.963	.961	.963
1983	.	.	.	.	.	.
1984	.931	.931	.931	.933	.93	.932
1985	.92	.922	.922	.924	.92	.923
1986	.906	.91	.91	.911	.908	.91
1987	.913	.915	.914	.915	.913	.915
1988	.921	.925	.924	.926	.922	.925
1989	.915	.921	.91	.912	.907	.912
1990	.926	.932	.922	.924	.919	.924
1991	.905	.91	.901	.903	.898	.903
1992	.904	.909	.9	.903	.898	.903
1993	.887	.892	.882	.885	.879	.885
1994	.885	.89	.878	.88	.875	.88
1995	.874	.879	.868	.872	.866	.871
1996	.881	.885	.873	.876	.87	.876
1997	.874	.879	.866	.87	.864	.87

Table 8: Price of Efficiency Units of Labour (Time Varying Coefficients): Canada 1981-97

Year	(1)	(2)	(3)	(4)
1981	1	1	1	1
1982	.962	.963	.962	.964
1983	.	.	.	.
1984	.876	.892	.86	.866
1985	.866	.883	.85	.858
1986	.854	.87	.839	.845
1987	.9	.893	.909	.884
1988	.91	.903	.919	.894
1989	.896	.89	.904	.882
1990	.891	.885	.898	.861
1991	.871	.866	.878	.842
1992	.87	.865	.877	.842
1993	.87	.864	.852	.806
1994	.867	.86	.848	.802
1995	.857	.852	.839	.794
1996	.827	.829	.828	.79
1997	.822	.823	.822	.785

Table 9: Hourly Wages, Efficiency Units Price and Efficiency Units per Worker-Hour: Canada 1981-1997

Year	Wage	Price(F)	Units(F)	Price(V)	Units(V)
1981	11.498	1	11.498	1	11.498
1982	11.338	.963	11.774	.962	11.786
1983	.	.	.	.	.
1984	11.161	.931	11.988	.876	12.741
1985	11.346	.92	12.333	.866	13.102
1986	11.289	.906	12.461	.854	13.219
1987	11.256	.913	12.329	.9	12.507
1988	11.325	.921	12.296	.91	12.445
1989	11.415	.915	12.475	.896	12.74
1990	11.631	.926	12.56	.891	13.054
1991	11.393	.905	12.589	.871	13.08
1992	11.668	.904	12.907	.87	13.412
1993	11.453	.887	12.912	.87	13.164
1994	11.41	.885	12.892	.867	13.16
1995	11.264	.874	12.888	.857	13.144
1996	11.503	.881	13.056	.827	13.909
1997	11.385	.874	13.027	.822	13.851

Notes

Table 10: Hourly Wages, the Efficiency Units Price and Efficiency Units per Worker-Hour: Canada 1981-1997

Year	Price	ED < 12		ED = 12		12 < ED < 16		ED = 16+	
		Wage	Units	Wage	Units	Wage	Units	Wage	Units
1981	1	9.98	9.98	10.811	10.811	12.053	12.053	16.24	16.24
1982	.962	9.929	10.321	10.584	11.002	11.873	12.342	15.529	16.143
1983	.	.	.	.	.	.	.	.	.
1984	.876	9.801	11.188	10.013	11.431	11.71	13.368	15.42	17.603
1985	.866	9.774	11.286	10.192	11.768	11.797	13.623	15.94	18.407
1986	.854	9.81	11.487	10.163	11.901	11.769	13.782	15.298	17.914
1987	.9	9.813	10.904	10.373	11.526	11.364	12.627	15.16	16.845
1988	.91	9.788	10.756	10.466	11.501	11.597	12.744	14.996	16.479
1989	.896	9.744	10.875	10.446	11.659	11.267	12.575	15.547	17.352
1990	.891	9.996	11.219	10.591	11.886	11.762	13.201	14.87	16.69
1991	.871	9.615	11.039	10.11	11.607	11.227	12.889	15.296	17.562
1992	.87	9.684	11.131	10.458	12.021	11.531	13.254	15.301	17.587
1993	.87	9.859	11.333	10.244	11.775	11.228	12.906	14.781	16.99
1994	.867	9.784	11.285	10.067	11.611	11.165	12.878	14.663	16.912
1995	.857	9.591	11.192	10.014	11.685	11.191	13.058	14.157	16.519
1996	.827	9.282	11.224	10.202	12.336	10.994	13.294	15.239	18.426
1997	.822	9.361	11.388	9.993	12.157	11.111	13.517	14.728	17.917

Notes

Table 11: Fraction of Total Efficiency Units and Employment by Education: Canada 1981-1997

Year	ED < 12		ED = 12		12 < ED < 16		ED = 16+	
	Workers	Units	Workers	Units	Workers	Units	Workers	Units
1981	.368	.3246	.2648	.2462	.239	.2396	.1282	.1896
1982	.3547	.3034	.2676	.2476	.2409	.2419	.1368	.2071
1983	.	.	.	.	.	.	.	.
1984	.3341	.2927	.2672	.2392	.2525	.2475	.1461	.2205
1985	.3161	.2684	.2664	.2422	.2687	.2628	.1488	.2266
1986	.3045	.26	.2695	.2447	.2703	.2631	.1557	.2322
1987	.3008	.2543	.2584	.2369	.2788	.2672	.1619	.2417
1988	.2895	.2416	.2643	.2474	.2843	.2765	.1619	.2345
1989	.2374	.1917	.2349	.2123	.3638	.3544	.164	.2417
1990	.2264	.1813	.2383	.2157	.3591	.3532	.1762	.2499
1991	.207	.1627	.2399	.2121	.3643	.3467	.1887	.2785
1992	.192	.1455	.2389	.2153	.3707	.3525	.1985	.2867
1993	.1927	.155	.228	.2027	.3787	.3595	.2006	.2829
1994	.1795	.1397	.2203	.1941	.3903	.3696	.2099	.2966
1995	.1778	.1412	.2251	.1991	.3872	.3693	.2099	.2904
1996	.1625	.125	.2088	.1848	.4042	.3778	.2244	.3124
1997	.1595	.1223	.2138	.1892	.4076	.3881	.2191	.3004

DATA APPENDIX

The annual wage and salaries earnings data are from the unicom variable _incwag, derived from the original MCPS incwag (income from wage and salary). The definition is as follows:

Money wages or salary is defined as total money earnings received for work performed as an employee during the income year. It includes wages, salaries, Armed Forces pay, commissions, tips, piece-rate payments and cash bonuses earned, before deductions are made for bonds, pensions, union dues, etc. Earnings for self-employed incorporated businesses are considered wage and salary.

Thus, this variable would be zero for example, for someone who worked as unincorporated self-employed for the whole year. Top coding is applied to earnings in a variable way. For _incwag, top values were $50,000 for the 1976-1981 surveys, $75,000 for the 1982-1984 surveys, $99,999 for the 1985 - 1988 surveys. The topcoding flag for these surveys is tpcdws. After the 1988 survey, according to unicom, the top coding is $199,998 for the 1989 - 1995 surveys, but variable thereafter. Top coding is explicitly taken into account in the analysis. The hours data come from the MCPS variable hrslyr (hours worked per week last year) and the unicom variable _wkslyr derived from the MCPS wkslyr (weeks worked last year).

Hourly wages are constructed as the ratio of annual wages and salaries (wagsal) to the product of weeks worked last year (wkswrk, 1981-89, wkswrkyr, 1990-97) and total hours usually worked (hrswrk, 1981-89, ushours, 1990-97). While weeks worked last year refers to the same period as wages and salaries, total hours usually worked unfortunately refers to the survey reference week - not to the previous year.

[Incomplete]