Income Instability and Fiscal Progression*

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Abstract

We construct the ratio of the post-fisc transitory income variance to the pre-fisc transitory income variance of family incomes as a measure of fiscal progressivity in Canada between 1993 and 2008. This ratio can be interpreted as measuring the extent to which the fiscal system attenuates personal income instability. We find that the tax and transfer system has been less effective in stabilizing market incomes after 1998 compared to the previous years. This is attributable to the provincial and federal tax reforms from 1999-2001, which particularly affected families headed by individuals with less than high school education. While the reforms reduced the effective marginal tax rates faced across all educational groups, the reduction is relatively larger among families with highly educated main earners. Moreover, the group with less than high school education is distinct in that the average effective tax burden in this group increased. Changes to Social Assistance also appear to have played a role.

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1 Introduction

A progressive system of taxes and transfers can improve social welfare not only by reducing long-term income inequality but also by stabilizing the incomes of families against fluctuations due to business cycles or other transitory events.[1] In particular, a schedule of increasing marginal tax rates restricts both income gains and income losses (Kniesner and Ziliak, 2002), while social insurance programs provide benefits to unemployed individuals. Previous empirical work suggests that temporary income instability accounts for about one-quarter of the total cross-sectional variance of a population of workers' pre-tax earnings (Beach *et al.*, 2010).

In Canada, the federal and provincial income tax reforms during the past two decades have reduced tax progressivity, while the Employment Insurance (EI) and Social Assistance (SA) programs became less generous and harder to obtain (Frenette *et al.*, 2009). These observations suggest that the tax and transfer system in Canada may have become relatively less effective for income smoothing.[2] To the extent that families are credit constrained or lack private means of smoothing incomes, the reduced protection of families against income shocks is an important policy issue.

In this paper, we examine the changes between 1993 and 2009 in Canada in the ratio of the post-fisc transitory income variance to the pre-fisc transitory income variance. By construction, the ratio of variances controls for the direct effect of variation in market incomes and can therefore be interpreted as measuring the extent to which the fiscal system attenuates market income instability. A lower ratio implies that the tax and transfer system dampens market volatility relatively more effectively. The unit of analysis is family income (adjusted for equivalent scales), as certain tax credits are based on family incomes and on the number of dependent children.[3] To obtain the annual time series of pre- and post-fisc instability variances, we use the method of multi-year rolling windows introduced by Beach *et al.* (2010), in an otherwise standard non-parametric decomposition of the total income variance of longitudinal data into "permanent" and "transitory" components. In this way, we are able to identify gradual changes over time in how well the tax and transfer system protects families against income fluctuations, due to legislated changes in fiscal policy or to the interaction between policy and business cycles.

We provide a simple theoretical model to show an equivalence between the concept of "residual income progression" (RIP) and the ratio of variances described above. RIP measures the elasticity of income after taxes and transfers with respect to income before taxes and transfers and hence it captures overall fiscal progression in a parsimonious manner (Jakobsson, 1976). The elasticity is a simple function of marginal and average effective tax rates (i.e., inclusive of transfers and clawbacks on program benefits). It falls with the marginal tax rate and rises with the average tax rate. Hence, we can use the RIP measure to help explain changes over time in the ratio of post-fisc to pre-fisc

[1] See Bibi *et al.* (2011) for a method of decomposing social welfare into a component of inequality in permanent incomes and a component of periodic variability around permanent incomes.

[2] See OECD (2012) for a review of statutory tax changes in OECD countries between 1981 and 2010. The general trend is toward reductions in the top personal income tax rate and increases in the bottom rate.

[3] The instability of family earnings is generally lower than the instability of individual earners, as each spouse provides implicit insurance to the other against idiosyncratic shocks. See Morissette and Ostrovsky (2005) for empirical evidence of this.

transitory variances by considering how policies impacted marginal or average effective tax rates.

Our approach provides a novel way to examine the evolution of income instability. It is complementary to the method of Frenette *et al.* (2009) who use regressions to estimate the taxes paid and the transfers received by families in different years, according to their socio-economic characteristics, and then use these estimates in counterfactual simulations of post-fisc income distributions, in order to isolate the impacts of each policy change on progressivity. They measure changes in progressivity based on the log of the ratio of income at the 95th percentile to income at the 5th percentile of the post-fisc income distribution and they address income inequality rather than instability.[4] An advantage of our approach over counterfactual simulations is that the behavioral responses of households to policy changes are accounted for in our analysis, since we estimate the transitory variances from the actually observed incomes. The only previous study of the year-by-year evolution of post-fisc income instability that we are aware of is by DeBacker *et al.* (2013). They provide graphical depictions of both the pre-tax transitory income variance and the after-(federal)-tax transitory income variance from 1987 to 2009 in the United States, generated by the estimated autocovariance functions from income regressions. We take a more comprehensive approach to studying the effects of policy by factoring in all the major social insurance programs, federal and provincial personal income taxes, and all sources of market income.

Our study uses the longitudinal panel data in the Survey of Labour and Income Dynamics (SLID). All previous works on earnings variability in Canada use administrative data.[5] An advantage of the SLID over the Longitudinal Administrative Database (LAD) is the availability of information on educational attainment.[6] Education (of the main earner) is used to study subgroups of the population of families. These are interesting because the groups have varying exposures to labour market volatility. We calculate the annual value of RIP for each subgroup of the population using the Canadian Tax and Credit Simulator (CTaCS) developed by Milligan (2008), which allows us to take into account the impacts that benefit clawbacks have on progressivity.

The main findings from our study are as follows. Our measure of fiscal protection against income instability—i.e. the ratio of post-fisc to pre-fisc transitory income variances—was about 50 percent on average over the period 1993-2008. The ratio worsened (increased) substantially during the half decade following the spate of federal and provincial income tax reforms around year 2000, with some improvement in the mid-2000s. The overall pattern very closely mimics the one for the category of families where the main earner has less than high school education. This group exhibits the greatest variance in transitory incomes and it comprises 19 percent of our sample of families. The worsening of protection against risk for families where the main earner has less than high school education is attributable to a combination of reduced marginal tax rates and *increased* average effective tax rates for this group. In contrast, the college and university educated main

[4] Frenette et al. (2009) examine the years 1980, 1985, 1990, 1995, and 2000. Hence, there is a partial overlap of periods with our study.

[5] Baker and Solon (2003) use various tax files from the Canada Customs and Revenue Agency. Morissette and Ostrovsky (2005), Ostrovsky (2008), and Beach, *et al.* (2010) all use the Longitudinal Administrative Database.

[6] A drawback of the SLID, however, is that it spans significantly fewer years than the LAD.

earners saw their average effective tax burdens decline over the same period. The increased average effective tax rate for the group with low education following the tax reforms is therefore surprising. It appears to be attributable to both a higher personal income tax burden (relative to income) and to reduced Social Assistance benefits paid to this group. Finally, the ratio of transitory income variances does not vary significantly across phases of the business cycle.

The remainder of the paper proceeds as follows. Section 2 reviews the most relevant literature. Section 3 provides a simple theoretical model linking income variation to the RIP measure of progressivity. Section 4 describes the SLID data, the decomposition of the total income variance, as well as the calculation of RIP. Section 5 provides a graphical presentation of the trends in the ratio of variances and in the RIP measure. Section 6 contains our regression results relating the ratio of variances to the unemployment rate and to residual income progression. Section 6 contains our conclusions. Details of the variance decomposition method are provided in an Appendix.

2 Related Literature

A burgeoning literature has emerged from the work of Gottschalk and Moffit (1994), who decomposed the total longitudinal earnings variance in the United States into transitory and permanent components using a random effects model of the residuals of log earnings regressed against age dummies. Gottschalk and Moffit (1995) and Haider (2001) used, instead, parametric approaches to estimating the transitory and permanent variance components. These studies, all based on PSID data, generally found that earnings instability accounts for a substantial part of the increase in cross-sectional inequality in the United States during the 1970s and 1980s.[7]

DeBacker *et al.* (2013) depart from the use of PSID data by employing a confidential panel of tax returns from the Internal Revenue Service (IRS) to study individual male earnings and total household income, both before and after taxes. Their measure of after-tax income reflects all federal personal income taxes, including all refundable tax credits, as well as payroll taxes. The authors find that the total variance after-tax was about 15 percent below the total variance before-tax throughout the period 1987-2009, and hence that the progressivity of the U.S. federal tax system was insufficient to offset the trend of rising before-tax income inequality. They also find that the rising inequality is attributable to increases in the permanent component, as the transitory component was stable.

Using Canadian data, Baker and Solon (2003) and Ostrovsky (2010) attribute the rise in pre-fisc total earnings variance for men to increases in both the permanent and transitory components. Those studies are based on a dynamic modelling approach to the variance decomposition. In contrast, Beach *et al.* (2010) apply the non-parametric approach of Gottschalk and Moffit (1994) to decompose the variance of earnings in five-year rolling windows to define permanent versus transitory variations in earnings. Unlike the previous Canadian studies, Beach *et al.* find that the rise of earnings inequality has been due exclusively to increases in the permanent component of variation. Morissette and Ostrovsky (2005) is the only variance decomposition study for Canada

[7] Related studies include Shin and Solon (2011), Moffit and Gottschalk (2008), and Heathcote, *et al.* (2010).

to consider the impact of taxes and transfers. They examine the changes in earnings instability before- and after-taxes between two periods: 1986-1991 and 1996-2001. They find that income taxes and government transfers reduce substantially the instability of post-fisc earnings, with transfers playing the major role. Similarly, a new study by Blundell et al. (2014) finds that the variances of the transitory and permanent shocks to disposable income are substantially smaller than the variances of the shocks to market incomes in Norway. The authors focus on income dynamics over the individual life cycle, rather than the effects of tax reforms across calender time. Hence, the effects of the tax and transfer system on incomes at each age is an average over different cohorts at the same point in their life cycles. In contrast, we study income variations across cohorts in each window of calender time in order to understand the evolution of tax and transfer policies.

Frenette, *et al.* (2009) infer from their analysis of counterfactual policy simulations that, in the 1990s, the Canadian tax and transfer system became less progressive than in the previous decade. They point in particular to the reductions in progressivity in the interval 1995 to 2000 due to the decreases in federal and provincial surtaxes on high-income and large cuts to Social Assistance payments as well as shortened benefit periods for Employment Insurance.

3 Variance and Residual Income Progression

This section provides a simple model linking residual income progression to the ratio of post-fisc to pre-fisc income variances. Let y_t^i be person i's pre-fisc income at time t and suppose that

$$\ln y_t^i = \ln w^i + \ln z_t \tag{1}$$

where w^i represents a permanent person-specific indicator of skill and z_t is a transitory macroeconomic shock that is common to all individuals. Differences in w_i across people generates permanent income inequality while the common shock z_t represents income fluctuations arising from business cycles. Assume that $\ln w^i$ and $\ln z_t$ are independent and normally distributed:

$$\begin{aligned} \ln w &\sim N(\mu_w, \sigma_w^2) \\ \ln z_t &\sim N(\mu_z, \sigma_z^2). \end{aligned}$$

These assumptions imply that the distribution of the log of income across the population at time t is given by

$$\ln y_t \sim N(\mu, \sigma^2)$$

where $\mu \equiv \mu_w + \mu_z$ and $\sigma^2 \equiv \sigma_w^2 + \sigma_z^2$.

Suppose the tax/transfer system converts an amount pre-fisc income y_t^i into an amount of post-fisc income x_t^i according to the function

$$x_t = y_t^{1-\tau_t} \widehat{y}_t^{\tau_t} \tag{2}$$

where τ_t is an index of marginal tax rate progressivity and $\widehat{y}_t$ is the break-even income level implied by the tax and transfer system. Note that if $\tau_t = 0$ then no redistribution occurs since $x_t^i = y_t^i$, while if $\tau_t = 1$ then there is full redistribution as everyone obtains an identical post-fisc amount equal to $\widehat{y}_t$. The exponent $1 - \tau_t$ measures the elasticity of post-fisc income with respect to pre-fisc income, which is commonly called residual income progression (RIP). The smaller is RIP the more progressive is the tax/transfer system. Specifically, Jakobsson (1976) shows that if the system can be characterized by a constant value of RIP across all income levels, then RIP accords with Lorenz dominance for ranking income distributions. RIP can also vary across income levels, i.e., RIP equal to $(1 - \tau_t(y_t))$.[8] In our empirical work we take into account the non-constancy of RIP by studying subgroups of the population classified by educational attainment of the main earner in the family, since more years of schooling is known to be a strong predictor of income.

The tax/transfer function (2) implies that

$$\ln x_t \sim N(\tau_t \ln \hat{y}_t + (1 - \tau_t)\mu, (1 - \tau_t)^2\sigma^2)$$

and hence the ratio of the post-fisc income variance to the pre-fisc income variance is given by

$$R_t \equiv \frac{V(\ln x_t)}{V(\ln y_t)} = \frac{(1 - \tau_t)^2 \left(\sigma_w^2 + \sigma_z^2\right)}{\sigma_w^2 + \sigma_z^2} = (1 - \tau_t)^2. \tag{3}$$

In theory the ratio of variances (R) equals the residual income progression of the tax/transfer system in a given year. Note also that R can refer to the ratio of total variances or to the ratio of each variance component separately. That is, the long-term component of the ratio of variances is

$$R_{wt} \equiv \frac{(1 - \tau_t)^2 \left(\sigma_w^2\right)}{\sigma_w^2} = (1 - \tau_t)^2$$

and similarly the short-term component of the ratio of variances is

$$R_{zt} \equiv \frac{(1 - \tau_t)^2 \left(\sigma_z^2\right)}{\sigma_z^2} = (1 - \tau_t)^2.$$

This suggests that the time series variation of R_{zt} (also R_{wt} and R_t) is explainable by changes in $(1 - \tau_t)^2$. Notice that the tax function implicit in (2) is $T(y_t) \equiv y_t - x_t$, from which it follows that $1 - dT/dy_j^i = (1 - \tau)(\widehat{y}/y_j^i)^\tau$ and $1 - T/y_j^i = (\widehat{y}/y_j^i)^\tau$, where dT/dy_t^i is the marginal tax rate and T/y_t^i is the average tax rate faced by an agent with income y_t^i. Therefore, empirical values of RIP (and RIP-squared) can be obtained from the calculation

$$\text{RIP} \equiv 1 - \tau = \frac{(1 - \text{ Marginal tax rate})}{(1 \ - \ \text{Average tax rate})}. \tag{4}$$

We explain in more detail in Section 4 how we calculated RIP for each subgroup of families using SLID and CTaCS.

[8] See Ebert (1992) for an analysis of local values of RIP and their relation to global indexes of progression.

While the equality between the ratio of transitory variances R_{zt} and RIP-squared illustrates nicely a theoretical connection between fiscal policy and income instability, it must be stressed that the model abstracts from some important considerations that would likely make RIP-squared deviate from the estimated ratio of variances. In particular, the above tax function $T(y)$ assumes that taxes and transfers depend only on the total market income of a taxpayer. In reality, different sources of income are taxed at different rates (e.g., dividends versus capital gains versus earnings). Perhaps more importantly, social transfers are contingent on events, such as unemployment or having children, and hence two households with the same market income may be treated differently by the tax/transfer system. Consequently, the measure of RIP applicable to income instability may not be the same measure that applies to income inequality. Furthermore, an average value of RIP-squared across families, even within an educational attainment category, may pose problems of aggregation due to the contingent nature of cash transfers and to the dispersion of incomes within a subgroup.

4 Data and Empirical Methods

4.1 SLID

We use confidential files of the Survey of Labour and Income Dynamics (SLID) collected annually by Statistics Canada. The survey has a structure of six-year overlapping panels, and interviews 15,000 households from 10 Canadian provinces excluding Indian reserves.[9] The data include detailed information on the respondent's personal tax and transfers files and a rich set of individual and family socio-economic characteristics.[10] Our sample consists of 505,983 main income earners aged 20 to 64 years who reported earnings over $1,000 (in constant 2010 dollars) for at least two consecutive years, with self-employment income not greater than employment earnings, and income reported for at least four years. Income information on the main earner's spouse is also present. Main earners who are full-time students are excluded as their limited labour force participation would increase the measurement error of the estimates. We construct four education groups defined by degree completion: Less than High School (19% of main earners), completed High School (27%), non-university College (35%), and University including post-graduate studies (19%).[11]

4.2 Definitions of Pre-Fisc and Post-Fisc Family Incomes

The definition of pre-fisc income, i.e. before taxes and transfers, consists of labour earnings, dividends, capital gains, rental incomes, alimony, etc. The amounts are expressed in constant dollars of 2010 by deflating with the Consumer Price Index. The unit of study is the family, hence we

[9] Each households is interviewed for six consecutive years. Every three years a new sample of households is surveyed, making two panels overlap for three years. The five available panels since the SLID started, commenced in 1993, 1996, 1999, 2002, 2005 and 2008.

[10] Over 80% of respondents grant consent to Statistics Canada for the extraction of their information from the T1 tax and income administrative files, the rest report tax information directly through the questionnaire.

[11] The correlation in the data between number of years of schooling and income is 25 percent on average over 1993-2009. This indicates that the educational categories are a reasonably good proxy for broad income groups.

sum all of the family members' incomes, scaled using the family equivalent scale.[12] We use family income because some government transfers and tax credits are granted based on family characteristics. We scale family income by family size and composition to standardize the unit of analysis. Post-fisc income is income after federal and provincial taxes and transfers. The transfer programs include Employment Insurance (EI), Social Assistance (SA), Canada Pension Plan (CPP), Old Age Security (OAS), the Guaranteed Income Supplement (GIS), Child Tax Benefit (CTB), etc.[13]

Table 1 provides summary statistics for our sample of families. The average main earner of Canadian families over the 1993-2009 period had $41,000 of pre-fisc income and $36,000 of post-fisc income (in 2010 dollars). The average EI benefit for families was $920 and the average SA benefit was $790. The average family paid $8,780 in income tax. There are, however, important differences when the population is grouped by the main earner's education.

On average, a main earner with less than high school obtained 47 percent of the amount earned by an average earner with university education. The percentage increases to 54 percent when comparing post-fisc incomes. As for program benefits, family heads with less than high school received 59 percent more in EI benefits than family heads with university. The latter group received on average only 8 percent of the SA benefits received by the former group. Income taxes paid by families with less than high school was 32 percent the amount paid by families with university educated heads. As expected, EI benefits are counter-cyclical, while SA benefits show a clear decline since the program reforms in the mid-1990s.

4.3 Variance Decomposition

We follow the methodology of Beach *et al.* (2010). We first eliminate life-cycle effects from the income profile of each family in the data. This is done because we are not interested in the variation in income due solely to the predictable influence of age (of the main earner). Hence, we regress the log of pre-fisc family income on a quartic in age using the full panel of data and we define the adjusted log of income by $ya_{it} = \ln y_{it} - \widehat{\ln y_{it}}$, where $\widehat{\ln y_{it}}$ denotes the fitted values of the quartic.

The variance of the adjusted log of income ya_{it} is then decomposed into long-term and short-term components using the random effects model introduced by Gottschalk and Moffit (1994). This yields

$$var_{total} = var_{permanent} + var_{transitory}$$

which corresponds to $\sigma^2 = \sigma_w^2 + \sigma_z^2$ using the notation of Section 3, where σ_w^2 is associated with persistent income inequality and σ_z^2 is associated with transitory income instability. The formulas for the variance decomposition are described in the Appendix.

The income variance decomposition technique is applied to rolling windows of years as in Beach *et al.* (2010). That is, we estimate the earnings instability over 1993-2009 by dividing the 17-year

[12] To account for economies of scale within a family (an additional family member increases expenses but at a lower rate), family income is scaled assigning weight of 1 to the oldest member of the family, 0.4 to other adults older than 16 years, and 0.3 to each person younger than 16.

[13] As we have restricted our sample to exclude main earners aged 65 or older from the sample, and OAS and GIS is available only at age 65, these program benefits affect the families in the sample only if the non-main earner of a family is a benefit recipient.

Table 1: Summary Descriptives of Canadian Earners by Education: 1993-2005.

	(1)	(2)	(3)	(4)	(5)		(6)	(7)	(8)	(9)	(10)
Year	All	Less than HS	High School	College	University		All	Less than HS	High School	College	University
Pre-fisc Income						Post-fisc Inc					
1993	36.70	23.73	32.84	37.64	57.03		32.81	25.79	30.22	33.12	44.91
1994	37.49	23.06	33.50	38.58	58.50		33.19	24.84	30.47	33.70	45.99
1995	37.55	23.50	33.87	38.02	57.82		32.95	25.28	30.30	33.29	44.78
1996	38.01	23.70	35.05	38.19	58.02		33.34	25.04	31.47	33.35	45.44
1997	38.77	24.16	35.35	39.46	59.04		33.73	25.35	31.52	34.17	45.69
1998	40.97	24.71	37.52	40.67	63.17		35.33	25.69	33.12	35.02	48.91
1999	41.45	25.94	37.76	40.87	63.89		35.76	26.56	33.40	35.25	49.53
2000	43.09	26.93	38.73	42.33	67.28		36.94	27.37	34.12	36.40	52.04
2001	44.71	27.60	39.31	43.00	70.68		39.16	28.69	35.47	37.90	55.82
2002	44.02	28.13	40.24	42.74	64.92		38.83	28.94	36.06	37.87	52.48
2003	44.28	28.24	40.01	42.57	65.30		38.88	28.86	35.95	37.53	52.61
2004	45.27	28.68	40.52	43.19	66.19		39.69	29.36	36.20	38.25	53.42
2005	45.75	27.74	40.23	44.63	65.90		40.16	28.72	36.29	39.39	53.30
EI benefits						SA benefits					
1993	1.39	1.80	1.34	1.38	0.98		1.09	2.38	1.15	0.61	0.19
1994	1.23	1.56	1.05	1.26	1.00		1.00	2.23	1.11	0.51	0.15
1995	1.02	1.32	0.86	1.05	0.89		1.03	2.28	1.05	0.66	0.22
1996	0.99	1.21	0.89	1.08	0.75		1.06	2.29	1.15	0.64	0.21
1997	0.89	1.14	0.88	0.91	0.68		0.95	2.15	0.92	0.56	0.20
1998	0.87	1.11	0.87	0.89	0.67		0.89	2.01	0.94	0.47	0.19
1999	0.73	0.93	0.72	0.79	0.49		0.75	1.89	0.73	0.43	0.12
2000	0.70	0.83	0.65	0.80	0.46		0.66	1.79	0.63	0.33	0.11
2001	0.79	1.03	0.75	0.79	0.55		0.64	1.63	0.63	0.35	0.13
2002	0.93	1.08	0.85	0.98	0.78		0.58	1.31	0.67	0.37	0.09
2003	0.85	1.01	0.82	0.85	0.72		0.56	1.27	0.67	0.33	0.10
2004	0.86	0.99	0.82	0.88	0.83		0.54	1.34	0.63	0.33	0.09
2005	0.78	0.99	0.81	0.78	0.63		0.57	1.47	0.63	0.34	0.12
Income Tax						Gov Transfers					
1993	8.18	4.92	6.94	8.08	14.24		4.30	6.98	4.32	0.00	2.13
1994	8.31	4.71	7.12	8.22	14.53		4.01	6.48	4.08	3.33	2.01
1995	8.53	4.81	7.30	8.22	15.07		3.93	6.59	3.73	3.49	2.03
1996	8.51	4.92	7.41	8.21	14.59		3.85	6.26	3.83	3.37	2.01
1997	8.68	4.89	7.41	8.37	15.34		3.64	6.07	3.57	3.09	2.00
1998	9.24	5.04	8.07	8.70	16.17		3.60	6.01	3.68	3.05	1.91
1999	9.04	5.09	7.75	8.52	16.03		3.35	5.71	3.38	2.91	1.67
2000	9.36	5.08	7.76	8.76	16.97		3.21	5.53	3.15	2.82	1.73
2001	9.01	4.79	7.28	8.09	16.86		3.46	5.88	3.44	2.98	2.00
2002	8.66	4.81	7.77	7.90	14.52		3.47	5.62	3.59	3.03	2.09
2003	8.74	4.79	7.67	7.90	14.68		3.34	5.41	3.61	2.86	1.99
2004	8.94	4.88	7.86	7.88	14.87		3.37	5.57	3.54	2.94	2.10
2005	8.94	4.57	7.42	8.24	14.71		3.35	5.55	3.48	3.01	2.11

Notes: All income definitions are annual averages of family aggregates, scaled by family size and composition and expressed in thousands of real canadian dollars of 2010. Family equivalent scale used to scale family amounts. Pre-fisc income is the before tax and transfers income, also known as market income. Post-fisc income is income after tax and transfers. Employment Insurance and Social Assistance refer to benefits received by all family members, scaled using Family Equivalent Scale. Income tax is the tax paid by family scaled by family size and composition. Source: Author's calculations using SLID 1993-2005.

interval into 14 rolling windows: 1993-1997, 1994-1998, 1995-1998, 1996-2000, 1997-2001, 1998-2001, 1999-2003, 2000-2004, 2001-2004, 2002-2006, 2003-2007, 2004-2007, 2005-2008, 2006-2009. Since two different panels overlap every three years, the length of every third rolling window is four instead of five years. Rolling windows imply that the "permanent" income of a given family at any given year is based on the family's average income (net of life-cycle effects) over the next five (or four) years, while the family's transitory income refers to fluctuations around this average. There is a necessary tradeoff between the length of the window and the number of annual variances that can be calculated. The choice of five years for the windows is the same as Beach *et al.*, although the length of the panels in SLID (six years) does oblige us to make due with four year windows in 1995, 1998, 2001, and 2004, as well as for the final year 2006 because the data in SLID currently ends in 2009. The overlap of years across windows implies a moving average process over five (or four) consecutive years, but despite the high degree of autocorrelation in the estimated variances, distinct turning points can be identified over the global interval from 1993 to 2009.

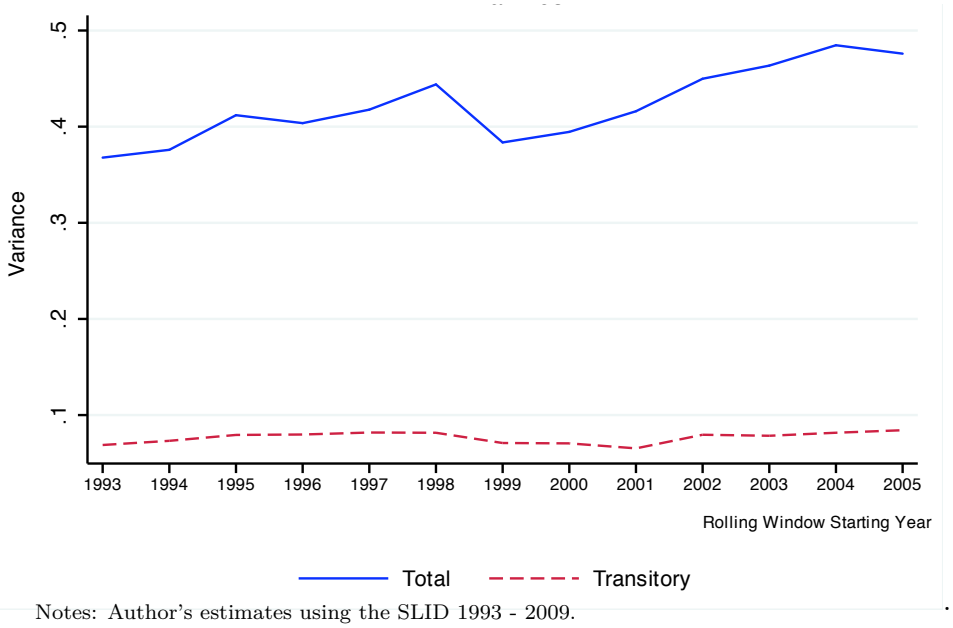
The whole procedure is then repeated with the log of post-fisc family incomes.

4.4 Residual Income Progression

To obtain an annual time series of RIP, we calculate the average value of RIP for the population of families each year, and we do this also for each subgroup of families. We proceded as follows. The amount of each source of income in the family, as well as each tax deduction, and the family's characteristics, notably the number of dependent children, is inputed from the SLID into the Canadian Tax and Credit Simulator (CTaCS). CTaCS then calculates the net tax burden of the family. This is defined as the sum of federal and provincial tax liabilities minus all non-refundable and refundable tax credits. Any EI or SA benefits are also subtracted from the total net tax amount to represent the family's overall *net fiscal position* with respect to government taxes and transfers. We then add $5,000 to the income of the main earner in the family and then we recalculate the net fiscal position of the family. CTaCS takes into account the clawback on EI benefits that may arise. However, it cannot calculate the clawback on SA benefits, so some inaccuracies will arise in the calculation of the change in the net fiscal position of certain families.

The marginal tax rate (MTR) of the family is then simply the change in its net fiscal position divided by $5,000. The family's average tax rate (ATR) is its original net fiscal position divided by its total market income. RIP equals (1 - MTR)/(1 - ATR). The calculation of RIP is undertaken for subgroups of the population of families defined by categories of educational attainment of the main earner. As income and education are strongly correlated, the average value of RIP in each subgrouping reflects broadly the degree of progressivity over different income ranges.

Figure 1: Total and Transitory Variance of Pre-fisc Income for all families



Notes: Author's estimates using the SLID 1993 - 2009.
Recall that the year 1996 corresponds to the period 1996 to 2000, the point for 1997 reflects 1997-2001, and the point for 2006 is constructed from data from 2006-2009.

5 Graphical Results

5.1 Pre-Fisc Variance

5.1.1 All Families

Figure 1 depicts the 1993-2009 time series of the total variance of pre-fisc family income and the variance of the transitory component – the inequality variance is the difference between the two. The total variance based on all families shows an increasing trend over the whole period, except for a sharp decline in 1999. By 2005 the total variance is 29 percent higher than in 1993. The pattern resembles closely an approximate average of the pattern for the labour earnings of individual men and women reported in Beach et al (2010).

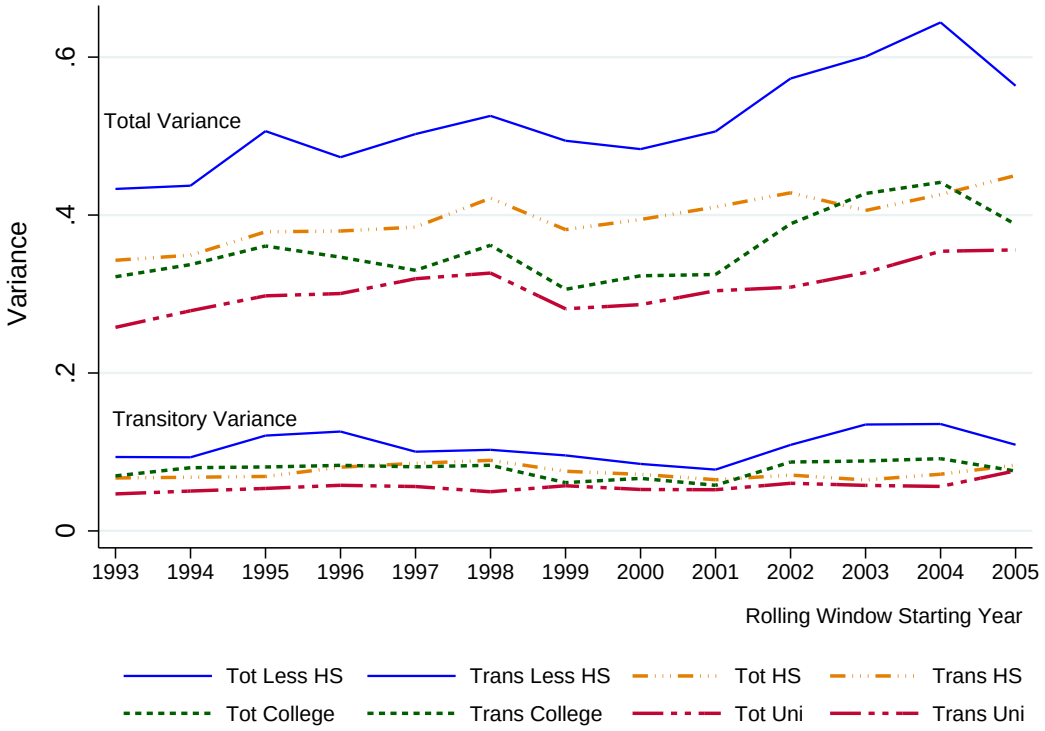
The transitory variance is on average 18 percent of the total variance over the whole period. Instability is fairly constant throughout the period, similar again to the patterns found by Beach *et al.* Overall, the increase in the total variance over the 1993-2009 period is attributable to widening inequality, rather than increasing instability of family incomes.

5.1.2 Families by Education

Figure 2 shows the pre-fisc total variance and the pre-fisc transitory variance by educational category.

The temporal patterns are similar across the educational groups, but not surprisingly the sizes of both the total and the transitory variances are ordered by educational attainment. Families in

Figure 2: Total and Transitory Variance of Pre-fisc Income by Education



Notes: Author's estimates using the SLID 1993 - 2009.

which the main earner has less than high school education have total income variances that are about 69 percent higher than families in which the main earner has a university degree; similarly, their instability variance is about 82 percent higher.

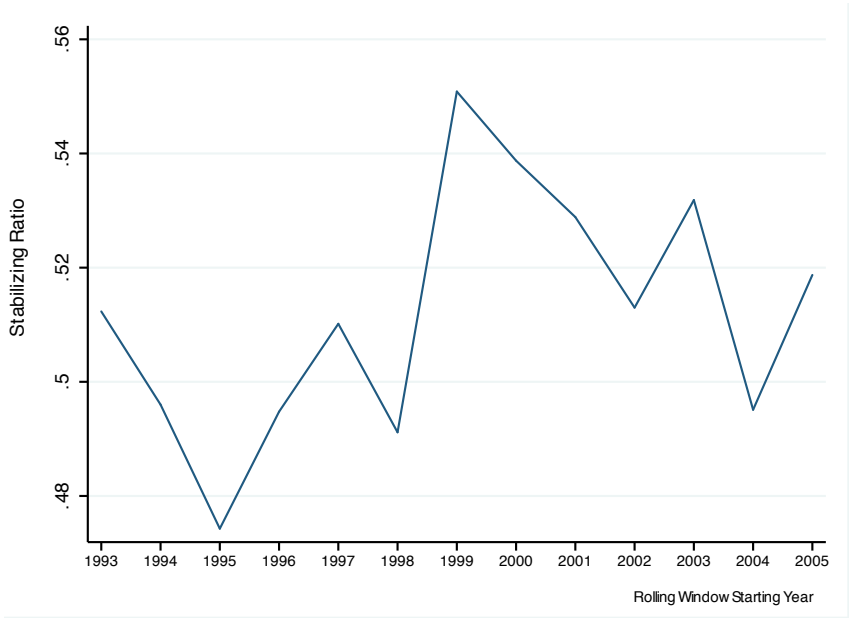
5.2 Ratio of Transitory Variances

5.2.1 All Families

The ratio of the post-fisc to pre-fisc variance of the transitory component of family incomes captures the extent to which the tax and transfer system attenuates volatility in market incomes; the lower the ratio the more stabilizing is the fiscal system. The ratio of variances is shown in Figure 3 for all families. To interpret the results it is important to remember that the data point for a given year corresponds to the effects of policies and business cycles over several years; thus, for example, the ratio of variances in 1996 refers to the period 1996 to 2000; similarly, the point for 1997 reflects 1997-2001, etc. Over the entire 1993-2009 period the ratio of variances averaged 0.51, indicating that about half of the year-to-year volatility of market incomes was absorbed by the tax and transfer system.

The reductions in progressivity reported in Frenette *et al.* (2009) over the period 1995 and 2000, due to the tax reforms and reduced SA and EI benefits, are clearly observable in Figure 3

Figure 3: Ratio of Post- to Pre-fisc Income Instability of All Families



Notes: Author's estimates using the SLID 1993 - 2009.

as the ratio of variances rises from 0.47 percent to 0.55 percent between these years. The ratio moderates somewhat in the mid-2000s.

5.2.2 Families by Education

Figure 4 shows the ratio of variances by educational category. It suggests that the broad pattern for ratio of variances seen previously for all families in Figure 3 is driven mainly by families headed by earners with less than high school education. This is not surprising since families with relatively low education exhibit the most unstable incomes, as shown in Figure 2 above. In contrast, the ratio for university educated heads of households has trended modestly downward throughout 1993-2009 period. Furthermore, the ratio of variances for the university educated group is about 1.68 times higher than for the less than high school group, indicating that the system contributes much more to stabilizing the incomes at the lower end of the income distribution.

In order to better understand the sources of the changes in the ratio of variances, we turn to the estimates of residual income progression and its marginal and avarage effective tax rate components.

5.3 Residual Income Progression

5.3.1 All Families

The size of RIP captures a measure of fiscal progressivity. As with the ratio of variances the closer is RIP (and RIP-squared) to zero the more redistributive is the system of taxes and transfers. Figure 5 depicts the value of the squared value of RIP for all families, along with the (squared) numerator and denominator of RIP, as per equation (4). Broadly speaking, RIP-squared captures

Figure 4: Ratio of Post- to Pre-fisc Income Instability by Education

Notes: Author's estimates using the SLID 1993 - 2009.

a pattern of decreasing progressivity over the entire period, but especially after 1998, consistent with the pattern of the ratio of variances in Figure 3. Looking at the components of RIP in Figure 5, we can see that this pattern is driven by both a decreasing marginal tax rate (which increases the numerator of RIP) and a rising average tax rate (which decreases the denominator of RIP).

5.3.2 Families by Education

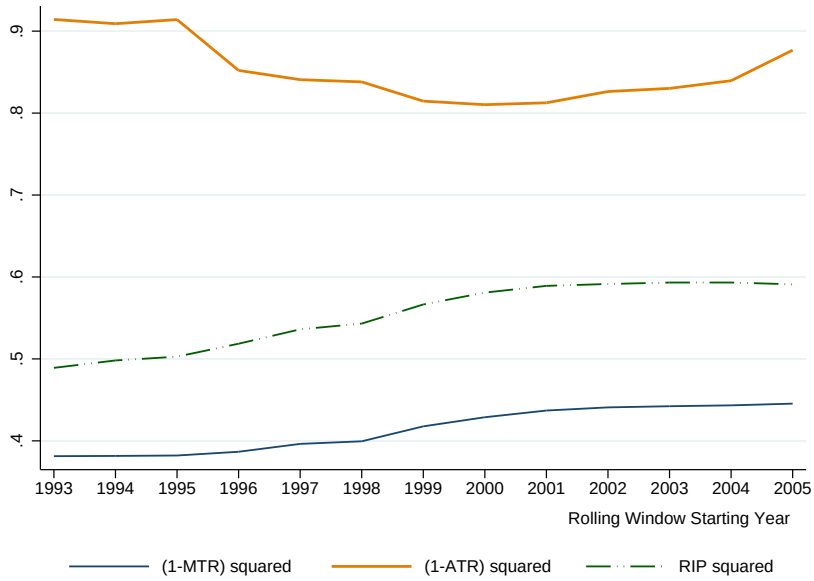
Figure 6 shows RIP by educational attainment.[14] The pattern of RIP over time for each group is similar to the pattern for all families, but the increase in RIP after 1998 is largest for the group with less than high school education. This is consistent with our earlier observation that the rise in the ratio of post-fisc to pre-fisc transitory variances is being driven primarily by what is happening to this group. Figure 7 pursues this further by showing the numerator and the denominator of RIP-squared for each educational group. The fall in the marginal tax rate in every group corresponds to the elimination of the federal surtax on incomes above $50,000 in 1999, the reduction in provincial surtaxes, and reductions in federal statutory tax rates in 2000 and 2001. What is particularly striking in Figure 7 is the *rise* in the average tax rate (i.e. the fall in $(1 - ATR)^2$) faced by families in the less than high school education group. In contrast, the college and university educated families saw their average tax rates fall after 1998.

5.3.3 Discussion

Figure 8 depicts the "implicit" personal income tax rate of each income quintile, as reported directly by Statistics Canada. This is defined as the average personal income tax paid as a fraction of the

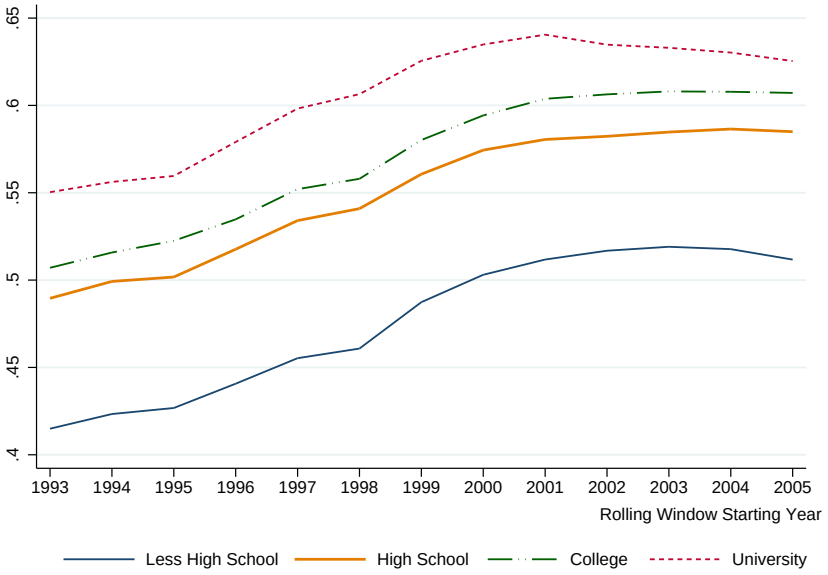
[14]The calculation of RIP ends with 2008 because that is the last available year for the CTaCS program.

Figure 5: Residual Income Progression Squared (RIP^2) of All Families



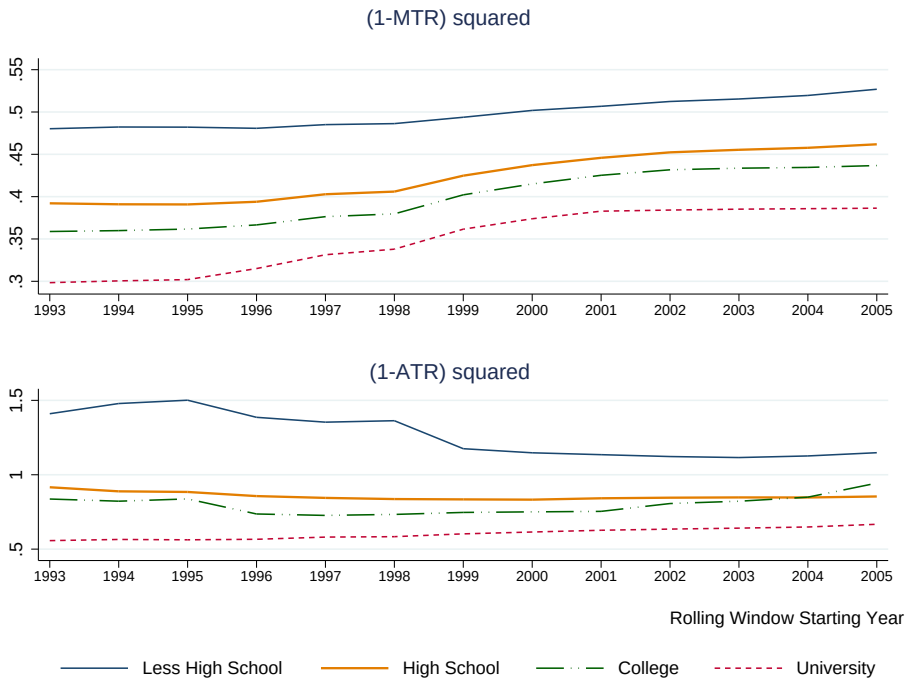
Notes: Author's estimates using the SLID 1993 - 2008 and CTaCS.

Figure 6: Residual Income Progression squared (RIP^2) by Education



Notes: Author's estimates using the SLID 1993 - 2008 and CTaCS.

Figure 7: RIP's Numerator and Denominator by Education



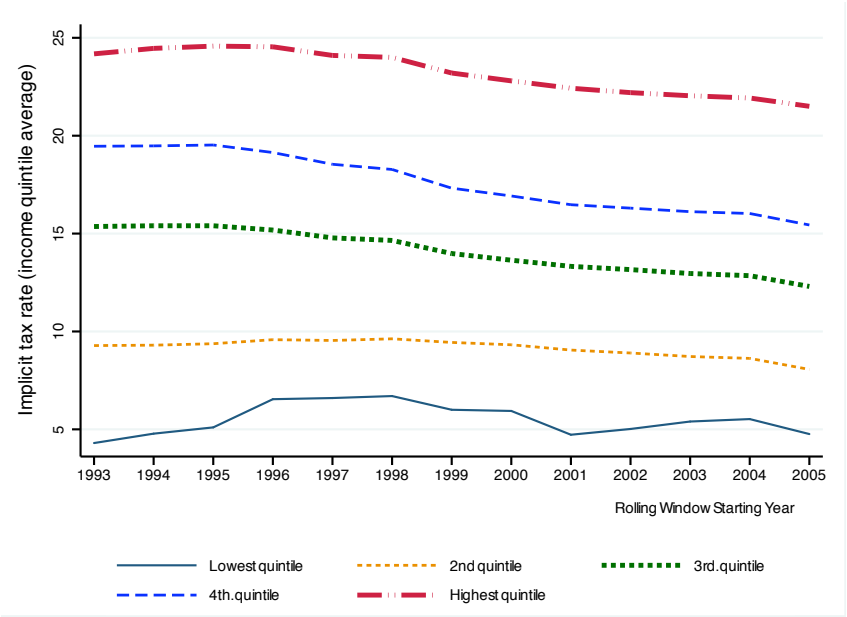
Notes: Author's estimates using the SLID 1993 - 2008 and CTaCS.

average pre-tax income in each quintile. The lowest quintile, which is most likely to be representative of earners with less than high school education, is the only one among the quintiles to exhibit a persistently higher implicit tax rate after 1996, and with a large jump in 1999.[15] Hence, changes in the personal income tax have eroded the protection of low income families against income fluctuations by raising their average personal income tax burden while lowering their marginal burden. These observations have not been previously noted in the literature.

Another contributor to the rise during the second half of the 1990s, and subsequent moderation, in the ratio of post-fisc to pre-fisc transitory variances of families with less than high school education may have been the changes to the Social Assistance program. Figure 9 shows the generosity of Social Assistance from 1993-2009 as measured by SA payments as a percentage of Statistics Canada's after-tax Low Income Cutoff (LICO) for couples with two children. The percentage declined substantially from 1993 to 2001 and then rose moderately from 2001 to 2005. Reforms to the Employment Insurance program during the 1990s probably had little effect on the decline in progressivity after 1998. In particular, the ratio of EI beneficiaries to the number of unemployed was virtually constant at 44 percent between 1997 and 2007.

[15]For consistency with the previous graphs, the implicit tax rates are averaged over the years corresponding to each rolling window.

Figure 8: Implicit Personal Income Tax Rate by Quintile, 1993-2009.



Notes: Implicit personal income tax rate by quintile. Source: Table 202-0501 of Statistics Canada. Averages by rolling window.

Figure 9: Social Assistance Generosity, 1993-2009

Notes: Social Assistance Generosity measured as the provincial weighted average of Social Assistance income as a percentage of After-tax LICOS. Source: Welfare Income Report 2009 by the National Council of Welfare, and the SLID for provincial percentages of couples with two children. Averages by rolling window.

6 Regression Results

In this section we use regression techniques to relate the changes in the ratio of variances over time to the unemployment rate and to RIP-squared.[16] Table 2 reports the regression results.[17] The first column regresses the ratio of the post-fisc to the pre-fisc transitory variances only against the unemployment rate (UR). The coefficient is insignificantly different from zero for all families and all groups (except for marginal significance in the case of the college group). This may reflect offsetting effects of unemployment on the ratio of variances. The fiscal system is more stabilizing when the unemployment rate is high, because EI payments increase and many individuals face lower marginal tax rates as their incomes are diminished in economic downturns. At the same time, some individuals may be more exposed to income losses during slumps, if they do not qualify for EI benefits, and more than half do not.

Table 2: Ratio of Post- to Pre-fisc Income Instability Models using Moving Average Process

Variable	(1) UR	(2) Squared RIP
All families		
RIP squared		0.478***
Unemployment Rate	-0.008	
Constant	0.558***	0.243**
Less than High School		
RIP squared		0.788**
Unemployment Rate	0.006	
Constant	0.354*	0.018
High School		
RIP squared		1.313***
Unemployment Rate	-0.019	
Constant	0.629***	-0.215
College		
RIP squared		-0.179
Unemployment Rate	0.021*	
Constant	0.364***	0.601***
University		
RIP squared		-0.103
Unemployment Rate	0.016	
Constant	0.543***	0.724***

Notes: The dependent variable is the ratio of post-fisc to pre-fisc transitory income variables. Residual income progression (RIP) is a measure of progresivity of the tax and transfer system. Full information maximum likelihood (FIML) estimators with three-period moving average disturbances. ***, **, * indicate statistical significance at the 1%, 5% and 10% levels.

[16] Both the unemployment rate and RIP-squared are constructed as moving averages over the same years as the construction of the transitory variances. For example, UR for 1996 is the average unemployment rate from 1996-2000.

[17] The residuals are are modelled with a moving average (MA) process. The construction of the variances using rolling windows implies that the period-by-period variances are likely to be serially correlated, as noted by Beach et al. (2010). It does not necessarily follow that the ratio of variances will be serially correlated, but it is the case for some of the educational groups.

The second column provides regression results of the ratio of variances against RIP-squared. An ideal fit between the variables entails a slope coefficient equal unity and a constant equal to zero. We observe a positive coefficient on RIP-squared for all families, but the constant term is also statistically significant. The residual income progression model works best for the less than high school and high school groups, where the coefficients on RIP-squared are not too far from one (0.788 and 1.313, respectively) and the constants are statistically insignificant. These results suggest that, identifying the statutory changes to programs and taxes that would alter the effective marginal and average tax rates, is useful for explaining changes in the ratio of variances for the high school and less than high school education groups. In particular, the sharp increase in the ratio of variances for the less than high school group between 1998 and 2001 that is clear in Figure 4, indicating a fall in progressivity in the income range of that group, is reflected in the corresponding rise in the value of RIP for that group as observed previously in Figure 6.

In the cases of college and university educated heads of households, the coefficients of RIP-squared are statistically not different from zero while the constants are highly significant. This indicates that the RIP measure used to assess the stabilizing influence of tax and transfer policy is less relevant for understanding income instability for the more educated groups. This could arise because the market incomes of these groups are fairly stable, so that the impacts of programs and taxes are less important. There may also be an aggregation problem in the calculation of RIP for the relatively more educated groups. Future research could focus on refining the technique, for instance, by calculating RIP separately for the impacts of transfer programs versus personal income taxes, and decomposing the income variances for alternative income definitions, such as family market income plus EI benefits. This disaggregation could provide a closer match between residual income progression and the corresponding reduction in income volatility.

7 Conclusions

This paper describes the changes in the capacity of the tax and transfer system to stabilize family incomes in Canada over the period 1993-2009. The analysis is based on the ratio of the post-fisc variance of the transitory component of incomes to the pre-fisc variance of transitory incomes. This ratio can be interpreted as the proportion of the market income risk of families that is not absorbed by government policies. The closer the ratio of variances is to zero the more stabilizing the fiscal system. The variances of the post- and pre-fisc transitory incomes are calculated using a widely used variance decomposition of the total longitudinal variation in incomes into long-term (permanent) and short-term (transitory) components, based on a rolling window of years. The rolling window approach, which uses overlapping panels of longitudinal data, was developed recently by Beach *et al.* (2010). The ratio of variances is calculated for all families and for families categorized by the educational attainment of the head. We also provide a theoretical model linking the ratio of variances to the residual income progression (RIP) measure of fiscal progressivity. Regression analysis relates the ratio of variances to the unemployment rate and to residual income progression.

Our principal finding is that the ratio of variances increased substantially after 1998 compared

to the earlier years, indicating a turn toward less progressivity. The pattern is driven mainly by the families with heads who have less than high school education, who account for almost one-fifth of all families in our sample. The ratios of variances for the college and university educated heads are more constant. The trend toward less progressivity appears to be due to a combination of less personal income tax progressivity and to reductions in the generosity of Social Assistance benefits for low income households. The subsequent improvement in Social Assistance generosity in the early 2000s is reflected in some moderation by the mid-2000s in the trend towards more progressivity

The relationship between the ratio of variances and the RIP measure of progressivity is reasonably good for the less than high school and high school groups. This allows us to interpret for these two groups the changes in the ratio of variances in terms of policies affecting either the marginal or average effective tax rates, where these rates factor in program benefits as well as personal income tax rates. However, for the college and university groups there was no statistical relationship between the ratio of variances and the RIP measure we calculated. Future research could address a better correspondence both in theory and in practice between the RIP concept and the ratio of post-fisc to pre-fisc transitory income variances.

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8 Appendix: Variance Decomposition

The literature of earnings inequality uses the earnings variance decomposition technique proposed by Gottschalk and Moffit (1994) decomposes the net of life-cycle effects income into a long-term and short-term component. The variance of the predicted earnings is decomposed by its two components, as follows:

$$\begin{aligned} var_{total}(y_{it}) &= var_{permanent}(y_{it}) + var_{transitory}(y_{it}) \\ \sigma^2_{total} &= \sigma^2_{perm} + \sigma^2_{trans} \end{aligned}$$

where the total variance is defined by

$$var_{total}(y_{it}) = \sigma^2_{total} = \left(\frac{1}{K-1}\right) \sum_{i=1}^{N} \sum_{t=1}^{T_i} \left(y_{it} - \bar{\bar{y}}\right)^2$$

which can be decomposed by the short-term, called transitory variance:

$$var_{transitory}(y_{it}) = \sigma^2_{trans} = \left(\frac{1}{N}\right) \sum_{i=1}^{N} \left[\left(\frac{1}{T_i - 1}\right) \sum_{t=1}^{T_i} (y_{it} - \bar{y_i})^2 \right]$$

and the second component, the long-term variation is a measure of the persistent determinant of the variance, called permanent component:

$$var_{permanent}(y_{it}) = \sigma^2_{perm} = \left(\frac{1}{N-1}\right) \sum_{i=1}^{N} \left(\bar{y_i} - \bar{\bar{y}}\right)^2 - \frac{\sigma^2_{trans}}{\bar{T}}$$

where $\bar{\bar{y}}$ is the mean income across individuals over time, $\bar{y_i}$ is the mean income of an individual over time, T_i is the number of periods where individual i is observed, N is the number of individuals, and K is the sum of year-periods observed by all the individuals. The assumption that every individual is observed the full time period, $T_i = T$ ensures the variance of earnings is fully decomposed on transitory and permanent components. $K = \sum_{i=1}^{N} T_i$

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