Internal and External Wage Effects Associated with a Changing Share of College Graduates

A Thesis Submitted to the College of

Graduate Studies and Research

in Partial Fulfillment of the Requirements

for the Degree of Master of Arts

in the Department of Economics

University of Saskatchewan

Saskatoon

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ABSTRACT

The main objective of this research is to estimate internal and external wage effects associated with a changing share of college graduates in Canada. This paper uses data drawn from the Canadian 1991, 1996, and 2001 Public Use Microdata File for 25 to 65 years old individuals working full-time and full-year in metropolitan areas. These workers are then separated into four different levels of education groups in order to estimate the effect of change in the share of college-educated workers on their earnings.

The *Ordinary Least Squares* (OLS) estimates, controlling for potential work experience, total years of schooling, individual occupation, employment industry, immigration status, visible minority status, show a significant positive relationship between the percentage change of the share of college-educated workers and the percentage change of individuals' real weekly wage rates. We found that one percentage point increase in a census metropolitan area's share of college-graduated workers was associated with a 0.35 percentage change in all workers' wage rates in that city. For separated education groups, our results showed that a one percentage expansion in the supply of college-graduated workers raised less than high schools' wage rate by 0.245 percent, raised high-school graduates' wage rate by 0.363 percent, raised more than college-educated workers' wage rate by 0.385 percent, and raised college-educated wage rate by 0.326 percentage. These results are consistent with the conclusion arrived at by E. Moretti, (2004) that all types of workers' earnings increased when a city's share of college graduates rose.

ACKNOWLEDGMENTS

This thesis would not have been possible without the support of many people. First and foremost, I would like to thank my supervisor, Professor Mobinul Huq who gave me support and guidance throughout the preparation of this paper. Also thanks to my committee members, Professor Cristina Echevarria, Professor Eric Howe and Rosemary Venne who kindly read this draft and advised me.

I express my gratitude to my family who have provided me with encouragement and support. Thanks to my dear husband, Wei who has been assisted me with data management and has been most supportive. Thanks to my parents who have always believed in me, and have given me confidence to challenge myself.

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Chapter One

Introduction

Since Adam Smith (1776) first posited that the social return of education might exceed the private return, thousands of studies have addressed this topic. Based on those papers' results, governments began to invest in education in many different ways. Some examples of these would be education saving grants, student loans, government scholarships, tuition fee subsidies and research funding. According to a 2001 Canadian government report, that year Canadian governments as a whole spent 15% of their total expenditures on education (http://www.statcan.gc.ca/english/freepub/81-582-XIE/2003001/highlights.htm). The magnitude of this number motivates us to more closely consider the economists' research conclusions. Basically there are two stream education effects on wages: internal and external effects. Education can bring significant return not only at the private level but also at the social level. Private return comprises the costs and benefits to the individual and is clearly net of any transfers from the state and any taxes paid. Earning is the key point for private return from education. Social return (or external return) is total return minus private return. The definition of the external return to education as proposed by Acemoglu and Angrist (2000) and Moretti (2004), and which I am going to follow in this paper is that the external return to education is the total wage effect due to the share of educated workers in a city minus the effect due to private returns to education. Education generates social benefits most prominently in areas involving civic behavior and attitude. Some examples of social benefits are reduced crime, stabilized democratic society, and enlarged voter groups. Other benefits include increased quality of civic knowledge, promotion of knowledge spillovers, and accelerated technology diffusion in the workplace. In addition a mother's education level has a positive effect on her children's education levels. Empirical results indicate that people with high level of education have fewer children who become teenage parents.

Although education unarguably spawns all of these and other benefits, the gross domestic product (GDP) of Canada is growing slowly. Expenditure on education cannot increase unendingly, and policy-makers face competing demands from several levels of education programs for scarce education funds. The major issue is how to allocate government spending on the wide variety of education programs, and how such expenditures can bring the best result both to the individual and to the society. This paper will focus on finding the internal and external wage effects associated with a changing share of college graduates, and will attempt to use those results to answer the challenges posed in the preceding paragraph.

This paper, "Internal and External Wage Effects Associated with a Changing Share of College Graduates," uses data drawn from the Canadian 1991, 1996, and 2001 Public Use Microdata File of Individuals. To avoid the inflation problem, 1991 was used as the base year. Statistics Canada data were used to calculate the relative price levels in 1996 and 2001. The selection group for this paper was the full-time full-year labor force living in Census Metropolitan Areas (CMAs) and was drawn from those aged 25 to 64, inclusive. These workers were then separated into four different levels of education groups in order to estimate the effect of change in the share of college-educated workers on the logarithm weekly wage rate. Logarithm weekly wage rate was chosen for my dependent variable. The independent variables were: potential work experience, total years of schooling, individual occupation, employment industry, immigration status, visible minority status, and share of college-educated workers in a CMA. Other further variables can illuminate wage rate, e.g., unobserved individual ability and individual cities' characteristics. However, it is difficult to ascertain a way to measure unobserved individual ability. Further, the Roy model of self-selection demonstrated that "unobserved individual ability does not play a major role in explaining the relationship between wages and college share," so the first assumption of this paper is that there is no unobserved individual ability. The second assumption is that the labor force in Canada is fixed.

The *Ordinary Least Squares* (OLS) estimates show a significant positive relationship between the percentage change of the share of college-educated workers and the percentage change of individuals' real weekly wage rates. Based on these data calculations, the empirical result is that the percentage of expansion in the supply of college-graduated workers raises the less than high school wage rate by 0.245%, raises the high-school graduate wage rate by 0.363%, raises the more than college-educated worker wage rate by 0.326%, and raises the college-educated wage rate by 0.385%. These results are consistent with the conclusion arrived at by E. Moretti, (2004). In his paper "Estimating the Social Return to Higher Education: Evidence from Longitudinal and Repeated Cross-sectional Data," he used evidence contained in US data files to support his claim that a positive relationship existed between the percentage change of college graduates and wage rate. All types of workers' earnings increased when a city's share of college graduates rose.

The outline of this paper is as follows. The second chapter discusses theoretical framework of this paper and indicates why the variables were chosen. Chapter 3 describes the data and variables used in the estimation, as well as the variables that were derived from the census were brought to the final equation variables. The fourth chapter presents the empirical results, wherein three different data sets were used to prove the conclusions, and the final section comprised the concluding remarks.

Chapter Two

Methodology

This chapter discusses the theoretical framework of this paper and indicates why the variables were chosen. I will begin by presenting the standard wage function, namely, *The Mincer Human Capital Earnings Equation* (hereafter *Mincer Equation*). By using the Roback Model, I will explain why cities' characteristics should be included in the human capital wage equation, more specifically, why there is a positive relationship between education level and worker's wage rate. Furthermore, by using Cobb-Douglas production function, I will describe why there is a positive effect of share of educated worker on the wages of unskilled workers.

2.1 Mincer Human Capital Earnings Equation

Mincer Equation is one of the most successful empirical equations for the purpose of explaining individual (logged) wages depending on years of schooling and personal work experience. The Mincer Equation states that, if every person retires at the same age, additional period of school reduces an individual worker's earning life. Education, just like any other types of investment, is costly both in terms of time and money. These investments are not undertaken unless education brings benefits in the form of higher earnings. In other words, education should be used as a factor in deciding a worker's wage, and the rate of return on education should be positive.

The derivation of the standard earnings function can be written in the following way. Assume that the wage of an individual who has zero years of schooling is W_0. With ψ rate of return from schooling, his/her earning after one year of schooling can be written as:

$$W_1 = (1+\psi)W_0 \tag{2.1}$$

Assuming that the rate of return from schooling remains the same for different levels of education, earnings after t years of schooling can be written as:

$$W_t = (1+\psi)^t W_0 \tag{2.2}$$

Calculating the natural logarithms of both sides, the human capital earnings function is given by:

$$\ln W_t = t\ln(1+\psi) + \ln W_0 \tag{2.3}$$

When ψ is a small number, $\ln(1+\psi)$ approximately equals ψ. With $\ln W_0$ always remaining a constant number, equation (3.3) now is:

$$\ln W_t = \alpha + \psi t \tag{2.4}$$

The standard model is extended by adding on-the-job training and expressing wage as a quadratic function of work experience (EXP):

$$W = f(SCH, EXP) \tag{2.5}$$

$$\ln W = \alpha_0 + \alpha_1 SCH + \alpha_2 EXP + \alpha_3 EXP^2 \tag{2.6}$$

where α_1 measures the rate of return to education. The coefficient on work experience also can be interpreted as the rate of return to labour market experience, and α_3 shows the changing rate of return to work experience.

2.2 City Amenities and Wages

"The empirical work on wage shows that the regional wage difference can be explained largely by these local attributes" observed Roback (1988), who went on to state that "city education level is one of the local attributes." To understand why city average education level can affect an individual's wage rate, I will now use the Roback Model to explain that equilibrium exists when cities' amenities are different. The following part will use two figures to demonstrate the wage differences for both high educated worker and low educated worker. The first figure—figure 2.1 will illustrate the effects of an increase in average education level that is driven by a shift of more supply of educated workers because educated workers value the amenity. The second figure—figure 2.2 will depict the effects of an increase in average education level that is driven by a rising demand for high educated worker. Additionally, the left-hand side of each figure depicts the market for high educated workers while the right-hand side depicts the market for low educated workers. For simplicity, assume: (1) there are two cities, A and B; (2) there are two types of goods, nationally traded goods (composite good y) and locally traded goods (land h). Since y is nationally traded, y's price is the same; let it be 1. Land cost (let it be p) is varied cross the cities; however, we assume in the same city, each worker spends the same amount of money for land; (3) there are two types of workers, high educated workers (or skilled workers) and low educated workers (or unskilled workers). Workers and firms are perfectly mobile, which means that workers' utilities are identical in different cities. Workers maximize their utility subject to their budget constraints, where income depends on the wage rate (w), by making the choice between y, h, and city amenity v. When workers have equal utility and firms have equal costs in all cities, equilibrium exists.

In the figures (figures 2.1 and figures 2.2), the horizontal exes depict worker's wage rate, and the vertical exes depict city land price which indicated by renting price in this paper. Different wage and land rent combinations that generate a same satisfaction level for a worker is shown by indifference curves (U). Workers always prefer higher wages and lower rent which leads to an upward sloping indifference curve. When a higher level of amenity is positively valued by a worker, the utility curve corresponding to a fixed level of satisfaction will shift inward with an increase in v. An isocost curve (C curve) that shows equal cost of production of one unit of a good with different combinations of wages and land rent. Negative slope of a C curve implies that for a firm a higher wage needs to be compensated by a lower land rent to keep the cost constant. A city with lower labour and/or land requirement, for example due to spillover effect, will result in an outward shift in the C curve. The market clearing outcome will be reached at the intersection of the firm's cost functions and individual worker's utility functions. In the Figures the equilibriums for city A are shown by E_{AH} and E_{AL} for workers with higher and lower levels of education respectively, and for city B are shown by E_{BH} and E_{BL}.

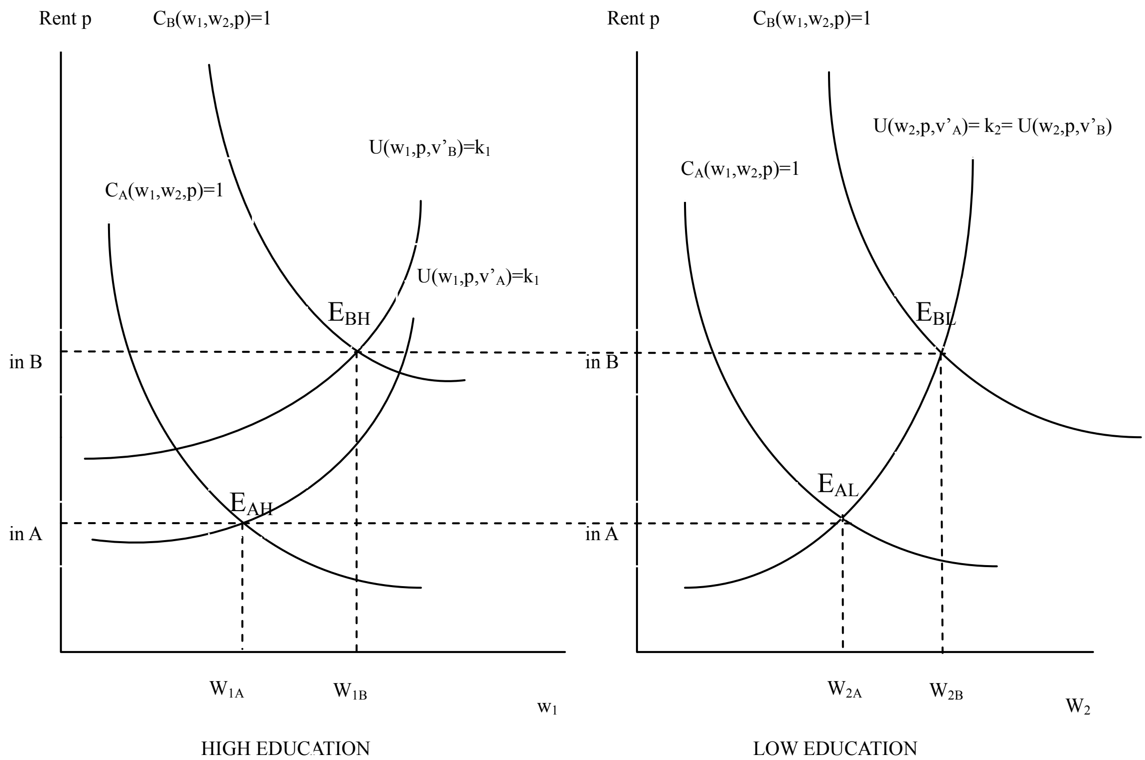

Figure 2.1 Equilibrium wages of educated and uneducated workers and rent when amenities differ across cities

Figure 2.1 shows that assume city B has a higher amenity level than city A ($v_B > v_A$), when educated workers value the amenity while uneducated workers do not, an increase in the supply of educated-workers, say city B, will lead to a higher education level than city A. In other words, skilled workers are willing to sacrifice wages for amenities, the consequent decrease in wages of skilled workers increases demand (wages) for unskilled workers which further decreases the wages for skilled workers, this change will cause the utility curve to shift inward in the left panel. Further more, because of spillover effect the cost of production in city B will be lower than that in city A, which will result in an outward shift in the C curves. The new market clearing points are shown by E_{BH} and E_{BL} for workers with higher and lower levels of education respectively. From a market-clearing point we can say that the low-education worker makes more money in a higher amenity city; however, this might not be the truth for the high educated worker. If the additional spillover effect is not high enough, skilled workers might have to sacrifice part of their incomes for the better amenity (so what shows on part one of Figure 2.1 could be $w_{1A} > w_{1B}$).

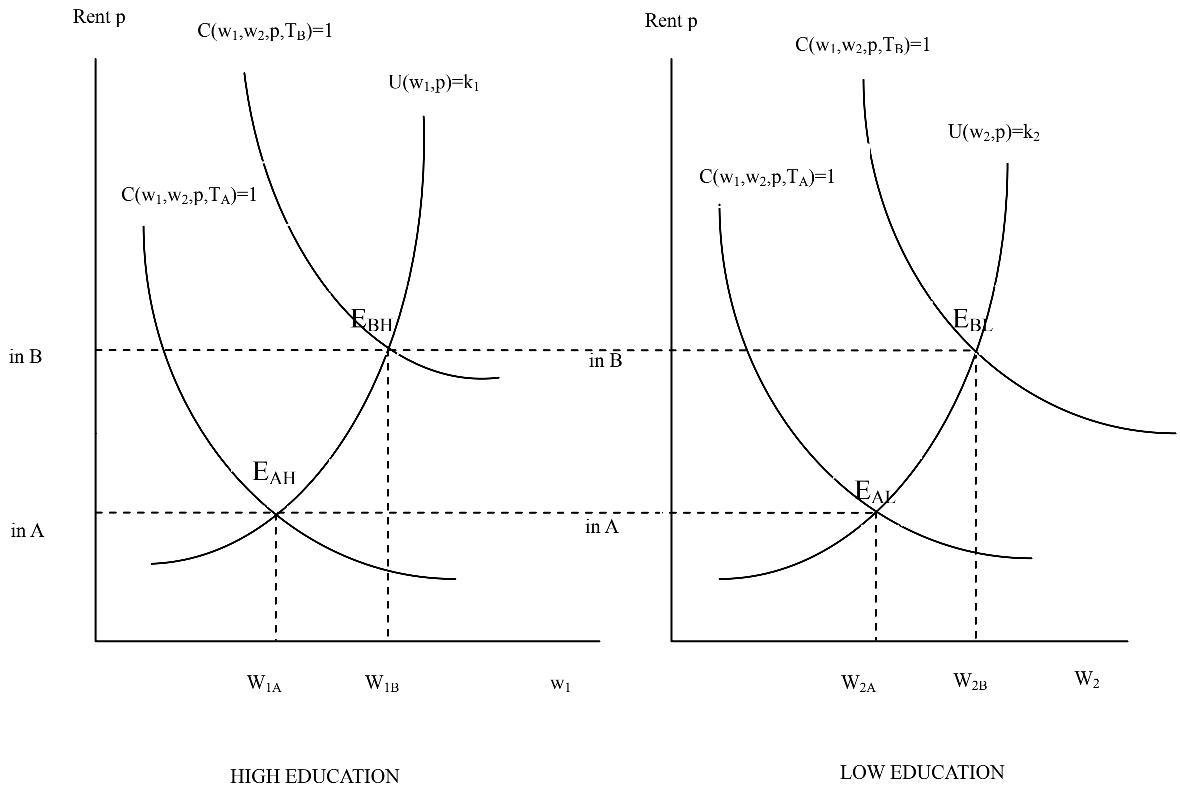

Figure 2.2 Equilibrium wages of educated and uneducated workers and rent when technology differs across cities

Now turn to the situation where a rising demand for high educated worker causes cities average education levels increase. In figure 2.2, cities have the same amenities but different technology levels ($T_B > T_A$). Skilled workers are more productive in city B and city B needs more skilled workers. The new market-clearing points for both skilled and unskilled workers are higher than before. Demand shift of skilled worker raises all workers' wage rates.

In summing up these two circumstances—that is, when education level increases in a city and the low-educated worker's wage faces a positive jump—the effects caused by changing of the educated worker's wage is not so clear. If the additional spillover is strong enough, the skilled worker is going to receive a higher wage. Cities' amenities differences have different effect on different education groups of workers' wage rates. Meanwhile, technology differences bring the same direction changes on all education groups of workers' wage rates. When education is considered, the change in proportion of skilled worker in a city will affect all workers' wage rates.

The model can be interpreted as the effects of an increase in the number of college graduates in the same city, if we consider a larger number of graduates an amenity.

2.3 City Density of Skilled Worker and Wages

I will now clarify the reason how the density of college graduated workers in a city has influence on not only educated workers' wage but also on uneducated workers' wage by using Cobb-Douglas function. We assume that spillovers (external effects) exist. For simplicity we assume there is a Cobb-Douglas economy wherein exists only two types of workers — skilled and unskilled:

$$Q = (\theta_1 N_1)^{\alpha_1} (\theta_2 N_2)^{\alpha_2} K^{1-\alpha_1-\alpha_2} \tag{2.7}$$

where $0 < \alpha_1 < 1$, $0 < \alpha_2 < 1$, and $0 < \alpha_1 + \alpha_2 < 1$; N_1 is the number of skilled workers and N_2 is the number of unskilled workers in the city; θ_1 and θ_2 are productivity shifters; and K is total stock of capital. Let workers' productivity depend on density of college graduated worker and workers' own human capital:

$$\ln(\theta_i) = \phi_i + \lambda(\frac{N_1}{N_1 + N_2}) \qquad i=1,2 \qquad (2.8)$$

where ϕ_i is group i's own human capital effect on productivity ($\phi_1 > \phi_2$) and $\frac{N_1}{N_1 + N_2}$ represents share of college graduated workers or share of skilled workers in the city. If $\lambda = 0$, the model is the Mincer Equation without spillovers. If $\lambda > 0$, spillovers exist.

From (2.7) we know that:

$$W_1 = \frac{\partial Q}{\partial N_1} = \frac{\alpha_1}{N_1}(\theta_1 N_1)^{\alpha_1}(\theta_2 N_2)^{\alpha_2} K^{1-\alpha_1-\alpha_2} \qquad (2.9)$$

By calculating the logarithm of (2.9) we have:

$$\ln W_1 = \ln\alpha_1 - \ln N_1 + \alpha_1 \ln\theta_1 + \alpha_1 \ln N_1 + \alpha_2 \ln\theta_2 + \alpha_2 \ln N_2 + (1-\alpha_1-\alpha_2)\ln K$$

(2.10)

In simplified version:

$$\ln W_1 = \ln\alpha_1 - (1-\alpha_1)\ln N_1 + \alpha_1 \ln\theta_1 + \alpha_2 \ln(\theta_2 N_2) + (1-\alpha_1-\alpha_2)\ln K \qquad (2.11)$$

similarly, for $\ln W_2$:

$$\ln W_2 = \ln\alpha_2 - (1-\alpha_2)\ln N_2 + \alpha_2 \ln\theta_2 + \alpha_1 \ln(\theta_1 N_1) + (1-\alpha_1-\alpha_2)\ln K \qquad (2.12)$$

since S=$\frac{N_1}{N_1 + N_2}$ and $N = N_1 + N_2$, then $N_1 = SN$, and $N_2 = (1-S)N$

by substitute these into equations (2.11), we have:

$$\ln W_1 = \ln\alpha_1 - (1-\alpha_1)\ln(SN) + \alpha_1 \ln\theta_1 + \alpha_2 \ln[\theta_2(1-S)N] + (1-\alpha_1-\alpha_2)\ln K \quad (2.13)$$

then $$\ln W_1 = \ln\alpha_1 - (1-\alpha_1)(\ln S + \ln N) + \alpha_1 \ln\theta_1 + \alpha_2 \ln\theta_2 + \alpha_2 \ln(1-S) + \alpha_2 \ln N + (1-\alpha_1-\alpha_2)\ln K \quad (2.14)$$

then

$$\ln W_1 = \ln\alpha_1 + \alpha_1 \ln\theta_1 - (1-\alpha_1-\alpha_2)\ln N + (\alpha_1 - 1)\ln S + \alpha_2 \ln\theta_2 + \alpha_2 \ln(1-S) \quad (2.15)$$

similar for $\ln W_2$.

we can conclude:

$$\ln W_1 = \ln\alpha_1 + \alpha_1 \ln\theta_1 + (1-\alpha_1-\alpha_2)\ln(K/N) + (\alpha_1 - 1)\ln S + \alpha_2 \ln[\theta_2(1-S)] \quad (2.16)$$

and

$$\ln W_2 = \ln\alpha_2 + \alpha_2 \ln\theta_2 + (1-\alpha_1-\alpha_2)\ln(K/N) + (\alpha_2 - 1)\ln(1-S) + \alpha_1 \ln(\theta_1 S) \quad (2.17)$$

when the number of skilled worker increases, the share of skilled workers also rises ; therefore:

$$\frac{d\ln W_1}{dS} = -\frac{1-\alpha_1}{S} - \frac{\alpha_2}{1-S} + (\alpha_1+\alpha_2)\lambda \quad (2.18)$$

$$\frac{d\ln W_2}{dS} = \frac{1-\alpha_2}{1-S} + \frac{\alpha_1}{S} + (\alpha_1+\alpha_2)\lambda \quad (2.19)$$

From the above result, we can see that the unskilled worker's wage rate, W_2, benefits for two reasons. First, since $\frac{1-\alpha_2}{1-S} + \frac{\alpha_1}{S} > 0$ is always true, a rise of S causes W_2 increase. These are the effects of changing proportion of skilled workers in a city. Second, $(\alpha_1+\alpha_2)\lambda > 0$ is the additional spillover effect. The impact of an increase in share of graduated workers makes on educated workers' wage rate, W_1 is undetermined. Since $-\frac{1-\alpha_1}{S}-\frac{\alpha_2}{1-S}$ <0 but $(\alpha_1+\alpha_2)\lambda$ >0, the overall effect of these two opposite forces is inconclusive with regard to wage effect.

Chapter Three

Data Summary

This section will cover the source, characteristics, and some explanations of the data.

Equations are estimated using the Canada Census 1991, 1996, and 2001 Public Use Microdata File of Individuals. These microdata files are based on samples of 809,654 individuals in 1991, 792,448 individuals in 1996, and 801,055 individuals in 2001, representing between 1 and 3 percent of the Canadian population. The sample contains extensive demographic and economic variables such as earnings and income, sex, age, and years of schooling. From our perspective, the availability of detailed educational attainment information is the principal advantage to using the Census data. Other important factors supporting use of census data include the large sample size, consequent increased statistical reliability of the results, the detailed data on personal characteristics, and the availability of Census metropolitan area (CMA) information. The main disadvantage of using the Census data is its lack of information on real work experience and on varied total years of schooling for the post-secondary education level.

In order to represent a homogeneous group of individuals, this paper selects a full-time (30 or more hours per week), full-year (49 or more weeks per year) labor force, reporting positive wages and salaries and living in CMAs of Canada. As a local labor market, a CMA is defined to be one or more adjacent municipalities centred on a large urban area. The census population count of the urban core must be at least 100,000 for formation of a CMA. According to Canada Census, there are 19 CMAs in our country. This paper is restricted to drawing from people aged 25 to 64 (inclusive) years. I drop youths under 25 since this group of people carries high possibility for negative potential work experience. I also delete observation of those aged 65 or older, since most of this group is about to leave or has left the labor market. In addition, workers selected for the sample collection must be Canadian born or at least be immigrant (not temporary residents), and must not work in an agricultural industry. The reasons for removing the agriculture-employed population from the sample are that (1) few agriculture workers live in a CMA; (2) most workers in agricultural industries are self-employed and their wages and salaries are widely varied; and (3) for agricultural workers, the income of the self-employed mixes returns to physical capital with returns to human capital, since wages and salaries may not be the major sources of income. For these reasons, the agriculture industry population is not statistically useful for this paper's purposes. Furthermore, to avoid the problem of inflation, the wages are adjusted by the Canadian Consumer Price Index (CPI) to the 1991 base year. Data from Statistic Canada are used to calculate the relative price levels in 1996 and 2001. CPI for 1996 is 107.51 and CPI for 2001 is 118.17.

Table 3.1

Variables definitions

Variable Name	Variable Definition
Lnwages (Lnw)	Natural logarithm of weekly wage rate (in Canadian dollars)
School (SCH)	Total years of schooling
$School^2$ (SCH^2)	Total years of schooling squared
Experience (EXP)	Potential work experience = Age-6-SCH
$Experience^2$ (EXP^2)	Potential work experience squared
Occupation (OCCU)	Dummy variable, based on the National Occupational Classification. In total, 14 OCCU are counted
Immigration (IMMI)	Dummy variable, residents only. Dummy variable=1 if individual is non-immigrant; dummy variable=0 if individual is immigrant.
Visible minority (VISS)	Dummy variable=1 if individual is non-member of visible minority; dummy variable=0 if individual is member of visible minority.
Gender (GEND)	Dummy variable=1 if individual is male; dummy variable =0 if individual is female.
Share of college (S)	Share of college-graduated workers

The dependent variable "log weekly wage rate" is derived from the census variables "weeks worked in last year (WKSWKP)" and "wages and salaries (WAGESP)" during last year. The logarithm of annual wages placed over weeks worked during that year forms the final number for the dependent variable. Although economists stipulate that hourly wage rate is more accurate than the above weekly configuration for the estimation of the wage effects, data from Canada Census do not provide those figures. Information on hours worked per week ("Hours Worked in Reference Week (HRSWKP)") relates to the work week immediately preceding the survey, HRSWKP is not correspondent with WKSWKP and WAGESP because the latter two pertain to the previous calendar year. This forms one of the shortcomings of this paper, a shortcoming that can be remedied only when Canada has another new survey that encompasses both CMAs and parallel hourly wage data. Due to the fact of meaningful purpose of the weekly wage rate, some further deletions have been made. Although it is quite possible that the reported weekly wage rates for some youth, women, and migrant workers were lower than the minimum weekly wage rate, these types of phenomena are abnormal and in most cases possibly illegal. Observations involving weekly wage rates of less than the legal minimum wage have been removed from the sample data. Based on Human Resources and Social Development Canada's database on minimum hourly wages, I calculate a rough number for the full-year, full-time worker's minimum weekly wages by multiplying 30 times each CMA's minimum hourly wages (see appendix for minimum wage rate tables).

The variable "total years of schooling" is one of the most important dependent variables used for estimation of human capital private return. However, one problem that arises is that in available census data, there are no real numbers representing total years of schooling. Users can read only "rough" numbers describing years of education. For example, in the 1991 Microdata, the census variable "total year of schooling (TOTSCHP)" shows code number 9, thereby indicating that the individual's total years of education is from 14 years to 17. However, in this paper, to estimate the effects of the share of college graduates on all education group workers' wage rates, years of education have to be more specifically varied. To allow for more degrees of freedom, this paper combines the census variables TOTSCHP, "years of university (PSUVP)", and "years of non-university or college (PSOTP)". From the 1996 Canada Census 100% non-omitted sample, we can see that 143,994 individuals attended university and 212,746 individuals attended college. Adding these two numbers together, it is 356,740. This number exceeds 212,027, which is the number indicating how many individuals attended university and college. This means that 144,713 individuals received both university and college education. Eventually in order to calculate the real number of total years of schooling, we need to add the PSUVP with the PSOTP to compute the total years of post-secondary education. The real number of years of university equals 0 when PSUVP is less than 2. When PSUVP equals or exceeds 2, the real number of years of university equals PSUVP minus 1. similarly, with regard to PSOTP, the real number of years of non-university equals 0 when PSOTP is less than 2. When PSOTP equals or exceeds 2, the real number of years of non-university equals PSOTP minus 1. After all of these transitions, adding the actual number of years of university and years of non-university together gives us the useful years of post-secondary education. For the groups of workers whose education years are from 14 to 18, the useful number for the years can be calculated by using the data in the following table (for year 1991 observations):

Table 3.2
Calculation for total years of schooling

TOTSCHP	Post secondary	Total years of schooling
9	≤ 2	14
9	3	15
9	4	16
9	≥ 5	17
10	≤ 6	18
10	7	19
10	8	20
10	9	21
10	10	22

Appendix provides more detailed information on TOTSCHP, PSUVP, PSOTP, and DGREEP.

The variable "work experience" is another dependent variable the can be used to estimate human capital internal return. This variable is constructed using the information on age and education. Age minus 6 minus individual years of schooling equals the individual's work experience, which means that the experience we are hereby referring to is only potential experience, not effective work experience. For individuals whose attachment to the labor force is not continuous, the age formula is not a very good measurement tool since this could drive the OLS and GLS results higher or lower, thus revealing a further shortcoming of this paper. Although the Survey of Labour and Income Dynamics (SLID) can provide an individual's exact work experience, this survey does not give any information at the CMA level, thereby rendering the city's characteristic estimation impossible. Furthermore, since female workers are more likely to be working on part-time bases, their work experience will be overestimated. This in turn might cause the OLS estimator for experience to be underestimated.

The variables "occupation," "industry," "immigration," and "visible minority" are also added into the equation as individual-level characteristics dummy variables. These all were extracted directly from the Canada Census Microdata Files. There are in total 14 occupations based on the National Occupational Classification (NOC) and 15 different types of industry (with removal of agriculture industry) based on the 1980 Standard Industrial Classification (SIC).

The most important dependent variable for this paper is "share of college graduated workers." This variable shows a CMA's education level and is also an indicator of the unobserved average human capital level. It is used to estimate the external return of human capital, as calculated from the collected sample data. For each CMA in a particular year, the share of college graduated workers is equal to the number of observations for college graduates over the number of observations from that CMA. In terms of DGREEP (DGREE: Highest Degree, Certificate or Diploma), share of college graduated workers equals the number of observations of whoever's DGREEP is between 4 and 8 over number of observations in this individual's residence CMA.

$$S = \frac{\text{observations DGREEP between 4 and 8}}{\text{observations in a CMA}} * 100\%$$

Table 3.3

Share of college graduated for CMAs

CMAs	1991	1996	2001
Halifax	37.47	45.42	45.01
Quebec	39.34	43.68	47.68
Montreal	34.91	41.14	44.54
Sherbrooke+Trois-Riv	26.02	42.48	45.49
Ottawa-Hull	40.58	46.92	49.15
Oshawa	31.73	38.84	40.46
Toronto	37.44	44.28	46.74
Hamilton	34.19	41.40	43.42
St. Catharines - Niagara	29.01	35.89	35.59
Kitchener	30.23	36.13	38.56
London	34.75	43.03	41.51
Windsor	30.18	37.00	35.85
Sudbury+Thunder Bay	33.62	39.50	41.48
Winnipeg	33.71	39.05	41.64
Regina+Saskatoon	33.88	39.72	41.61
Calgary	38.92	44.02	44.38
Edmonton	34.81	39.14	40.30
Vancouver	35.78	42.75	45.81
Victoria	33.73	41.21	46.30
total	35.98	42.34	44.62

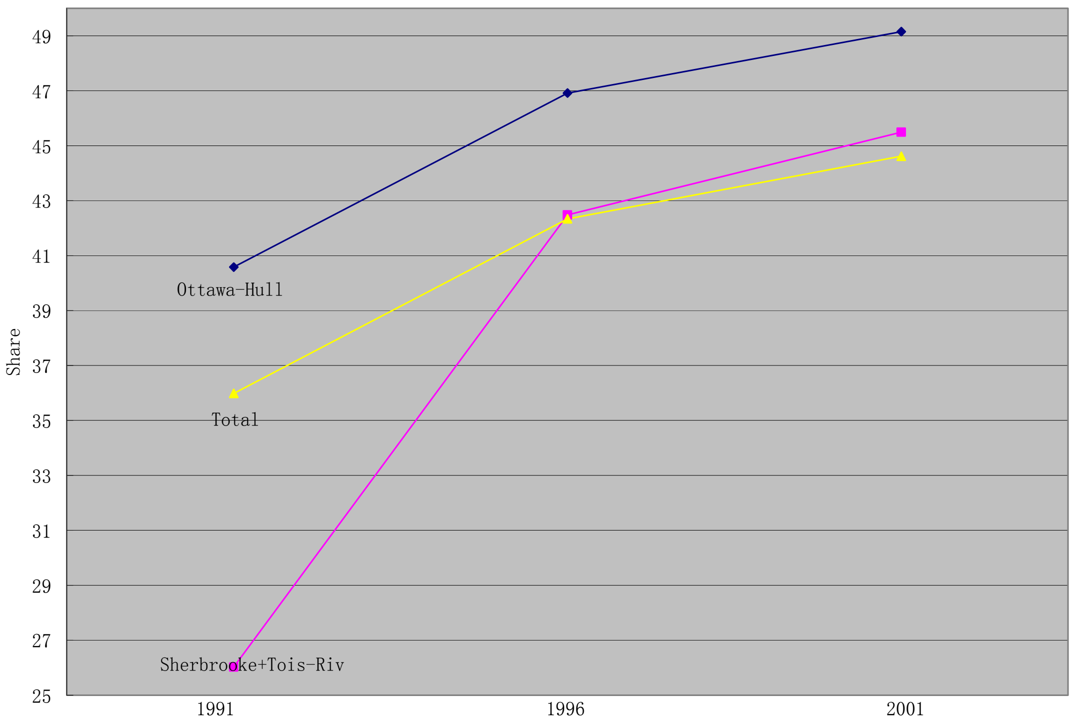

Figure 3.1 Share of college graduated for CMAs

The table above shows that an upward trend of national share of college-graduated workers occurred during our data period. For most of the CMAs, the same was true. The share changes between 1991 and 1996 were significant; however, share changes in the between 1996 and 2001 sub-period were not very big and in fact for some CMAs, during that time, the share change decreased. Figure 3.1 clearly depicts the upward shift for the share of college graduated workers. This phenomenon was consistent both with reality and also with many other studies in this area. Even though the upward shift in national level in our data period may have been caused by education inflation problems, nevertheless it belongs to the labour signaling theory study category. This paper is attempting to uncover the explanation for wage rate change from a human capital theory angle, so education inflation effect will not be further discussed. Table 3.3 also shows that three years down the road, Ottawa-Hull's share of college graduated workers is highest. Many national and worldwide institutions are located in this area, attracting large numbers of well-educated workers into the city and resulting in Ottawa-Hull's having the highest share of college graduated workers in the country. By comparison with all other CMAs, St. Catharines-Niagara had the lowest level of share of college graduated workers during our data period. Possible explanations for this include that no widely-known university exists within that area and also that the area's industry structure is geared more toward retail trade and tourism than it is toward either manufacturing or research.

After all the data computations and omissions were completed, the final sample sizes were as followings:

Table 3.4.1
Sample size

Education Groups	Sample Size					
	Male			Female		
	1991	1996	2001	1991	1996	2001
High-School Drop-out	16139	11468	11719	10506	7150	7613
High-School Graduated	14882	12958	14695	13795	11760	12541
College	34585	32638	38038	23697	24840	31217
More Than College	4117	4183	4806	1753	2038	2794
Total	69723	61247	69258	49751	45788	54165

Regarding the different education levels, definitions were based on census variable DGREEP. The first group consisted of workers whose education level was below high school (high-school dropouts) (DGREEP=1). The second group was workers who had graduated from high-school (DGREEP=2). The third group were those with some college or university experience (DGREEP=from 3 to 8). The final and highest education group was the more than college graduated workers (DGREEP=9 and 10).

By comparing the numbers in table 3.4.1 over that fifteen years period, the data reveal that men were more likely than women to occupy full-time, full-year jobs. Basically, this trend resulted from historical, religious, and child care factors. At the same time, the tables also shows that the number of observations for females increased from 49751 to 54165 over our data period, while for the same time span observations for males remained almost constant. This reflects increasing female participation rates in full-time, full-year work.

It can be seen from table 3.4.2 that the pattern of educational attainment was similar in both the 1991 and the 1996 censuses. Males were more likely than females to drop out from high school (17% vs. 14% in 2001) and females were more likely to be high-school graduates (23% vs. 21%). Males' and females' college attendance levels were varied during our data period.

Table 3.4.2
Share in own gender group (%)

Education Groups	Share in own gender group (%)					
	Male			Female		
	1991	1996	2001	1991	1996	2001
High-school Drop-out	23.15	18.72	16.92	21.12	15.62	14.06
High-school Graduated	21.34	21.16	21.22	27.73	25.68	23.15
College	49.60	53.29	54.92	47.63	54.25	57.63
More Than College	5.91	6.83	6.94	3.52	4.45	5.16

While males always had higher attendance rates than females in the category of more than college education level (6.9% vs. 5.2% in 2001), the gap was narrowing (2.39%

in 1991 vs. 2.38% in 1996 vs. 1.78% in 2001). The most notable changes between 1991 and 2001 were the increases in the share of those with college experience. The men's college attendance rate rose from 50% to 55% and women's college attendance rate significantly rose, from 48% to 58%.

Table 3.5.1 presents the average wages of both genders for the nineteen different CMAs in 1991, 1996, and 2001. The average wage rate was not the same across all CMAs in Canada. It varied from $638 for Winnipeg to Oshawa's $767 dollars in1991; from Halifax's $652 to Oshawa's $793 in 1996, and from Quebec's $661 to Windsor's $858 in 2001. Comparing the numbers, we can see that the mean wage

Table 3.5.1 Average wage rate for CMAs by sex and year (in real dollars)

CMAs	1991			1996			2001		
	Total	M	F	Total	M	F	Total	M	F
Halifax	653	745	515	652	736	542	686	775	570
Quebec	648	740	515	661	749	538	661	734	569
Montreal	665	757	538	694	783	574	707	798	594
Sherbrooke +Trois-Riv	640	722	503	663	745	533	671	765	538
Ottawa-Hull	762	864	628	792	887	671	844	934	732
Oshawa	767	871	587	793	895	643	833	958	648
Toronto	754	865	611	779	875	661	818	926	686
Hamilton	731	845	556	778	892	612	794	910	632
St.Catharines -Niagara	664	758	506	711	829	540	689	786	546
Kitchener	679	775	527	719	814	571	756	866	590
London	680	785	541	749	850	618	751	860	611
Windsor	707	820	542	789	907	609	858	998	644
Sudbury +ThunderBay	744	858	557	782	889	624	750	857	605
Winnipeg	638	723	516	655	739	538	665	742	566
Regina +Saskatoon	657	747	522	688	784	557	695	799	564
Calgary	738	854	567	761	882	588	814	936	647
Edmonton	699	800	545	706	804	567	739	857	581
Vancouver	722	832	566	772	870	639	780	872	663
Victoria	669	765	535	734	804	645	729	798	649

rate level increased in total during our data period but at the CMA level, this was not always the case. In some CMAs and for some gender groups, the mean wage rate decreased between 1996 and 2001. For example, in Sudbury + Thunder Bay, the mean wage rate was down from $782 to $750. For male full-time, full-year workers, this number decreased from $889 to $857; for female full-time, full-year workers, the real average wage rate dropped from $624 to $605. This trend only exists between 1996 and 2001 and in 5 CMAs. This table also shows that gender wage inequality existed during those years.

Table 3.5.2
Average wage rate and wage ratio by sex and year (in real dollars)

Year	Total	Male	Female	Ratio
1991	709	811	566	$\overline{W_f} / \overline{W_m} = 0.6979$
1996	740	836	612	$\overline{W_f} / \overline{W_m} = 0.7321$
2001	766	867	636	$\overline{W_f} / \overline{W_m} = 0.7336$

Table 3.5.2 presents the mean wages of both genders and their wage ratios in 1991, 1996, and 2001. From this table we can deduce first that mean wages were escalating during our data period but that the rate of rising was decreasing. The difference between 1991 and 1996 was $31 dollars per week; between 1996 and 2001, this difference decreased to $26. Second, in 1991 the wage ratio was 69.79 percent. In

other words, on average women earned 70¢ for every $1 earned by men. In 1996 the wage ratio increased to 73.21 percent, and the wage ratio was up to 73.36 percent in 2001. Therefore, during our data period, the gender wage gap decreased but the rate of rising slowed down. However, this gender wage difference is still significant. Women who took time off to have children experienced a loss in salary, and they were often disadvantaged in the areas of both promotions and other opportunities for earning higher salaries.

Table 3.5.3
Average wage rate at different education levels by sex and year (in real dollars)

Education Groups	1991			1996			2001		
	M	F	Ratio	M	F	Ratio	M	F	Ratio
High-school Drop-out	659	449	0.6813	664	471	0.7093	668	485	0.7260
High-school Graduated	746	515	0.6903	743	544	0.7322	751	563	0.7497
College	868	622	0.7166	887	658	0.7418	926	676	0.7300
More Than College	1169	913	0.7810	1198	937	0.7821	1238	945	0.7633

Table 3.5.3 reports mean weekly wages by level of education over the time period, together with the gender wage ratios. As the level of education increased, both men's and women's mean wages trended upwards. Individuals with more than 18 years of schooling earned the highest average wages. Over our data period, the gender wage ratios were increasing. For college-educated workers, this number grew from 78 percent in 1991 to 76 percent in 2001. As the level of education increased, the gender wage ratios also increased. That means that the gender wage gap decreased during

the 1991 to 2001 period, and also that the gender wage gap decreased while the average education level increased.

Table 3.6.1
Average total years of schooling for workers in CMAs by sex and year

CMAs	1991 M	1991 F	1996 M	1996 F	2001 M	2001 F
Halifax	13.44	13.47	13.73	13.96	14.01	14.22
Quebec	13.77	13.53	14.18	13.92	14.37	14.52
Montreal	13.17	13.21	13.64	13.75	14.06	14.20
Sherbrooke+Trois-Riv	13.47	13.46	13.69	13.93	14.13	14.30
Ottawa-Hull	14.18	13.73	14.62	14.20	14.70	14.56
Oshawa	13.01	13.04	13.25	13.47	13.51	13.79
Toronto	13.51	13.39	13.89	13.91	14.23	14.25
Hamilton	13.18	13.08	13.50	13.63	13.80	13.97
St.Catharines-Niagara	12.76	13.00	13.24	13.42	13.38	13.59
Kitchener	13.00	12.80	13.24	13.12	13.62	13.58
London	13.37	13.18	13.80	13.84	13.73	14.09
Windsor	13.18	13.30	13.54	13.67	13.83	13.81
Sudbury+ThunderBay	12.91	13.18	13.15	13.65	13.58	13.92
Winnipeg	13.18	13.06	13.54	13.44	13.69	13.77
Regina+Saskatoon	13.35	13.28	13.70	13.64	13.78	13.77
Calgary	14.01	13.43	14.23	13.88	14.34	14.06
Edmonton	13.58	13.23	13.77	13.56	14.00	13.75
Vancouver	13.72	13.41	14.11	13.93	14.29	14.32
Victoria	13.73	13.35	14.17	14.04	14.32	14.28

In 1991 the lowest average education for males was 12.76 years, in St. Catharines-Niagara, while Ottawa-Hull showed the highest average education, 14.18 years.

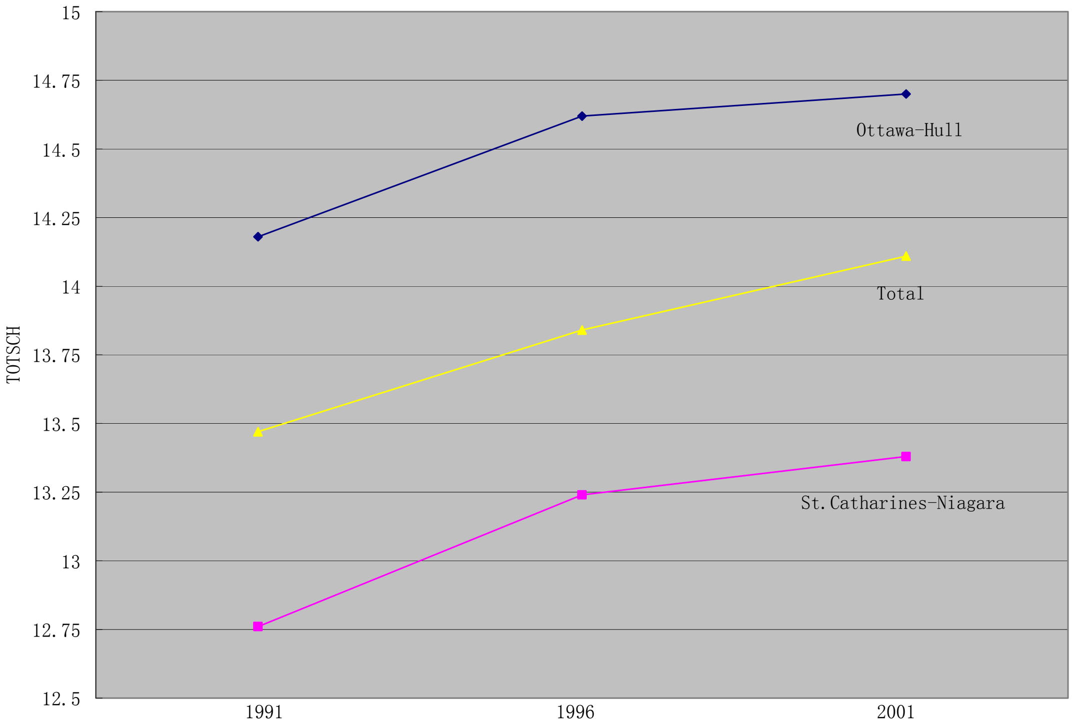

Figure 3.2 Average total years of schooling for males in 1991, 1996, and 2001

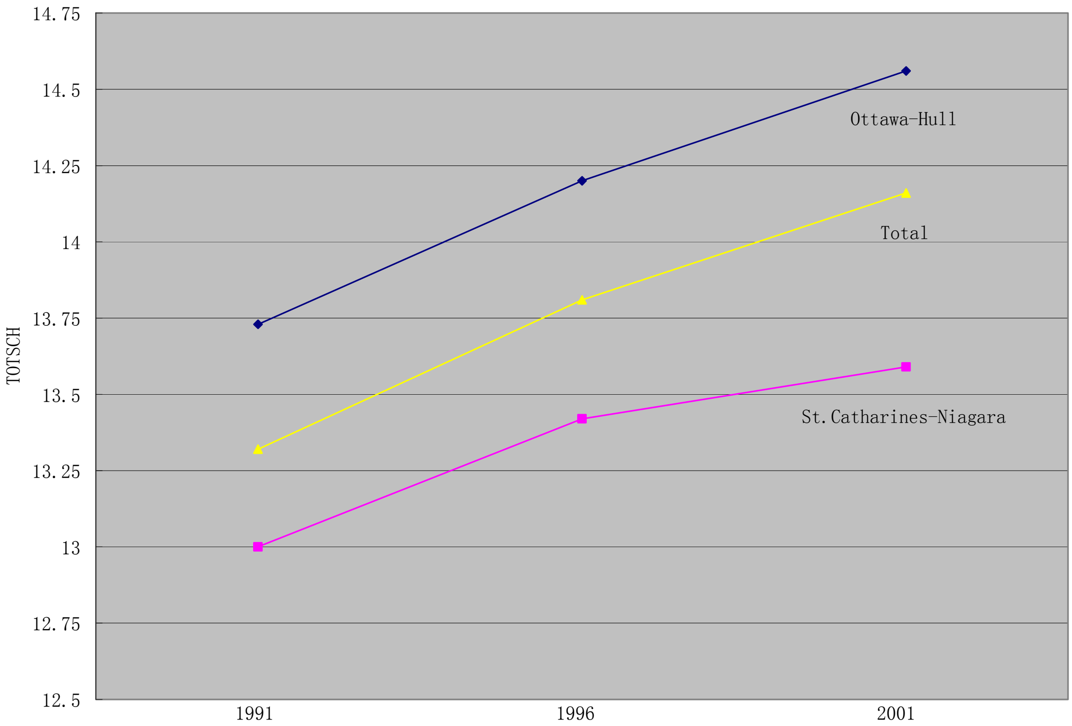

Figure 3.3 Average total years of schooling for females in 1991, 1996, and 2001

As figure 3.2 and figure 3.3 show, total years of schooling were increasing substantially for both gender groups. During the two sub-periods and except for the male group in London, all the other CMAs' mean total years of schooling escalated. In some CMAs, female full-year, full-time workers' total years of schooling were higher than male workers'. Nevertheless, however, the related wage rate for female was lower than that for male.

Table 3.6.2
Average total years of schooling by year

Year	Total	Male	Female
1991	13.41	13.47	13.32
1996	13.83	13.84	13.81
2001	14.13	14.11	14.16

During our data period, mean total years of schooling increased from 13.41 to 14.13 years. In this ten-year phase, individuals' education investments rose by eight and one-half months. Each year, people spent 26 more days in school. During those ten years, male workers' total years of schooling increased by 0.64 years and female workers' increased by 0.84; female workers thus experienced a faster increase in education level. At the end of year 2001, female workers' total years of schooling exceeded males' average level. This is consistent with many other concurrent studies wherein women participants show a higher level of schooling.

Table 3.7.1
Average work experience for workers in CMAs by year

CMAs	1991 M	1991 F	1996 M	1996 F	2001 M	2001 F
Halifax	20.35	18.81	19.95	19.09	21.04	20.84
Quebec	20.73	19.35	20.98	20.78	21.40	21.37
Montreal	21.43	20.43	21.70	20.87	21.71	21.28
Sherbrooke+Trois-Riv	21.29	19.25	22.19	20.81	22.39	21.17
Ottawa-Hull	20.06	19.47	20.54	20.51	20.75	20.60
Oshawa	20.79	19.63	21.23	20.61	21.97	21.18
Toronto	21.26	20.49	21.11	20.64	21.56	21.06
Hamilton	22.24	20.91	21.95	21.01	21.90	21.46
St.Catharines-Niagara	22.95	21.07	23.35	21.95	23.14	22.90
Kitchener	21.20	20.42	21.47	21.45	21.35	21.89
London	21.33	20.07	21.40	20.88	22.65	21.41
Windsor	21.78	20.69	21.52	20.83	21.64	21.37
Sudbury+ThunderBay	22.00	20.46	23.30	21.37	22.49	21.80
Winnipeg	21.07	20.65	21.88	21.74	22.12	22.46
Regina+Saskatoon	20.15	19.49	21.09	21.00	22.19	21.98
Calgary	19.27	19.11	19.97	19.80	20.59	20.80
Edmonton	20.03	19.82	20.89	20.69	21.69	22.08
Vancouver	21.02	20.24	20.89	20.62	21.97	21.27
Victoria	20.88	21.09	21.79	21.27	22.15	22.55

Comparing the potential work experience figures for each gender group, we can see that male workers more likely had more work experience than did female workers. However, it is notable that female workers' mean work experience in 2001 for Kitchener, Winnipeg, Calgary, Edmonton, and Victoria was above male workers' work experience. Usually this should not have been the case, first because women usually retire earlier than their male coworkers, and second because reasons such as maternity result in making women's work experience less than that of men. Only one reason can explain the above-mentioned negative difference between women's and men's work experiences. The average age for women was higher than that of men in

2001 in those CMAs. Other studies have agreed that the mean age for women was increasing during those years and their retirement age was increasing, too.

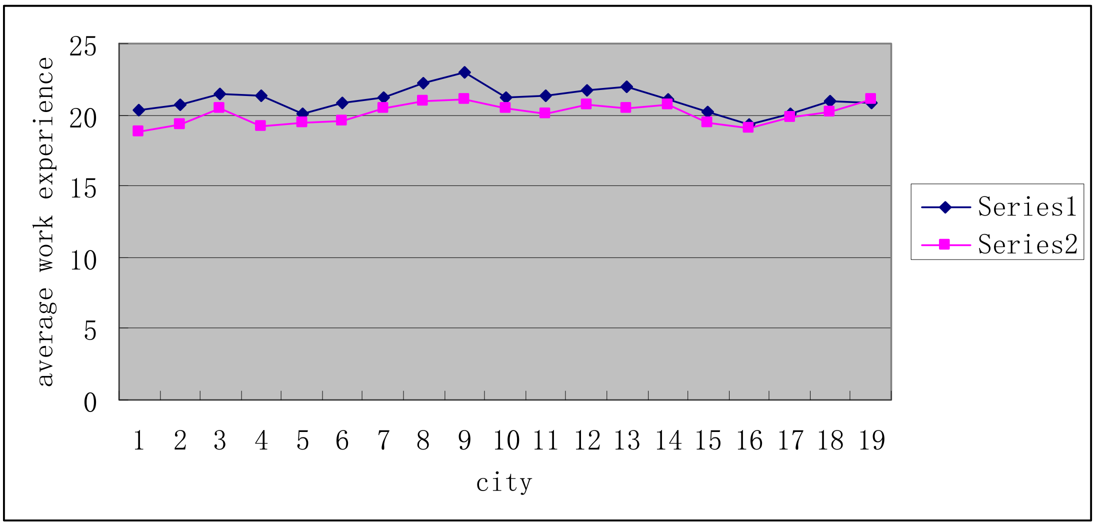

Figure 3.4 Average work experiences for workers in CMAs in 1991

Figure 3.4 depicts the very similar work experience patterns of male and female workers. In a CMA, if the work experience for males was high, female workers' experience also should have been high. Additionally, both partners of a working couple apparently chose to retire at approximately the same time.

Table 3.7.2
Average work experience by year

Year	Total	Male	Female
1991	20.68	21.03	20.19
1996	21.03	21.25	20.74
2001	21.50	21.65	21.30

As is evident in table 3.7.2, both male and female workers' potential work experience increased during 1991 to 2001. From table 3.6.2, we can see also that male and female workers' total years of schooling was increasing. If average age in work force was stable, then according to our formula for potential work experience, work experience should have been decreasing. This phenomenon acts contrary to our data report; however, the action of baby boomers' labor market participation can be used to explain this "odd" occurrence (following World War Ⅱ, many countries experienced a unusual spike in birth rates. A widely accepted definition is that a person born between 1946 and 1964). The average education level for baby boomers is higher than that of the previous generation. In 1991, ages of baby boomers ranged from 27 to 45 years. Their work experiences were not long. Comparing 25 percent of the labor market, baby boomers' total years of schooling had a rare effect on the total age group's mean education level. Ten years later in 2001 baby boomers had become the majority segment of the labor market. Their high education levels made the total age group's mean education level increase and their work experiences were far higher than those of the younger generation. For these reasons, both total years of schooling and work experience revealed upward trends during our data period.

Chapter Four

Regression Results

This section presents the empirical results on the implications of the previous earning model. The earnings data used for these tests are described in chapter 3. Individual's visible minority status and citizenship status both are expected to show strong positive effects on earnings. It is also our belief that there is little reason for the β coefficients to be identical for men and women, or, in other words, that individual and job characteristics affect men and women differently. For these reasons, the regressions are confined to Canadian-born non-visible-minority men aged over 24 years who reported positive wage and salaries and who lived in one of the nineteen CMAs. This group forms as the base group. In the following sections, first regressions are run using the simplest model in total level, then using different genders, and then finally comparing the differences in education's private returns and social returns. The second part separately runs the regression in different education groups. Third, different education groups are added, and the results are presented separately by combining the two gender groups with the four levels of education. The econometric ideas are reported in the final section.

4.1 Basic Earning Equation

The following general earnings equation has been estimated using the OLS method:

suppose that the wage of individual i living in city c in period t is determined by an equation of the form

$$\ln w_{ict} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 S_{ct} + u_{ict} \tag{4.1}$$

where X_{it} denotes the individual characteristics for person i in time t (t=1991, 1996, 2001), including years of schooling (SCH), its square (SCH^2), potential work experience (EXP), its square (EXP^2), visible minority status (VISI), citizenship status (IMMI), occupation (OCCU), and industry (INDU); S_{ct} represents the percentage of college-educated workers in city c in year t. The residual u_{ict} is the sum of several components: city characteristics, such as cost of living or pollution level of the city; unobservable components of human capital, such as unobserved abilities and skills or individual's family background; and time effects, such as year effects or time-varying shocks to labor demand and supply in the city.

The interested coefficient is α_2, which is the estimation of the effect of share of college-graduated workers on the average wages in the CMAs after controlling for the private return to education.

Table 4.1 shows the parameters of earning equation (4.1) of the quantitative explanatory variables for both male and female. OLS estimates show a large positive relationship between years of schooling, work experience, share of college-graduated worker, and individual's wage rate.

Table 4.1
Effect of change in percentage of college graduates on wages by both sexs

	Total	Male	Female
Constant	5.856387 (477.94)	5.878526 (359.97)	5.596965 (308.06)
GENDER	-0.235054 (-147.83)		
EXP	0.028029 (107.96)	0.033550 (93.98)	0.022892 (61.55)
EXP^2	-0.000429 (-78.44)	-0.000507 (-68.40)	-0.000373 (-46.59)
SCH	0.012973 (8.66)	0.011491 (5.79)	0.007234 (3.21)
SCH^2	0.001008 (18.45)	0.000982 (13.50)	0.001281 (15.67)
IMMI (Base: Canadian born)	-0.01868 (-9.52)	-0.014523 (-5.5)	-0.01943 (-6.75)
VISS (Base: not-visibleminority)	-0.122832 (-49.34)	-0.15864 (-46.68)	-0.069754 (-19.53)
S	0.003490 (22.94)	0.000906 (4.40)	0.007136 (32.31)
R^2	0.38	0.33	0.35
Sample Size	349,932	200,228	149,704

t-statistics are in parentheses.

Wages that can be explained by personal work experience and years of schooling are called individual internal monetary returns. Based on our results, at the individual level, the schooling of workers is significantly related to their higher wage rates. In year 1991, additional years of schooling is associated with a 4.1 percentage (0.041=0.012973+2*0.001008*13.41) increase in full-year, full-time worker' wage rates. From the previous data, we know that the average weekly wage rate for our sample was $709 Canadian in 1991. When wages increased by 4.1 percent for one worker, his or her weekly wage rate rose by $29. Thus, the average annual individual earnings increased by approximately $1504. For male full-time full-year worker in

1991, this number will be \$1612 (1612=(0.011491+2*0.000982*13.41)*811*52). For female worker, this number will be \$1196. This increased income would, for example, have allowed one double-income family to take at least one more family trip to a nearby city. Therefore, on the national scale, the effects of the above wage increases would be enormous.

The parameter for years of schooling squared is positive; however, over-education is clearly possible. Rudd (1990) suggested that, in the social sciences, education beyond a single degree level is damaging to earnings prospects. This must be explained. From the following separate regression, it is very clear that, the parameters for years of schooling squared are positive only for low-education workers; by contrast, for higher education workers this number is always negative and the absolute value increases as the education level increases.

Workers who had the same education but different levels of experience were imperfect substitutes in production. It was proved by our estimation that one additional year of experience brought a 1 (=0.028-2*0.000429*20.46) percentage increase in the wage rate. The negative sign preceding the work experience square shows that work experience and work's wage rate is not linearly related, the effect of work experience on wage rate increases at a decreasing rate.

Since

$$\ln w = \beta_0 + \beta_1 EXP + \beta_2 EXP^2 + ...$$

then $$\partial \ln W \big/ \partial EXP = \beta_1 + 2\beta_2 EXP = 0$$

and then $$\text{EXP}=\frac{0.028029}{2 * 0.000429} = 33$$

which means that after 33 years of work, further working caused a negative effect on individual's wage rate. According to our previous data, the mean years of schooling for our full-year, full-time worker was around fourteen years. Assuming that all of those workers started school while they were six years old, fourteen plus six, then adding 33 years of work, they would have reached their career peaking points when they were 53 years old. This number falls close to the broadly accepted number for career peaking point, namely, 55 years.

By comparison with education's internal monetary return, education's external monetary return is more important at the social level. According to the OLS estimator, a one percentage point increase in a CMA's share of college-graduated workers brought a 0.35 percentage change in all workers' wage rates. Share of college-graduated workers rose around 6.4 percentage points during 1991 and 1996, which implies that change in share of college-graduated workers was associated with a 2.23 percentage change in the wages of all workers in the same CMA. For instance, in 1991, if male worker John who lived in Toronto made $754 weekly, his weekly wage rate would have been only $772 ($\Delta S = 6.84$ percentage points) because of the shift in share of college graduates. In fact, the shift in share of college graduates had an influence on all the other workers who worked in Toronto. These figures are similar to Moretti's (2004) estimates of external returns. It is notable that the change in share of college-graduated workers had different effects on male and on female workers' wage rates. A one percentage point change in share of college graduates caused a 0.09 percentage change in male workers' wage rates; however, the same one percentage point change gave a 0.7 percentage change in all female workers' wage rates. We needed to explain this almost eightfold difference. We noticed from table 3.5.3 that the gender wage gap decreased as the average education level increased. Share of college-graduated worker increases meant that the average education level also increased. This phenomenon narrowed the gender wage gap by increasing the female wage rate more than that of the male.

Table 4.2
Effect of personal characteristics on wages by both sexes

	Total	Male	Female
OCCUPATION: (Base: senior managers)			
middle and other managers	0.337217	0.356417	0.252937
professionals	0.065284	0.077156	0.043047
semi-professionals and technicians	-0.180144	-0.177844	-0.178444
supervisors	-0.163966	-0.182282	-0.142541
supervisors: crafts and trades	-0.090479	-0.089604	-0.17297
administrative and senior clerical personnel	-0.228162	-0.164699	-0.238121
skilled sales and service personnel	-0.134356	-0.092228	-0.204035
skilled crafts and trades workers	-0.187475	-0.186775	-0.316649
clerical personnel	-0.333416	-0.378307	-0.313743
intermediate sales and service personnel	-0.270045	-0.215316	-0.32218
semi-skilled manual workers	-0.339555	-0.322632	-0.42132
other sales and service personnel	-0.42477	-0.450119	-0.387487
other manual workers	-0.389256	-0.370869	-0.440791
INDUSTRY: (Base: educational services)			
other primary industries	0.297974	0.347216	0.211472
manufacturing	0.103706	0.153921	0.051278
construction	0.056661	0.095988	-0.022726
transportation and storage	0.126645	0.149353	0.110972
communication and other utilities	0.173107	0.191341	0.185753
wholesale trade	0.052539	0.077192	0.031148

retail trade	-0.149248	-0.09659	-0.192248
finance, insurance, and real estate	0.078068	0.131199	0.03494
business services	0.059927	0.104125	0.031102
government services: Federal	0.124031	0.111796	0.151461
government services: other	0.094841	0.107307	0.080428
health and social services	-0.0316	-0.043978	-0.041356
accommodation food and beverage services	-0.350737	-0.354481	-0.332746
other services	-0.149991	-0.118543	-0.162528
IMMI (Base: Canadian born)	-0.01868	-0.014523	-0.01943
VISS (Base: not-visible minority)	-0.122832	-0.15864	-0.069754

All parameters are statistically significant at a 5 percent level

Table 4.2 shows the regression of personal characteristics of the log of weekly wage rate. These variables include all the usual individual attributes known to influence wages, for example, individual's visible minority status, citizenship status, occupation, and industry. All the variables were included in all subsequent regressions of wages on the city level. The coefficients for these variables changed little in the subsequent regressions.

As shown in table 4.2, for the occupational variables, coefficients for professionals and for middle and other managers are positive. This means that only these workers usually have higher earnings than the base group (senior manager). For the industries variables, only retail trade, health and social services, accommodation food and beverage services, and other services have negative parameters, which means that the educational services industry has a lower wage rate than most other industries. The greatest gaps can be found in other primary industries and construction industries. Wages of the female workers in the construction industry were even lower than those of females working in educational services, while the construction workers made more money than the males working in education services. The parameter for visible minority was as expected, with a strong negative effect on workers' wages. The parameter for immigration status was much smaller than the one for visible minority.

4.2 Earning Equations for Different Education Groups

There is no reason to expect that a one-year increase in a CMA average education level would have the same effect on a different education group (but same CMA) workers' wages. Table 4.3 shows the results from estimating wage functions separately for four different educational groups: high-school dropouts, high-school graduated, college experienced, and more than college. The results suggest that the effect is indeed different according to education group.

Table 4.3
Effect of change in percentage of college graduates on different education groups' wages

Education group	High-school dropouts	High-school Graduated	College	More Than College
constant	6.020983 (219.09)	6.180532 (367.27)	5.667913 (196.79)	3.412066 (8.95)
GENDER	-0.300592 (-77.69)	-0.263805 (-80.24)	-0.208537 (-95.57)	-0.147634 (-23.59)
EXPE	0.023906 (31.96)	0.026186 (40.96)	0.030928 (85.57)	0.038118 (30.77)
$EXPE^2$	-0.000328 (-25.15)	-0.000428 (-32.02)	-0.000515 (-61.40)	-0.000594 (-19.53)
SCH	-0.007414 (-2.26)		0.042120 (11.40)	0.312037 (7.61)
SCH^2	0.001927 (10.87)		-0.000274 (-2.23)	-0.008299 (-7.49)
S	0.002449 (6.74)	0.003632 (11.78)	0.003847 (18.49)	0.003256 (5.10)
R^2	0.28	0.31	0.35	0.32

Sample size	64,595	80,631	185,015	19,691

t-statistics are in parentheses.

From table 4.3, we find that the internal monetary return of education grows along with increasing education level. For high-school graduates, one additional year of schooling presented a 3.4 percent increase in their wage rates. For college-educated workers, one additional year of education brought a 4.2 percent increase in their wage rates. For more than college graduated workers, one additional year of schooling resulted in a huge difference in their wage rates. Although theoretically a higher return for more than college-graduated individuals is reasonable, the number here is too big to be true. This might have been caused by the lack of variations in total years of schooling for this group of workers. Therefore, this number is used only to show the increasing trend on the education internal monetary return. For workers with high school diplomas, the way to increase wages would be to attend college for additional education. However, because additional years within high school make no difference to wage rates, there is no reason to run the education return on high-school graduated workers.

Table 4.3 indicates that work experience became more and more important for individuals with increasingly high degrees. It is understandable that the major part of the high-school dropout group usually worked at either labor jobs or in service businesses. Workers in these types of industries are able to be efficient and productive without a great deal of experience. On the other hand, a major part of the workers holding Master's and PhD degrees and working for research institutions or in other positions required additional technical training and further experience in order to improve their productivity.

We can read from the parameters of Gender that the parameter for high-school dropout was -0.300592; for high-school graduates was -0.263805; for college experienced workers was -0.208537; while for more than college-educated workers was -0.147634. The absolute value decreased less along with increasing average education level. In other words, gender became less and less important in explaining wage differential when education levels grew.

In this section, I separately estimate the effect of share of college graduates on the wages of different education groups. As predicted before, the share effect on less than high school workers, on high-school graduated workers, and on more than college-graduated workers should be positive. Table 4.3 shows that even the effect on college experienced workers was positive. This means that there were not only conventional demand and supply shifts but also existing spillovers effects. One percentage point increase in share of college graduates caused a 0.24 percentage change in high-school dropout workers' wages, and a 0.36 percentage positive change in the wages of individuals holding high school diplomas. As anticipated, the share effect on high-school graduated workers was higher than that on high-school dropouts. This occurred because the demand and supply factor was much stronger between closer education groups. Surprisingly, the share of college graduated worker had an even higher effect (0.38 percentages) on the college experienced worker category. First, this provides the strong proof that spillovers exist. Second, since not all college-experienced workers held a degree or diploma, the demand and supply factor remained. These two factors can be used to explain why a worker with two years' college experience made more money employed in a bio-research company than did the worker with the same educational background but working for a harbour authority. Educational attainment was an extremely important issue with regard to an individual's wage. Share effect on the more than college graduated workers group became lower, as we had expected.

4.3 Earning Equation for Different Gender and Education Sub Groups

In the following section, different education groups are added to the equation, and the results are presented separately by combing the two gender groups with the four levels of education. We will present the share effect in eight different sub groups.

Table 4.4
Effect of change in percentage of college graduates on different education groups and different gender groups

Education group	Less high M	Less high F	High M	High F	College M	College F	More college M	More college F
constant	6.100442 (167.10)	5.616441 (137.15)	6.240672 (247.30)	5.837909 (259.01)	5.738288 (154.44)	5.194301 (113.93)	2.729956 (5.76)	4.920782 (7.78)
EXPE	0.029141 (30.60)	0.014994 (12.67)	0.032680 (36.75)	0.017686 (19.61)	0.036275 (71.93)	0.026762 (52.49)	0.040865 (25.40)	0.036099 (18.74)
$EXPE^2$	-0.000402 (-24.31)	-0.000205 (-9.89)	-0.000523 (-28.09)	-0.000303 (-16.10)	-0.000593 (-51.76)	-0.000480 (-39.40)	-0.000626 (-16.25)	-0.000625 (-12.50)

SCH	-0.003894 (-0.92)	-0.012825 (-2.55)			0.031891 (6.67)	0.069765 (11.98)	0.381268 (7.46)	0.139546 (2.06)
SCH^2	0.001597 (6.98)	0.002290 (8.35)			-7.66E-05 (-0.48)	-0.001011 (-5.26)	-0.010196 (-7.37)	-0.003635 (-1.99)
S	-0.001249 (-2.68)	0.008875 (15.67)	-0.000220 (-0.50848)	0.008677 (20.13)	0.001998 (7.03)	0.006445 (21.65)	0.003443 (4.27)	0.002942 (2.90)
R^2	0.21	0.20	0.29	0.22	0.29	0.31	0.30	0.26
Sample size	39,326	25,269	42,535	38,096	105,261	79,754	13,106	6,585

t-statistics are in parentheses.

Table 4.4 displays six cohorts: male and female workers who do not have high-school diplomas; male and female workers whose highest certificate or degree is a high-school diploma; male and female workers whose have college experience; male and female workers who have Master’s or PhD degrees. The above table shows that share of effect was more likely to have a greater effect on less educated workers than on better educated worker, and to have a greater effect on female than on male workers. For the male less than high-school graduated worker, share effect was negative. When workers increased their education investments, firms increased their physical capital investments and as a result, the demand for lower-educated workers fell. Female high-school dropouts were more likely to be working in the service or retail industries, since the demand for those types of workers underwent an opposite shift. It is notable that the share effect on the high-school graduated male worker is negative too; however, the parameter is statistically significant, even at the 60 percentage level. This negative effect is not worth discussing.

4.4 Econometric Solutions

4.4.1 Heteroscedasticity Test

Since the data are cross-sectional and involve a heterogeneity of cities, it is reasonable to expect heteroscedasticity in the error variance. White's heteroscedasticity test is used to test this problem. Based on the E-view results, one can conclude that, on the basis of the White test, there is no heteroscedasticity.

4.4.2 Autocorrelation Test

To detect the existence of serial correlation, we use the Durbin-Watson test. According to the E-View results, Durbin-Watson statistics are found to be between 1.693 and 1.826 in our regressions. Since all of the ds are around 2, we may assume that there is no first-order autocorrelation.

4.4.3 Reduced-Form

To detect whether a reduced variable is correlated with an existing variable, we should have introduced an instrumental variable to this paper. However, finding an appropriate instrumental variable is extremely difficult. Lagged age structure is used in some papers, but according to "Total, Average and Median Years of Schooling (9), Age Groups (13B) and Sex (3) for Population 15 Years and Over, for Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 1991 to 2001 Censuses - 20% Sample Data" (Statistic Canada), the average years of schooling for people the 30-34 years age group was 13.2 in 1991; the same group's mean years of schooling in 1996 was 13.3; further for the same group, in 2001 when they belonged to the 40-44 years age group, the average years of schooling changed to 13.5. This fact suggests that the average years of schooling for the immigrants was varied, so for a country like Canada with very high levels of immigration, the age structure indicator is not a good tool to be used as an instrumental variable.

Some economists assert that the presence of a land-grant college in a city is a good predictor of cross-sectional variation in college share. But this cannot be used as an instrument in a specification that includes city fixed effects, because it would be absorbed by the fixed effect. For Canadian data, this is not a good choice.

Other researchers suggest that father's education background is positively related to children's education level, and that it can be used as an instrumental variable. But for a great part of the large immigration group in Canada, accurate data regarding father's education level is not obtainable.

Chapter Five

Conclusions

This study presents effects of share of college graduates on individuals' wage rate in CMAs using Canadian Census Public Use Microdata File of Individuals. In the first chapter, pooling by all education groups, we found that a one-percentage point increase in a CMA's share of college-graduated workers was associated with a 0.35 percentage change in all workers' wage rates in that city. In the second chapter, the return to education was estimated by separated education groups, and our results showed that a one-percentage expansion in the supply of college-graduated workers raised less than high schools' wage rate by 0.245 percent, raised high-school graduates' wage rate by 0.362 percent, raised more than college-educated workers' wage rate by 0.385 percent, and raised college-educated wage rate by 0.325 percent. These results are consistent with the earlier results of Moretti (2004) in the sense that productivity gains from human capital spillovers appear to be empirically relevant. Although Moretti used macro-level data of average education levels of different cities and adjusted average wage rate to run his regression, we still arrived at a similar result. These findings not only confirmed our assumption from the beginning that human spillover existed but also showed that the spillover effect was large.

Should Harper's government cut taxes as a high-visibility tactic or should it retain present taxation levels and invest this money in education that will subsequently increase people's future incomes? Should municipal governments direct larger portions of their education investment funding toward the high-school level or at the university level? Public decision-makers should consider this paper's results when they are deciding spending policies. It is noticeable that there is a gap in income between college-experienced workers and college-graduated workers. Based on the results generated by this study, governments should encourage and support workers who have some college experience but are without completed degrees or certificates to finish their education. Having more workers with such credentials will not only improve workers' own chances of finding a better job but will also increase spillover effect for society in general and then will subsequently increase society's entire level of development.

There are various ways of encouraging people to complete their college education. One of the popular tools available to government is the lowering of tuition. Wilson, a member of the Saskatchewan Young New Democrats executive agrees: "We've always taken the stance that the cost of education is definitely a barrier for people getting post-secondary education." This issue, however, remains debatable, because earlier this year another related news story announced that "Quebec's low tuition has failed as a policy: Young people stay away in droves from the low-cost universities, and the poor are apparently no more likely to enroll than they are in other provinces" (*Globe and Mail,* January 29, 2007). But although a tuition freeze was not effective in Quebec, such a result would not necessarily be duplicated in other provinces since other provinces might comprise very different cultures. For example, in a different province, if students are more dependent on parents' savings for higher education, lower tuition could be an effective policy. It is evident that the current government of Saskatchewan is trying to make this tool work by using tuition cuts as means of assistance to help students gain higher education, with the further goal of eventually helping local economic development: "REGINA—A cut in university tuition – or at least a continuation of the ongoing tuition freeze—appears to be on the NDP government's agenda" (*Starphoenix*, April 12, 2007). Another useful policy for increasing the share of workers at the college-graduated level is to increase the minimum wage rates. A higher minimum wage paid to a student will enhance her or his ability to continue and complete their higher education that will then go on to carry the lifetime impact of higher career earnings. Another and very efficient way of achieving these goals is beginning at the family financial level, where an investment advisor could help by showing the enormous future benefits of higher education for their children, encouraging parents to form strong saving plans for their children's post-secondary schooling.

This study contains some disadvantages. First, due to a lack of data in corresponding hours worked in previous years, we must use weekly wage rate as the dependent variable. Second, due to a lack of suitably detailed data on effective work experience, we use potential work experience as a proxy. However, this proxy is a better fit for male workers than for female workers since female workers are more likely to work part-time during their lifetimes and many of them will take time off to have children. These reasons may lead to an overstatement of female workers' work experiences and subsequently make the OLS estimator for human capital return biased from its true value. Third, a city's amenity has a large effect on people's wage rates (Roback 1982 and 1988). For this reason, more city-level characteristics should be covered in the model, such as city's pollution indicator, city's population, city's industrial structure, and city's house price indicator. All these characteristics influence workers' and firms' location decisions, and affect workers' cost of living further so they should be used to adjust individual workers' real wage rate. Finally, share of college graduated should have different effects on workers at different age levels, and this study could not take that factor into account.

Some of the above shortcomings could be addressed by further study. Researchers could add more city-level characteristics when running the model. Also they could separate the entire labor force into five different age groups, for example 25—29, 30—40, 40—49, 50—59 and 60—64 years, then separately run the wage regression. For researchers who want to study the gender wage gap, a good approach would be to work on the cross-gender share of college graduated effect. Additionally, comparisons could be made of the effect of differences between Canada and the U.S.

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Appendix

TOTSCHP: Total Years of Schooling (from Census 1991)

Code	Description
99	Not applicable
1	Never or kindergarten only
2	1-4 years of schooling
3	5-8 years of schooling
4	9 years of schooling
5	10 years of schooling
6	11 years of schooling
7	12 years of schooling
8	13 years of schooling
9	14-17 years of schooling
10	18 or more years of schooling

TOTSCHP: Total Years of Schooling (from Census 1996 and 2001)

Code	Description
99	Not applicable
1	Less than Grade 5 or no schooling
2	5 to 8 years of schooling
3	9 years of schooling
4	10 years of schooling
5	11 years of schooling
6	12 years of schooling
7	13 years of schooling
8	14 to 17 years of schooling
9	18 or more years of schooling

DGREE: Highest Degree, Certificate or Diploma (from Census 1991, 1996 and 2001)

Code	Description
99	Not applicable
1	No degree, certificate or diploma
2	High school graduation certificate
3	Trades certificate or diploma
4	College certificate or diploma
5	University certificate or diploma below bachelor level
	University degree:
6	Bachelor’s degree
7	University certificate above bachelor level
8	Medical degree
9	Master’s degree
10	Earned doctorate

Minimum wage rate for CMA by year

CMAs	1990	1995	2000
Halifax (Nova Scotia)	4.5	5.15	5.625 =(5.6*9+5.7*3)/12
Quebec (Quebec)	5.075 =(5*9+5.3*3)/12	6.1125 =(6*9+6.45*3)/12	6.9
Montreal (Quebec)	5.075	6.1125	6.9
Sherbrooke+Trois-Riv (Quebec)	5.075	6.1125	6.9
Ottawa-Hull (Ontario)	5.1 =(5*9+5.4*3)/12	6.85	6.85
Oshawa (Ontario)	5.1	6.85	6.85
Toronto (Ontario)	5.1	6.85	6.85
Hamilton (Ontario)	5.1	6.85	6.85
St.Catharines–Niagara (Ontario)	5.1	6.85	6.85
Kitchener (Ontario)	5.1	6.85	6.85
London (Ontario)	5.1	6.85	6.85
Windsor (Ontario)	5.1	6.85	6.85
Sudbury+ThunderBay (Ontario)	5.1	6.85	6.85
Winnipeg (Manitoba)	4.7	5.125 =(5*6+5.25*6)/12	6
Regina+Saskatoon (Saskatchewan)	4.875 =(4.75*6+5*6)/12	5.35	6
Calgary (Albert)	4.5	5	5.9
Edmonton (Albert)	4.5	5	5.9
Vancouver (British Columbia)	4.9375 =(4.75*3+5*9)/12	6.5417 =(6*2+6.5*7+7*3)/12	7.225 =(7.15*10+7.6*2)/12
Victoria (British Columbia)	4.9375	6.5417	7.225

http://www110.hrdc-drhc.gc.ca/psait_spila/lmnec_eslc/eslc/salaire_minwage/report2/report2b_e.cfm

Minimum weekly wage rate = minimum hourly wage rate * 30

CMAs	1990	1995	2000
Halifax	135	154.5	168.75
Quebec	152.25	183.375	207
Montreal	152.25	183.375	207
Sherbrooke+Trois-Riv	152.25	183.375	207
Ottawa-Hull	153	205.5	205.5
Oshawa	153	205.5	205.5
Toronto	153	205.5	205.5
Hamilton	153	205.5	205.5
St. Catharines-Niagara	153	205.5	205.5
Kitchener	153	205.5	205.5
London	153	205.5	205.5
Windsor	153	205.5	205.5
Sudbury+Thunder Bay	153	205.5	205.5
Winnipeg	141	153.75	180
Regina+Saskatoon	146.25	160.5	180
Calgary	135	150	177
Edmonton	135	150	177
Vancouver	148.125	196.251	216.75
Victoria	148.125	196.251	216.75

Table 3.5.1 Average weekly wage rate ratio for CMAs by sex and year (in real dollars)

CMAs	1991				1996				2001			
	Total	M	F	Ratio	Total	M	F	Ratio	Total	M	F	Ratio
Halifax	653	745	515	0.6913	652	736	542	0.7364	686	775	570	0.7355
Quebec	648	740	515	0.6959	661	749	538	0.7183	661	734	569	0.7752
Montreal	665	757	538	0.7107	694	783	574	0.7331	707	798	594	0.7444
Sherbrooke +Trois-Riv	640	722	503	0.6967	663	745	533	0.7154	671	765	538	0.7033
Ottawa-Hull	762	864	628	0.7269	792	887	671	0.7565	844	934	732	0.7837
Oshawa	767	871	587	0.6739	793	895	643	0.7184	833	958	648	0.6764
Toronto	754	865	611	0.7064	779	875	661	0.7554	818	926	686	0.7408
Hamilton	731	845	556	0.6580	778	892	612	0.6861	794	910	632	0.6945
St.Catharines -Niagara	664	758	506	0.6675	711	829	540	0.6514	689	786	546	0.6947
Kitchener	679	775	527	0.68	719	814	571	0.7015	756	866	590	0.6813
London	680	785	541	0.6892	749	850	618	0.7271	751	860	611	0.7105
Windsor	707	820	542	0.6610	789	907	609	0.6714	858	998	644	0.6453
Sudbury +ThunderBay	744	858	557	0.64918	782	889	624	0.7019	750	857	605	0.7060
Winnipeg	638	723	516	0.7137	655	739	538	0.7280	665	742	566	0.7628
Regina +Saskatoon	657	747	522	0.6988	688	784	557	0.7105	695	799	564	0.7059
Calgary	738	854	567	0.6639	761	882	588	0.6667	814	936	647	0.6912
Edmonton	699	800	545	0.6813	706	804	567	0.7052	739	857	581	0.6779
Vancouver	722	832	566	0.6803	772	870	639	0.7345	780	872	663	0.7603
Victoria	669	765	535	0.6993	734	804	645	0.8022	729	798	649	0.8133

OLS estimation results for different occupations

	Total	Male	Female
OCCUPATION:(Base: senior managers)			
middle and other managers	0.337217	0.356417	0.252937
professionals	0.065284	0.077156	0.043047
semi-professionals and technicians	-0.180144	-0.177844	-0.178444
supervisors	-0.163966	-0.182282	-0.142541
supervisors: crafts and trades	-0.090479	-0.089604	-0.17297
administrative and senior clerical personnel	-0.228162	-0.164699	-0.238121
skilled sales and service personnel	-0.134356	-0.092228	-0.204035
skilled crafts and trades workers	-0.187475	-0.186775	-0.316649
clerical personnel	-0.333416	-0.378307	-0.313743
intermediate sales and service personnel	-0.270045	-0.215316	-0.32218
semi-skilled manual workers	-0.339555	-0.322632	-0.42132
other sales and service personnel	-0.42477	-0.450119	-0.387487
other manual workers	-0.389256	-0.370869	-0.440791

OLS estimation results for different industries, immigration and visible minority status

	total	Male	Female
INDUSTRY(Base: educational serivices):			
other primary industries	0.297974	0.347216	0.211472
manufacturing	0.103706	0.153921	0.051278
construction	0.056661	0.095988	-0.022726
transportation and storage	0.126645	0.149353	0.110972
communication and other utilities	0.173107	0.191341	0.185753
wholesale trade	0.052539	0.077192	0.031148
retail trade	-0.149248	-0.09659	-0.192248
finance, insurance and real estate	0.078068	0.131199	0.03494
business services	0.059927	0.104125	0.031102
government services: Federal	0.124031	0.111796	0.151461
government services: other	0.094841	0.107307	0.080428
Health and social services	-0.0316	-0.043978	-0.041356
Accommodation food and beverage services	-0.350737	-0.354481	-0.332746
other services	-0.149991	-0.118543	-0.162528
IMMI (Base: Canadian born)	-0.01868	-0.014523	-0.01943
VISS (Base: not-visible minority)	-0.122832	-0.15864	-0.069754