Labor Market Fluidity, Skill Accumulation and the Insurance Effects from Taxes (Preliminary)

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Abstract

This paper uses the Canadian tax reform in the year 2000 to study how changes in the income tax schedule affect workers' career choices and welfare. Using administrative data, we document a decrease in the mean and progressivity of the tax code and find that the reform decreased occupational mobility. We develop an equilibrium model of occupational choice with human capital accumulation and incomplete markets. In our theory, human capital accumulation and occupational mobility are intimately related. The reform affected labor markets through the incentives to accumulate human capital in an occupation and the insurance mechanism provided by a progressive tax system. A version of the model calibrated to Canadian data reproduces the observed decline in occupational mobility.

Keywords: Income Taxation, Insurance, Career Choice, Occupational Mobility, Tax Reform.

JEL classification: E21 ·E62 · H24 · J31

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1 Introduction

Can redistributive taxation affect workers' career choices and human capital accumulation? A comprehensive income tax reform in Canada in 2000 reduced the mean taxes and its degree of progressivity. This paper explores the labor market implications of such a reform. In particular, we ask how it affected occupational mobility, earnings, aggregate human capital, and welfare. We find that the reform decreased occupational mobility. We propose a theory in which human capital accumulation and occupational mobility are intimately related. In our framework, the reform affected labor markets through the incentives to accumulate human capital in an occupation and the insurance mechanism provided by a progressive tax system. Changes in the mean and progressivity of taxes affect the incentives to accumulate human capital. However, part of the human capital is occupation-specific, and the occupational choice of workers is filled with uncertainty. Trying new occupations is risky, and if workers are risk averse, changes in progressivity affect the risk-return trade-off workers face in the labor market.

There is a vast amount of literature on redistributive policies to show their importance in affecting human capital accumulation and providing insurance. However, how this insurance shapes the labor market careers of workers and its implications for occupational choice and skill accumulation has received little attention in the macroeconomics and public finance literature.[1] We make empirical, quantitative, and theoretical contributions by studying the Canadian tax reform's labor market effects. On the empirical, we use administrative data to estimate *effective* tax functions before and after the reform for the whole country and for some of its most populated provinces. First, through a difference-in-difference specification that exploits the variation in the decline of progressivity after the tax reform, we estimate a causal effect of the reform on occupational mobility using administrative data on workers' labor market histories obtained from the Survey of Labour and Income Dynamics. We find that occupational mobility decreased by three percentage points nationally. Second, Canadian provincial taxes are much more significant than US state taxes; we show that the tax reform variously decreased the degree of progressivity of total taxes–a total of federal and provincial taxes–across provinces, while the minor change happened in Quebec. We use a difference-in-difference specification that exploits the variation in the decline of progressivity across provinces, and we find that the mobility in Alberta, British Columbia, and Ontario decreased between two and five percentage points more than the mobility in Quebec.

[1] Cubas and Silos (2020) show that some differences in labor market dynamics between Germany and the US can be explained by the degree of progressivity of their tax systems.

The labor market is the primary source of income and offers excellent opportunities, but it is risky. Workers accumulate human capital and take risk to shape their careers by trying new occupations, industries or businesses. Part of that process is the natural discovery of their comparative advantage. In addition, due to technological change or trade reforms, some of the skills workers acquire could become obsolete, and thus, switching jobs is the way to restart a promising labor career. Thus, labor mobility is beneficial as it improves the matches and, as a result, increases productivity. However, some human capital workers accumulate occupation-specific, and thus, it is partially lost once they change occupations. Our theoretical contribution is constructing an incomplete market equilibrium model with human capital accumulation and endogenous occupational choice. In this context, the absence of private insurance markets for labor market career risk can significantly affect worker's allocations. For this reason, social insurance through the tax and transfer system can encourage labor mobility and thus increase productivity.

To our knowledge, it is the first equilibrium model that introduces endogenous human capital accumulation and occupational choice in an incomplete markets framework. Our life-cycle model incorporates the interaction between risky human capital accumulation, occupational risk, and mobility. In each period, risk-averse workers choose how much effort they devote to acquire occupation-specific human capital. There is also a general human that is transferable across occupations, but it is subject to occupation-specific shocks. After observing these shocks, workers decide to stay in their current occupations or move to other occupations, which are more uncertain as the return to their human capital would also alter by changing the occupation. The human capital accumulation technology is occupation-specific, so our model features richer earnings dynamics. An essential aspect of our framework is that the changes in the average taxes affect the incentives to accumulate human capital in the current occupation. For example, by lowering average taxes, the present value of alternative occupations is lower, and thus, it increases the value of staying in the current occupation. In addition, the insurance provided by progressive taxes increases the relative value of uncertainty. The reason is that workers dislike risk, and progressive taxes redistribute from high to low earnings realizations.

Finally, our quantitative contribution is to take the model to Canadian data and use it to interpret the reduced form evidence and measure the reform's effects on human capital accumulation, earnings, productivity, and welfare. We use data on mobility rates by age, earnings shocks, and earnings growth by occupation to calibrate our model. We compute the transition to a new tax regime with lower mean taxes and a less progressive schedule. Our model reproduces the observed decline in occupational mobility in Canada after the reform. In addition, it reproduces the mobility rate by age observed in the data. Lower average taxes are the leading force in deriving the decline in occupational mobility. The lower occupational mobility due to lower insurance (from lower progressivity) decreases the average earnings of workers in the new regime. However, lower average taxes incentivize human capital accumulation in their current occupation, increasing earnings.

The remainder of the paper is organized as follows. Section 2 reports the changes in income taxation and Section 3 shows reduced form evidence on tax reform and occupational mobility and work hours using administrative datasets also provides reduced form evidence between the tax reform and occupational mobility. Section 4 presents the macro model. Section 5 shows the quantitative analysis of the macro model. Section 6 concludes.

2 Income Taxation Reform in 2000

We briefly document the changes in the income taxation system in Canada at the beginning of the new century. First, the federal government increased the number of brackets from three to four and reduced the statutory tax rates for incomes less than $100,000 (see Table 1). Moreover, the federal government stopped collecting progressive surtaxes after 2000.

Table 1: Federal Marginal Tax Rates in 2000 and 2001

Taxable Income	2000 Rates	Taxable Income	2001 Rates
Up to 30,003	17%	Up to 30,753	16%
30,004-60,009	25%	30,754-61,508	22%
Over 60,009	29%	61,508-100,000	26%
		Over 100,000	29%

Source: Canada Revenue Agency.

Note: Before 2001, the federal government additionally collected progressive surtaxes at a range from 1.5% to 5% of tax liabilities.

Second, the provincial governments also changed the provincial tax system after 2000.[2] Except in Quebec, provincial taxes were calculated by multiplying the federal tax liabilities with the provinces' tax rate (tax-on-tax system). Beginning in 2000, provinces moved from the old tax system to a tax-on-income system, in which taxes are collected by provincial specific taxable income. In particular, the provincial tax systems in British Columbia

[2] It is worth noting that provincial income taxes in Canada are much more significant compared to state income taxes in the US. See Kurnaz and Yip (2021) for further details.

and Ontario changed in 2000 and in Alberta it changed in 2001. While British Columbia and Ontario created a progressive tax system, Alberta introduced a flat tax system.

One of the important contributions of this paper is to study *effective* taxes, which can be quite different than statutory taxes (see Guner, Kaygusuz, and Ventura (2014)). To calculate the aggregate changes in *effective* tax rates, there are two *administrative* data sources we can use.

Data Sources The first data source is Longitudinal Administrative Databank (LAD) from Statistics Canada (StatCan).[3] Starting in 1982, a randomly drawn 20% of all tax filers in the T1 Family File (T1FF), which is a yearly income tax return file of all tax filers and their families, is chosen for the LAD. The LAD is augmented with 20% of new tax filers in each of the following years. The second data source is Survey of Labour and Income Dynamics (SLID)–a longitudinal administrative dataset from Statistics Canada (StatCan)–that records workers' labor market activity for six consecutive years and their tax information over time.[4] A new panel is embedded to SLID every three years.[5] Both datasets have information on not only federal taxes and federal tax benefits but also provincial taxes and provincial tax benefits. We use LAD to calculate *effective* taxes as the sample size in SLID does not have allow us to release information on very rich individuals' taxes. However, Figure 5 in Appendix shows that the effective taxes from LAD and SLID are almost identical for many income levels.

Sample Restriction We use a sample of individuals who are between 25 and 60 years and whose labor income is more than 1000 times minimum hourly wage, is at least 60% and at most 120% of their total income.

Income and Tax Notions Our notion of income consists of market income and employment insurance benefits. Our notion of taxes is federal taxes plus provincial taxes minus all tax credits.

Figure 1 shows the effective tax rate changes in the entire Canada and its mostly populated provinces. Both figures show that effective tax rates declined for every income levels. In addition, the reduction was more for higher income earners which implies that the progressiveness of income taxes declined. We observe this reduction in average tax rates for higher incomes in Alberta, British Columbia, and Ontario. Despite the average

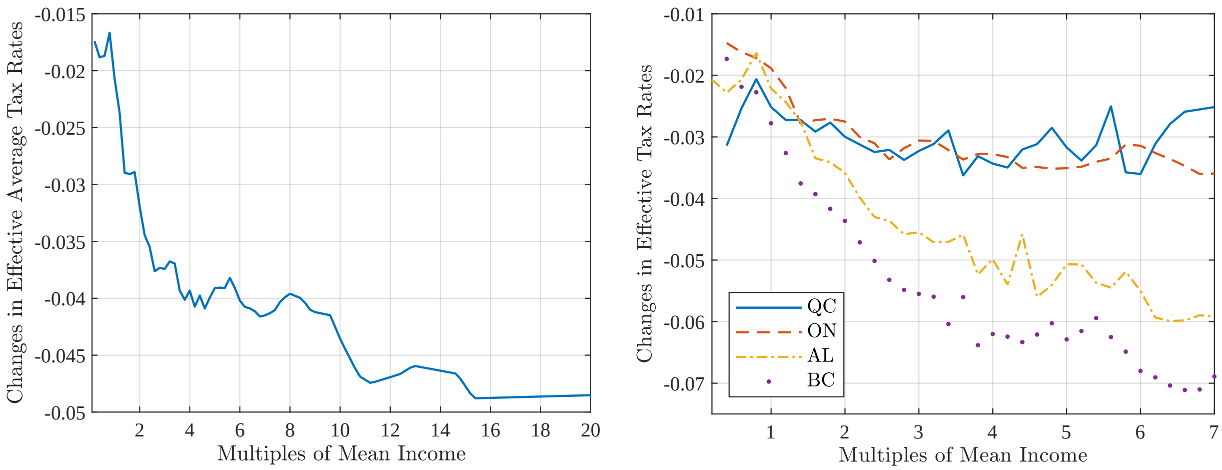
[3]See Kurnaz and Yip (2019) for further details.

[4]We rule out observations whose taxes are self reported.

[5]For more detail, please visit https://www150.statcan.gc.ca/n1/pub/75f0011x/75f0011x2013001-eng.htm.

tax rates declined in Quebec too, the reduction in the tax rate was almost the same for most of the income distribution.[6] This implies that progressivity rate in the tax rate of Quebecers should have less change compared to other provincial residents.

Figure 1: Changes in the Effective Tax Rates



(a) Canada

(b) Most Populated Provinces

Note: We use Longitudinal Administrative Databank (LAD) to calculate average tax rates, which is the ratio of taxes and income. Taxes equals total of federal and provincial taxes minus total of federal and provincial tax credits. Income consists of labor market income and unemployment benefits. ON stands for Ontario, QC stands for Quebec, AL stands for Alberta and BC stands for British Columbia.

To understand the progressivity change due to the reform, we use the measurement proposed by Musgrave and Thin (1948) that the progressivity rate equals to one minus residual income elasticity, i.e.

$$\tau := 1 - \frac{1 - T'(y)}{1 - t(y)} \tag{1}$$

where y is income, and T, T', t are income tax, marginal income tax, and average tax functions, respectively.[7]

[6] Note that seven times multiples of mean income is around the income level of top 0.3% of income distribution.

[7] Many researchers structure the progressivity parameter by assuming a parametric function that represents income taxes. One of the most well-known example is $T(y) = y - \lambda y^{1-\tau}$ introduced by Feldstein (1969) and followed by many researchers such as Benabou (2000) and Heathcote, Storesletten, and Violante (2017), where τ is the progressivity parameter. We assume this functional form in our quantitative model.

Table 2: Tax Progressivity: τ in Equation (1)

	Canada	**Quebec**	**Ontario**	**Alberta**	**British Columbia**
pre-reform	0.184	0.213	0.177	0.177	0.182
post-reform	0.170	0.209	0.164	0.157	0.156

Note: We use LAD to calculate the progressivity of income taxes. Taxes equals total of federal and provincial taxes minus total of federal and provincial tax credits. Income consists of labor market income and unemployment benefits. Pre-reform period is 1996-2000 and post-reform period is 2001-2004.

Table 2 shows that the progressivity rate of the income taxes was declined not for the entire Canada but also for its mostly populated provinces. On the other hand, as implied by Figure 5b, the reduction in the progressivity rate was very small for Quebec while it was modest in Ontario and was high in Alberta and British Columbia.

Discussion of the Reform The reform made two important changes in the income tax system. First, tax rates declined almost everywhere for the same income levels. Second, the taxes became less progressive except for Quebec residents. This may affect two particular decisions of workers. First, due to increase in marginal product of labor (as a result of decline in progressivity), workers might choose to work more or less depending on the strength the income effects. On the other hand, due to less progressivity in the taxes, workers had less public insurance to try their skills in different occupations and consequently workers might choose to be less mobile across occupations. We focus on each case in the next section.

3 Reduced Form Analysis for Tax Reform

This section provides reduced form analysis between the tax reform and the occupational mobility as well as the labor hours. We calculate occupational mobility and labor hours using SLID. To be able to consistent with the sample restriction on LAD, we make a similar sample restriction on SLID, i.e. we focus on the sample whose i) hourly wage is above the minimum wage; ii) hours worked is above 1040 hours but below 5840 hours; (iii) is not work in a farming occupation; (iv) labor share of income is between 0.6 and 1.2.; (v) and who are between 26 and 60 year old. [8]

First, we study the impact of the reform on occupational mobility.

[8] We exclude individuals who didn't report their residential status and annual working hours.

3.1 Occupational Mobility Analysis

Table 3 shows the occupational mobility rate before and after tax reform at one- and four-digit occupational levels. We find that the mobility rate in Canada declined by 16% (12%) at the one (four)-digit occupational level. We also observe similar trend in occupational mobility in Ontario, Alberta, and British Columbia. However, the occupational mobility almost did not change in Quebec. In fact, we observe a slight increase in mobility rate at the four-digit level in Quebec.

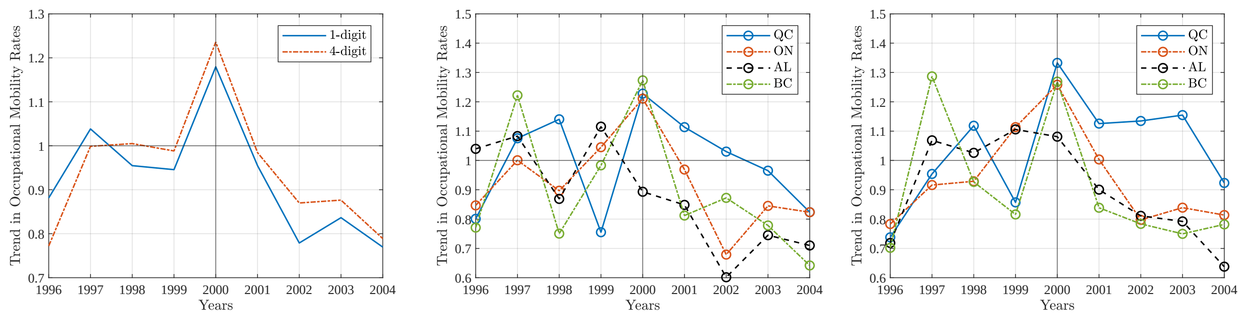
Table 3: Occupational Mobility Rates

	Canada	**Quebec**	**Ontario**	**Alberta**	**British Columbia**
One-digit level					
pre-reform	0.057	0.045	0.061	0.067	0.060
post-reform	0.048	0.045	0.051	0.049	0.047
Four-digit level					
pre-reform	0.100	0.081	0.105	0.120	0.102
post-reform	0.088	0.088	0.091	0.095	0.080

Note: Data source is the SLID. The occupational mobility rate measures the proportion of the population switching occupations from last year. Occupations are based on National Occupational Classification (NOC) at the one-digit and four-digit level. Pre reform period is 1996-2000 and post reform period is 2001-2004.

One might argue whether the trend in the mobility started earlier than the reform. Figure 2 shows that the mobility rates normalized by the average mobility rate before 2000. Figure 2a shows that while the mobility rate for the entire Canada had an upward trend, it had a downward trend after 2000 at both one- and four digit occupation classification, i.e. all occupational mobility rates are less than one and at the bottom right corner. If we specifically focus on provinces, Figure 2b (2c) shows the mobility had an upward trend until 2000 and downward trend after 2000 at one- (four-) digit level except for Quebec.

Figure 2: Occupational Mobility in Canada: 1996-2006



(a) Entire Canada (b) Provinces (1-digit) (c) Provinces (4-digit)

Note: Data source is the SLID. The occupational mobility rate measures the proportion of the population switching occupations from last year. Occupations are based on National Occupational Classification (NOC) at the one-digit and four-digit level. The trend is measured as the mobility rates normalized by the average mobility rate before the tax reform.

The reduction in the occupational mobility rates coincides with the tax reform which implies that workers became less mobile across occupations when the social insurance fell after the tax reform. To investigate the relationship between the tax reform and the occupation mobility, first, we estimate two linear probability models from year 1996 to 2004 with a set of year dummy and control variables using data from SLID.[9] Then, we introduce interaction term to the same specification, allowing us to compare mobility rate between QC and other provinces.

Our reduced form specifications are:

$$\Delta\, occ = \beta_0 + \mathbf{X}'\beta + \beta_r \mathbb{1}_{reform} + \epsilon_i, \tag{2}$$

where Δocc equals to one if an individual changes her occupation and zero otherwise, $\mathbf{X}$ is a set of control variables including age groups (Young (28 - 38), middle-age (39-49), and old (50+)), education (high school, college, and university), language (English, French or Other)gender, panel (cycle) dummy, annual hour worked, have a pre-school child, job duration, if the main job is at management level, union membership, own or renting a dwelling, immigration status, National Occupational Classification (NOC) at the one-digit and a set of dummy for each available Census metropolitan area (CMA). Variable $\mathbb{1}_{reform}, \mathbb{1}_{provinces}$ is a dummy for years after the tax reform and for provinces, respectively.[10]

[9]The year 1996 is when the 2nd panel of SLID first enters the sample while 2004 is the year the 3rd panel of SLID end. This sample period allows us to cover two full panels (2nd and 3rd) and two half panels (1st and 4th) of SLID.

[10]We don't include individual fixed effects in the estimation because (i) SLID has only information on

Table 4: Estimation Results for Equation (2)

Years after reform (β_r)	-0.0134*** (0.00306)	Labor market hours (in 000s)	0.0253*** (-0.00334)
Differential Hourly Wage	0.00167*** (0.000570)	Female	0.00622** (0.00247)
Middle age group (39 - 49 year old)	-0.0173*** (0.00301)	Job duration in months	-0.000349*** (0.0000325)
Old age group (50 - 60 year old)	-0.0329*** (0.00454)	Union	0.0227*** (0.00280)
French	-0.0106*** (0.00313)	Other language	-0.00432 (0.00390)
Immigrant	-0.00807** (0.00364)	Some college	0.000429 (0.00246)
House not owned	0.0219*** (0.00312)	University	0.0115*** (0.00307)
Don't have any pre-school child	0.00425 (0.00301)	Job as managerial	0.0666*** (0.00510)

Notes: Standard errors in parentheses: * p<0.05 ** p<0.01 ** p<0.01. Other control variables include Census metropolitan area (CMA) dummy, panel dummy, and occupations. Occupational mobility is at the four digits of occupation classification.

Estimation results of Equation (2) at four-digit level of occupation classification are stated in Table 4.[11] We observe that workers were less likely to change occupation after the tax reform. In particular, the occupational mobility significantly declined at a rate of 1.3%. In addition, we observe that workers positively reacts to occupational mobility when the potential new occupation has a higher wage.[12] In addition, getting older, job tenure, being a female, and having less education were likely to decrease occupational mobility at a significant level.

Equation (2) shows that Canadian workers became less mobile between occupations after the tax reform reduced social insurance, i.e. income taxes became less progressive. We, then, search for whether less mobility due to less social insurance holds at the provincial level. Our conjecture is since the reduction in social insurance was less in Quebec, we

workers only for 6 years; (ii) the information on the second, third, and fourth waves are available from 1996, 1999, and 2002, respectively. Only the second and the third waves' information are available before and after tax reform, which is even for a very short period of time, i.e. information from 2001 for the second and from 1999 and 2000 for the third wave.

[11]We present the estimation results at one-digit level of occupation classification in Table 4.

[12]Wage differentials are calculated by comparing the expected hourly wage of mover and stayer. To correct for the selective problem, we estimate the wage equation using Heckman correction model.

probably will observe more reduction in occupational mobility in other provinces. We estimate:

$$\Delta\, occ = \beta_0 + \mathbf{X}'\beta + \beta_r \mathbb{1}_{reform} + \sum_{\text{provinces}} \beta_{pr} \mathbb{1}_{provinces} + \beta_{r,QC} \mathbb{1}_{reform,nQC} + \epsilon_i, \tag{3}$$

where $\mathbf{X}$ is the same control variables stated in Equation (2), $\mathbb{1}_{provinces}$ is a dummy for provinces, and $\mathbb{1}_{reform,nQC}$ is the dummy (interaction term) for years after the tax reform and being a non Quebec resident, respectively. Table 5 presents the average marginal effect in occupational mobility at four-digit level with different control variables.[13] In particular, when we control for all possible important variables (i.e. Column (6)), we see that occupational mobility rate of non-Quebecers declined 1.8% more than the decline in the rate of Quebecers. Similarly, the occupational mobility rates in Ontario, Alberta, and British Columbia declined 1.3%, 2.9%, and 1.9%, respectively, more than the rate in Quebec.

[13] Table 12 shows the average marginal effect in the mobility at one-digit level. In contrast to the mobility at four-digit, we don't find always significant results.

Table 5: Estimation Results for Equation (3)

	(1)	(2)	(3)	(4)	(5)	(6)
			Quebec vs Rest of Canada			
Year after reform x nonQuebecer ($\beta_{r,nQC}$)	-0.0195***	-0.0251***	-0.0222***	-0.0194***	-0.0192***	-0.0181***
	(0.00446)	(0.00381)	(0.00450)	(0.00447)	(0.00459)	(0.00460)
			Quebec vs Ontario			
Year after reform x nonQuebecer ($\beta_{r,nQC}$)	-0.0149***	-0.0285***	-0.0162***	-0.0151***	-0.0144**	-0.0137**
	(0.00555)	(0.00479)	(0.00560)	(0.00556)	(0.00575)	(0.00575)
			Quebec vs Alberta			
Year after reform x nonQuebecer ($\beta_{r,nQC}$)	-0.0275***	-0.0326***	-0.0329***	-0.0266***	-0.0308***	-0.0292***
	(0.00797)	(0.00686)	(0.00804)	(0.00798)	(0.00830)	(0.00831)
			Quebec vs British Columbia			
Year after reform x nonQuebecer ($\beta_{r,nQC}$)	-0.0243***	-0.0201***	-0.0271***	-0.0241***	-0.0205***	-0.0199**
	(0.00763)	(0.00647)	(0.00770)	(0.00764)	(0.00796)	(0.00796)
Control						
Union	yes	yes		yes		yes
House owned	yes	yes		yes		yes
Don't have any pre-school child	yes	yes		yes		yes
Job as managerial	yes	yes		yes		yes
Job duration in months	yes	yes		yes		yes
CMA	yes	yes		yes		yes
Occupation	yes	yes				yes
Differential hourly wage					yes	yes
Time Period	1996-2004	1994-2006	1996-2004	1996-2004	1996-2004	1996-2004

Notes: Standard errors in parentheses: * p<0.10, ** p<0.05, *** p<0.01. Other control variables include age, gender, education, immigrant, panel dummy, hours, and language. Occupational mobility is at the four digit of occupation classification.

4 Model

We develop a model in which skill accumulation and occupational choice are intimately related. An essential element in our framework is that workers are risk-averse and face uninsurable occupational-specific shocks to their human capital. Workers respond to changes in degree of uncertainty and the public insurance by accumulating more skills and by choosing an occupations.

4.1 Environment

The economy is populated by a continuum of workers who value the consumption of a final good. Every period they are endowed with a unit of time that is devoted to work. They live for T periods, financing consumption using labor earnings. Workers rank levels of consumption c of the final good according to a utility function $u(c)$. This function is concave, and as a result, workers dislike risk. Workers also choose the effort level or human capital, e, to devote to their job. Exerting effort gives disability, according to a convex function $f(e)$. Finally, workers do not value leisure, supplying all of their time in a labor market described in detail below.

The labor market is divided into sub-markets, one for each occupation. There are J occupations available labeled by an index j from 1 to J. Occupations are mutually exclusive; workers can work in only one occupation during any given period. However, they may switch occupations between periods. During their tenure in occupation j, workers receive an exogenous wage w_j per unit of their human capital.

Human capital comes in two varieties. There is a general purpose human capital that is transferable across occupations. The stock of this type of human capital, denoted by z, evolves over a worker's career. Despite its generality, the evolution of this type of human capital depends on the worker's current occupation. To be more specific, while working in a given occupation, z changes randomly, and the shocks that affect it are occupation-specific. Shocks to z is the source of occupational mobility and are denoted by ϵ.[14] Formally, while an individual works in occupation j, his general human capital evolves according to

$$z_{t+1} = z_t + \epsilon_j \qquad \epsilon_j \sim F_j(\cdot) \tag{4}$$

[14] Occupation-specific earnings shocks are a feature of the models in Cubas and Silos (2017), Carroll and Samwick (1997) and Neumuller (2015).

While on the job, human capital is accumulated by changing "effort".

$$h' = h + (he)^{\alpha_j} \tag{5}$$

where α is occupation-specific.

Workers can switch occupations every period. Accumulated occupation-related human capital is only partly transferable. If they switch, they lose a fraction $\delta(h)$ of occupation-related human capital:

$$\delta(h) = 1 - \frac{1}{h^{\xi}} \tag{6}$$

When workers make an occupational choice they know the value ϵ_j in their current occupation. They do not know that value in a prospective occupation. These shocks capture, for example, the interaction between a worker's skills and an occupation's response to technological innovation. In other words, occupations react differently to changes in technology, and given such a reaction, a worker's human capital may suffer more or less depending on his portfolio of skills.

Thus, pre-tax earnings of a worker in occupation j in period t are given by:

$$y_{jt} = w_{jt}\tilde{h}_{it}z_t \tag{7}$$

where $\tilde{h}_{it} \equiv (1 - \delta(h)) \times \mathbb{1}(switch))h$ is the effective occupational-related human capital, w_{jt} is the wage rate in occupation j.

There is a government that progressively taxes workers according to a parametric tax function, T(y).

Following Feldstein (1969) and then Benabou (2000) and Heathcote, Storesletten, and Violante (2017), we assume that after tax income is given by:

$$T(y) = y - \lambda y^{1-\tau} \tag{8}$$

where λ governs the mean tax level and τ its degree of progressivity.

4.2 Worker Optimization

At the beginning of the period the worker faces an occupational choice decision. The worker knows her current level of general human capital z and the shock in the current occupation ϵ_j. She can remain in her current occupation, with total general human capital equal to $z + \epsilon_j$ and known human capital h. Alternatively, she/he can move to another occupation. In that case, the worker is going to lose some of the occupation-specific human capital.

Define by $W_a(h, z, \epsilon, j)$ the maximum value an age-a agent obtains by choosing among J mutually exclusive occupations. This choice depends on the current stock of occupation-specific human capital, the stock of general human capital z, its current innovation ϵ, and the current occupation j.

The following expression formally describes the choice between an occupation j and a set of alternative occupations $-J$.

$$W_a(h, z, j, \epsilon) = \max\{V_a(h, z, j, \epsilon), \{\mathbb{E}V_a(h, z, -j)\}_{-j \neq j}\}.$$

The value of remaining in the current occupation j, $V_a(h, z, \epsilon, j)$, is conditional on a particular value of the random variable ϵ (the shock to general human capital z). In other words, workers know the contemporaneous productivity shock in their current occupation, but take expectations over possible values of productivity in prospective occupations. Hence the dependence on ϵ_j of the value of staying in the current occupation. This assumption reflects workers' better information about their performance in their current job.

The value of staying is given by the maximum value attained by working in occupation j:

$$V_a(h, z, j, \epsilon) = \max_{e, h'} u(T(y)) + f(e) + \beta \int W_{a+1}(h', z', j, \epsilon') dF_j(\epsilon') \tag{9}$$

given

$$h' = h + (he)^{\alpha_j}$$

$$z' = z + \epsilon$$

$$y = w_j h z'$$

The continuation value is the maximum among J occupations, knowing that productivity in occupation j will experience a shock ϵ'. The (log of) general human capital z evolves according to (9). The current shock ϵ is added to the stock z to update it to its new value z'. A worker's future human capital z' is an increasing function of an idiosyncratic shock ϵ, current human capital z, effort devoted to accumulate human capital or skill production e. [15]

By switching occupations a worker bets that her/his performance will improve as a result of the change. The outcome is uncertain because she/he does not know the ϵ so

[15] In this sense, our work extend the risky human capital dynamic models of Krebs (2003) and Huggett, Ventura, and Yaron (2011).

the worker takes expectations with respect to the distribution to compute the value of the alternative occupation.

The value of the alternative occupation $-j$ is

$$\mathbb{E}V_a(h,z,-j) = \int \max_{e,h'} u((1-T(y))y) + f(e) + \beta \int W_{a+1}(h',z',j,\epsilon')dF_{-j}(\epsilon')dF_{-j}(\epsilon) \tag{10}$$

given

$$h' = h + (he)^{\alpha_{-j}}$$

$$z' = z + \epsilon$$

$$y = w_{-j}h(1-\delta(h))z'e^{-\kappa}$$

$$\delta(h) = 1 - \frac{1}{h^{\xi}}$$

The previous description of the occupational decision problem holds for all periods except the first one. In the first period a fraction f_j of workers is exogenously assigned to occupation j. These workers experience no ϵ shocks (i.e., their z is 0). In the second and subsequent periods they optimally choose their occupation as described above.

4.3 Equilibrium

Let us denote the policy function that describes the occupational decision of an individual of age a characterized by a realization ϵ, and human capital stocks h and z, who is currently in occupation j and who switches to occupation $-j$ by $I_{j,a}(-j,h,z,\epsilon)$.

For aggregation purposes it is necessary to specify the position of individuals across states. Let $\Psi_{j,a}(h,z,\epsilon)$ be the mass of individuals of age a in occupation j, with human capitals h and z, and shock ϵ. The measure Ψ is defined for all the possible values of h, z and ϵ that belong to sets that are Borel subsets of $\mathbb{R}$.

The dynamic evolution of the mass of individuals reads as follows. As described above, the initial mass of workers in the first period in occupation j is exogenously determined and given by f_j. Thus, for $a = 0$,

$$\Psi_{j,0}(h,z,\epsilon) = \frac{1}{S}f_j \quad \forall \quad j \in \{1,...,J\}.$$

In addition, since individuals live T number of years, we have that for $T+1$,

$$\Psi_{j,T+1}(h,z,\epsilon) = 0 \quad \forall \quad j \in \{1,...,J\}.$$

For $0 < a < T$, Ψ obeys the following recursion

$$\Psi_{j,a+1}(h,z,\epsilon) = \sum_{j'} \Psi_{j',a}(h,z,\epsilon) I_{j,a}(-j,h,\epsilon,z) \quad \forall \quad -j \in \{1,...,J\}.$$[16]

The aggregate mass of efficiency units in each occupation is thus given by

$$N_j = \frac{1}{T} \sum_{a \in A} \int e^z e^{\epsilon_{j'}} d\Psi_{j,a}(h,z,\epsilon) + \frac{1}{T} \sum_{a \in T} \sum_{j \neq -j} \int d\Psi_{-j,a-1}(h,z,\epsilon)$$

.

In equilibrium, given wages the occupation decision rules solve the optimization problems described above. In a given occupation j, Ψ_j is the stationary distribution.

5 Quantitative Analysis

We begin our quantitative analysis by calibrating a stripped down version of our model. Specifically, we assume that human capital follows a stochastic process. Formally, while an individual works in occupation j, his general human capital evolves according to $z' = z + \epsilon_j$ where ϵ_j is drawn from a distribution $F_j(\epsilon_j)$ with variance σ_j^2. The current shock ϵ_j is added to the stock z to update it to its new value z'. If the individual switches to occupation $-j$, then human capital next period will be $z' = z + \epsilon_{-j}$.

The main difference is that general human capital is now given by this stochastic process and thus it does not depend on the allocation of time of the worker. Thus, we abstract for now of these time allocation decision and assume that labor supply is inelastic. This human capital is carried over to other occupations if the worker decides to switch, thus occupation-specific shocks have persistent effects. In this way, this version of the model borrows from Cubas and Silos (2017). In addition, we constraint ourselves to an economy with ten occupations.

[16]Note that $-j$ can take the value j since there is a mass of individuals who were in j and stay in j.

5.1 Estimation of Permanent Shocks to Earnings

To calibrate the variance of the shocks to earnings, we uses a regression approach (see, e.g., Carroll and Samwick, 1997) to compute earnings variability at the individual level. We proceed to estimate a fixed effects model for a sample of individual data in ten different occupations. Then, we obtain the variance of the shocks to earnings for each of the occupations. We rank the ten occupations by the variance of the permanent shock. We aggregate them into low (S), medium (W) and high (R) risk group. The grouping of occupations are reported in the Online Appendix.

This standard estimation procedure does not consistently identify the true structural variance parameters (σ_j^2) in the model, since this estimation procedure does not take into account the occupational switches. As the realized shocks lead non switchers to remain in the same occupation, the estimated variances would be downward biased.

However, this procedure yields moments that we need to obtain the "true" underlying variances of the shocks within the structural model.

To obtain the moments, first, we calculate the residuals from an individual-level wage regression. Given a panel of N individuals over a period of time T , we estimate the following:

$$y_{ijt} = \alpha_{ij} + \beta_j X_{ijt} + u_{ijt}, \tag{11}$$

where y_{ijt} is the (log) earnings per hour for individual i in occupation j at time t.

The vector X is a set of control variable including age, gender, ethnicity, years of schooling, location, an industry dummy, and time dummies. β_j are the corresponding coefficients, α_{ij} is the individual fixed effect, and u_{ijt} is the residual. We estimate 11 for all individuals in a given occupation. Repeating this procedure for all occupations yields estimates $\{\hat{\alpha}_{ij}, \hat{\beta}_j\}_{j=1}^{10}$.

It is important for assessing the effect of nature of risk faced by workers on the welfare consequences of changing social policies. Unless the temporary shock is very large, worker should be able to overcome the shock with some savings, instead of changing careers choice. For that reason, we focus only on permanent (or very persistent) risk that can be associated with, for instance, a depreciation of occupation-specific human capital and can therefore lead to an occupational change.

Follow Carroll and Samwick (1997) and Low, Meghir, and Pistaferri (2010), among others, we decompose risk into a permanent component and a transitory component. We assume that

$$u_{ijt} = \nu_{ijt} + \omega_{ijt}, \tag{12}$$

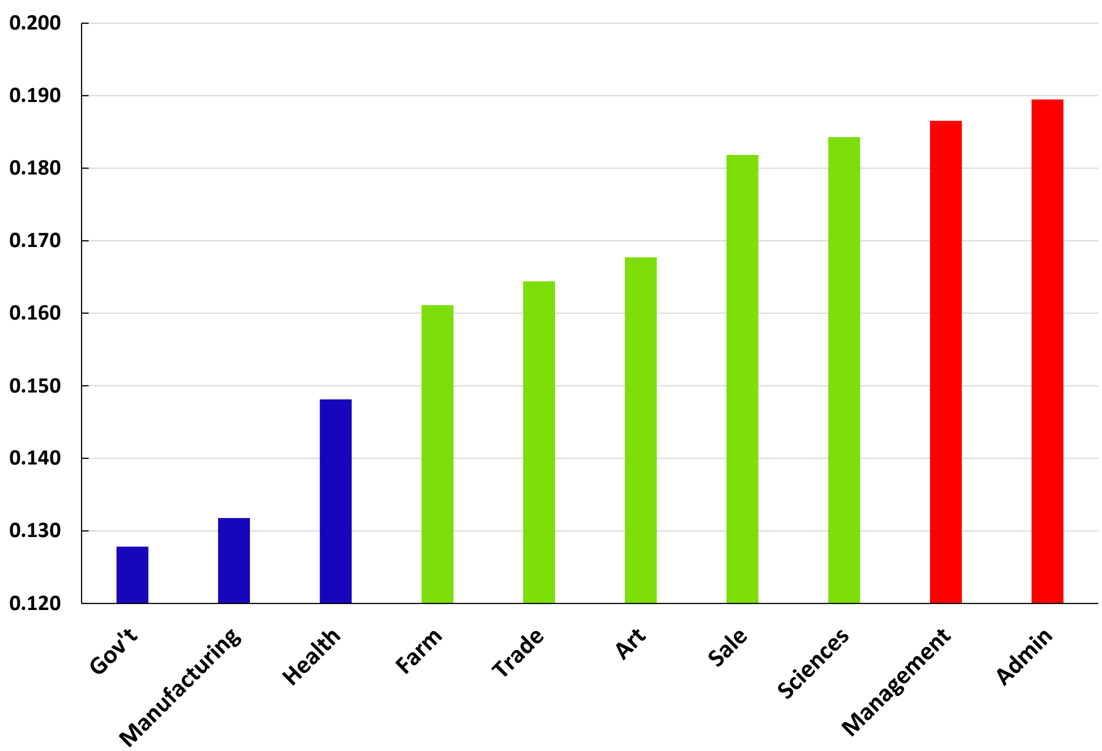
where ν_{ijt} is the transitory component that distributed i.i.d. $N(0, \sigma^2_{\nu j})$ and ω_{ijt} is the permanent component, follows a random walk,

$$\omega_{ijt} = \omega_{ij,t-1} + \epsilon_{ijt}, \tag{13}$$

where ϵ_{ijt} is an i.i.d. innovations that are distributed $N(0, \sigma^2_j)$. By estimating Equation (11), we obtain $\{\{\hat{u}_{ijt}\}_{i=1}^{N_j}\}_{t=1}^{T}$.

This procedure of estimating the variances of ϵ and ν follows the identification procedure of Low, Meghir, and Pistaferri (2010). We estimate $\hat{\sigma^2_{\epsilon_j}}$ and $\hat{\sigma_{\nu_j}}$ for the 10 original occupations. We then computing the weighted averages of these varaince, our moments of interest, $\hat{\sigma}_{\epsilon_S}$, $\hat{\sigma}_{\epsilon_M}$, $\hat{\sigma}_{\epsilon_R}$, that is, the variance of the permanent shocks for the three occupational groups. Figure 3 shows the estimated standard deviations of the permanent shocks.

Figure 3: Comparison of Effective Tax Rates



Note:

5.2 Calibration

We begin by calibrating our model to Canada in the period before the tax reform. The model period is set equal to 1 year and a worker's lifetime S is 33 years. We assume a utility function $u(c,e)$ is of the constant relative risk-aversion class:$u(c) = \frac{c^{1-\gamma}}{1-\gamma} - e^2$. We set the relative risk-aversion coefficient γ equal to 3, and the discount factor β equal to 0.96. The value for γ is well within the range of typically used figures. The value for β is consistent with a real interest rate of 4 percent in an infinite-horizon economy with complete markets when the period is one year.

The parameters of the tax function are also picked outside the model using Canadian administrative data. The values obtained for the pre-reform period are $\lambda = 0.79$ and $\phi = 0.136$.

The values for the remaining parameters are set so that our model economy replicates features of the Canadian economy. We assume that the distribution of shocks to human capital z is normal:

$$\epsilon_j \sim N(-0.5\sigma_j^2, \sigma_j^2), \tag{14}$$

Thus, the set of parameters to calibrate is

$$\Lambda = \left\{ \xi, \kappa, \left\{ \sigma_j^2, \alpha_j, \alpha_j, f_j \right\}_{j=1}^{10} \right\}, \tag{15}$$

We pick values for them by matching mobility rates by three groups of age, the estimated distribution of permanent shocks, regression coefficient associated with switching, and the average earnings growth of non-switchers.

In Table 6 we show the targeted mobility rates for young, middle aged and old workers.

Table 6: Targeted Mobility Rates: Canada

Overall	5.6%
Mob. rate young	7.4%
Mob. rate mid-age	5.2%
Mob. rate old	3.3%

Note: The table displays the moments and the values targeted in the estimation of the model for Canada. Mob, mobility.

Besides targeting the mobility rate by age groups, we also target the standard deviation of the permanent shocks to labor earnings, also by occupation. The variances of permanent shocks to earnings estimated in Section 5.1 are moments for the model to match. Recall that in the data these are estimated for a panel of workers using spells of work in the same occupation. The model counterpart to those moments are computed in an identical way. To be specific, recall that the reduced-form model estimated in Section 5.1 takes the form:

$$\tilde{y}_{ijt} = \alpha_{ij} + u_{ijt}, \tag{16}$$

where $\tilde{y_{ijt}}$ represents log-earnings net of the effect of observables (age, marital status, etc.). The term α_{ij} is a fixed effect of individual i who works for her entire career in occupation j. The term u_{ijt} is a sequence of shocks (transitory and permanent) for a worker who does not switch occupations. Log-earnings in the model for workers who never change occupations follow,

$$y_{ijt} = w_j + \theta_{ij} + z_{ijt}. \tag{17}$$

The fixed effect $w_j + \theta_{ij}$ is the analog of the reduced-form fixed effect α_{ij}. General human capital z_{ijt} follows a random walk, which implies that the evolution of log-earnings in the model (for non-switchers) follows the same dynamics as those implied by the reduced-form model. The only exception is that transitory shocks are assumed to be of zero variance.

We also targeted the earnings growth of non switchers. They help to pin down the parameters that governs the occupation-specific human capital accumulation. The rates are presented in Table 7

Table 7: Earnings Growth Rate of Non-Switchers

Management	7.2%
Business, Finance and Admin	5.7%
Natural and Applied Science	6.2%
Health	5.1%
Social Science Education and Govt	5.9%
Arts, Culture and, Recreation and Sport	4.5%
Sales and Service	5.4%
Trade Transport and Equipment	4.3%
Manufacturing	4.0%

Lastly, we estimate a regression that relates hourly earnings and occupational switching. Specifically, we estimate

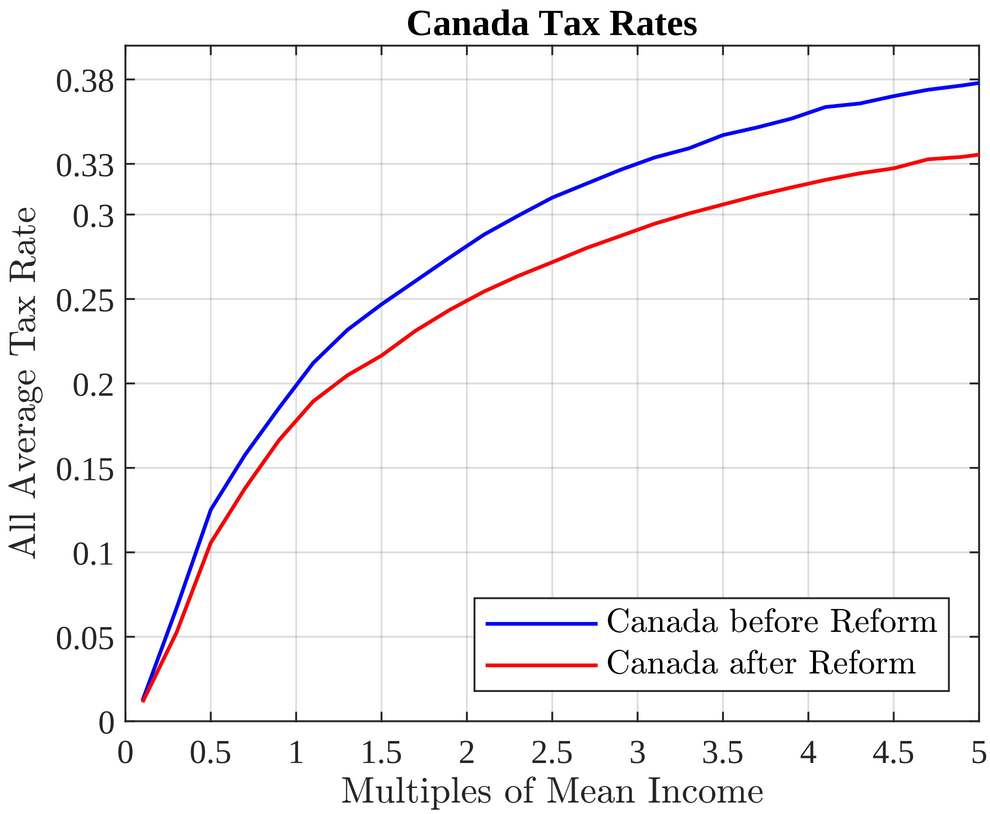
$$logy_{i,t} = \beta_S \mathbb{1}(switch) + \beta X_{i,t} + \epsilon i, t \tag{18}$$

where $y_{i,t}$ are hourly earnings, $\mathbb{1}(switch)$ is an indicator variable on switching, and $X_{i,t}$ is a set of control variables including occupational dummies and occupational tenure. The estimation renders a $\beta_S = -0.0325(0.00563)$. We match the same coefficient running the same regression using model generated data.

5.3 The Canadian Tax Reform and Occupational Mobility

We now use our calibrated model to simulate the Canadian tax reform. In particular, we study how changes in taxation affect allocations. We compute the stationary equilibrium of the model economy post-reform, i.e. with lower mean taxes and a less progressive tax code. Specifically, we use the estimated parameters of tax function after the Canadian reform, that is $\lambda = 0.82$ and $\phi = 0.115$. To illustrate how the shape of the tax function changes with the reform, Figure 4 depicts the two estimated tax functions.

Figure 4: Estimated Tax Functions



Note:

In Table 8 presents the model results regarding the occupational mobility by age groups. As in the data (column 5), occupational mobility dropped for all Canadian workers. The model does a very good job in predicting the mobility rates after the reform. As expected, most of the changes are concentrated among young and middle age workers. Giving Canadian workers less social insurance through lower progressivity lowers occupational mobility. In addition to the insurance effect, mean taxes are lower after the reform and thus the present value of switching to other occupations is lower. In other words, since switching is costly it pays relatively more (in present value terms) to stay in the same occupation to accumulate skills and enjoy the higher returns coming from lower taxes.

In order to decompose these two effects, we simulate a reform in which only the progressivity changes, keeping constant the mean taxes. Table 9 show the results. Although mobility drops, compared to the baseline or pre-reform period, it does so only slightly. Most of the observed changes in mobility are then explained by the changes in mean taxes.

The lower mobility rate may lead to a worse assignment of workers to occupations.

Table 8: Occupational Mobility and the Canadian Tax Reform

	Data (Pre)	Calibration	Tax Reform	Data (Post)
Overall	5.57%	5.3%	4.6%	4.60%
Young	7.4%	7.3%	6.8%	5.66%
Middle	5.2%	5.2%	4.4%	4.6%
Old	3.3%	3.3%	2.6%	3.3%

Table 9: Mobility rates by Age: Only Progressivity Changes

	Calibration	Progressivity Change
Overall	5.3%	5.2%
Young	7.3%	7.2%
Middle	5.2%	5.2%
Old	3.3%	3.2%

That worse assignment can lead to sizable decrease in average earnings. However, by staying in their current occupation and facing lower taxes they will accumulate more human capital and thus enjoy higher pre-tax earnings. In Table 10 we show the average earnings by age group.

Table 10: Average Earnings per Hour at Different Ages

	Calibration	Tax Reform
Young	2.99	3.00
Mid-Age	7.91	7.90
Old	13.10	13.00
Overall	8.33	8.32

6 Conclusions

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Table 11: Estimation Results for Equation (2) at one-digit level

Years after reform (β_r)	-0.00668*** (0.00231)	Labor market hours (in 000s)	0.0000223*** (0.00000252)
Differential hourly wage	0.00237*** (0.000430)	Female	0.00622** (0.00247)
Middle age group (39 - 49 year old)	-0.0154*** (0.00226)	Job duration in months	-0.000237*** (0.0000245)
Old age group (50 - 60 year old)	-0.0308*** (0.00342)	Union	0.00980*** (0.00211)
French	-0.0141*** (0.00236)	Other language	-0.00710** (0.00294)
Immigrant	-0.00765*** (0.00274)	Some college	-0.000438 (0.00186)
House not owned by a member of the household	0.0150*** (0.00235)	University	0.00733*** (0.00231)
Don't have any pre-school child	0.000119 (0.00227)	Job was perceived as managerial	0.0542*** (0.00384)

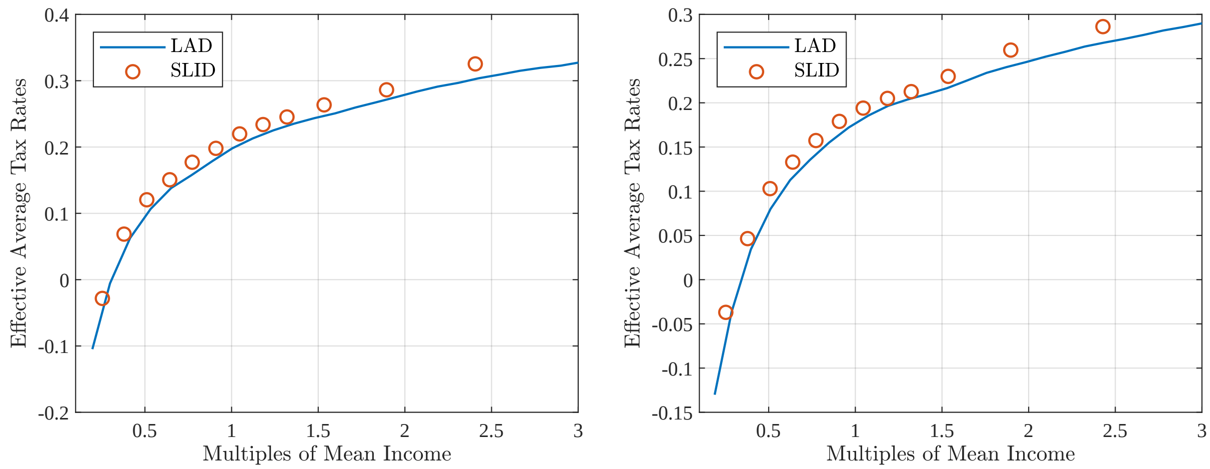
Notes: Standard errors in parentheses: * p<0.05 ** p<0.01 ** p<0.01. Other control variables include CMA, panel dummy, and occupations. Occupational mobility is at the four digit of occupation classification.

Table 12: Estimation Results for Equation (3) at one-digit level

	(1)	(2)	(3)	(4)	(5)	(6)
			Quebec vs Rest of Canada			
Year after reform x nonQuebecer ($\beta_{r,nQC}$)	-0.00475	-0.00824***	-0.00643*	-0.00461	-0.00323	-0.00246
	(0.00340)	(0.00293)	(0.00342)	(0.00341)	(0.00347)	(0.00346)
			Quebec vs Ontario			
Year after reform x nonQuebecer ($\beta_{r,nQC}$)	-0.00281	-0.0106***	-0.00358	-0.00284	0.000508	0.00103
	(0.00424)	(0.00369)	(0.00426)	(0.00425)	(0.00436)	(0.00436)
			Quebec vs Alberta			
Year after reform x nonQuebecer ($\beta_{r,nQC}$)	-0.00666	-0.00950*	-0.00982	-0.00627	-0.00835	-0.00656
	(0.00598)	(0.00520)	(0.00600)	(0.00598)	(0.00615)	(0.00615)
			Quebec vs British Columbia			
Year after reform x nonQuebecer ($\beta_{r,nQC}$)	-0.00630	-0.00605	-0.00789	-0.00593	-0.00611	-0.00594
	(0.00578)	(0.00498)	(0.00581)	(0.00578)	(0.00595)	(0.00594)
Control						
Union	yes	yes		yes		yes
House owned	yes	yes		yes		yes
Don't have any pre-school child	yes	yes		yes		yes
Job as managerial	yes	yes		yes		yes
Job duration in months	yes	yes		yes		yes
CMA	yes	yes		yes		yes
Occupation	yes	yes				yes
Differential hourly wage					yes	yes
Time Period	1996-2004	1994-2006	1996-2004	1996-2004	1996-2004	1996-2004

Notes:

Figure 5: Comparison of Effective Tax Rates



(a) Before Reform

(b) After Reform

Note: