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An Economic Model of the Distribution of Family Income in Canada

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1. Introduction

This paper develops a reduced-form model of the distribution of family income in Canada. The model consists of quintile and decile income shares and focuses on the major economic determinants of changes in income shares. It thus allows one to analyze how these different factors affect the distribution of income, includes such key features as the Middle Class, major income gaps and overall income inequality. More specifically, it examines hypotheses with respect to the claim that “a rising tide lifts all boats” and relative roles of automation and globalization on the distribution of market income and family income.

Recent years have seen a growing concern with the need for “inclusive growth” – driven by growing income and wealth inequality across most developed countries and by the so-called Great Recession in the United States of a decade ago (where massive supports were provided to the U.S. and European financial sectors while unemployment of workers hit multi-decade highs). Major recent studies have examined various aspects of this issue, including Ostry et al. (2014) for the IMF, van der Weide and Milanovic (2014) for the World Bank, and Summrs and Balls (2015) for the Centre for American Progress, and in Canada Johal and Yalnizyan (2018) for the Mowat Centre, Milligan (2014) for the C.D. Howe Institute, and the Queen’s International Institute on Social Policy (2019). Research efforts are also afoot to more closely link or unify National Accounts and the distribution of personal income in a “Distributional National Accounts” (Fixler et al., 2019; and Piketty, Saez and Zucman, 2018, 2019). There has also been growing concern about the aggregate employment and distributional effects of widening globalization and trade on the one hand and on-going advancements in automation and artificial intelligence on the other (e.g., Acemoglu and Restrepo, 2018a, 2019; Burstein and Vogel, 2017; Caliendo et al., 2019; Goos et al., 2014; Hummels et al., 2018; and Tobal, 2019). More broadly reviewed concerns of increasing income inequality can be found in Beach (2016).

Several early studies have examined how various economic, social and demographic factors have affected the distribution of income in Canada through to the 1980s with only limited time series of consistent data and a mix of methodologies (eg., Buse, 1982; McWatters and Beach, 1989, 1990; and Wolfson, 1986). There have been a great many studies describing how income inequality in Canada has changed since the early 1980s (eg., Marian, 2001; Beach and Slotsve, 1996; Morissette, Picot and Lu, 2013; and Beach, 2016), but few empirical studies providing a formal analysis of the relative roles of the major economic determinants contributing to these changes. There has also been a huge recent literature on why income inequality has changed in Canada (e.g., Fortin et al., 2012; Green, 2016; Green and Sand, 2015; and Green, Riddell and St-Hilaire, 2016), but no formal empirical model to integrate or pull these different effects together and examine where distributionally they operate. Most interest has also focused on earnings of individual workers, whereas here we principally address income of Canadian families. This paper seeks to fill this gap in the literature. Finally, the paper exploits a new consistent Statistics Canada set of annual time series on income (and earnings) shares since 1976. Very conveniently, this coverage interval encompasses the period since the early 1980s when income inequality started to markedly increase.

The paper proceeds as follows. The next section examines graphically some of the key features of changes in the Canadian family income distribution since 1976. Section 3 develops a quintile share income distribution model, while Section 4 extends the analysis to a decile share model. In Section 5, the empirical analysis is further extended to also examine a share-based model for the distribution of family earnings. Section 6 looks more closely at the degree of sharing of the distributional gains from overall economic growth over this period, or in the words of an earlier literature, does a rising tide lift all boats similarly. In Section 7, the study turns to sorting out the distributional effects of globalization and trade on the one hand vs automation and technological change on the other. The next section then examines estimated effects of major economic factors on aggregate inequality in the form of the Gini coefficient and on disaggregative income gaps across the distribution. Section 9 then concludes with a review of major findings and some of their implications.

The major contributions of the paper are two. First, it provides a formal model of how major economic determinants such as the unemployment rate, labour force participation rates, GDP growth and the inflation rate affect the distribution of income in Canada. It thus provides an empirical framework for examining the relative distributional importance of those determinants over different regions of the distribution and hence on major income gaps in the distribution. It could also serve as a component of a joint macro-distribution model. Second, the empirical analysis includes a formal test of the distributional benefits of economic growth in the Canadian economy over the 1976-2016 period (i.e., a test of "distributional neutrality"). Third, the model of income distribution for Canada is extended to include an examination of the effects of automation and globalization across the distribution. As a methodological aside, the study also offers a further interpretation of relative income shares effects as also relative income gap effects spanning the distribution.

2. Major Features of Canadian Family Income Change, 1976-2016

The measure of income used in this study is annual total money income receipts (before taxes but including government transfers) as defined in Statistics Canada's Canadian Income Survey (and earlier household surveys) over the period 1976-2016. The data come from Statistics Canada's CANSIM database Table 206-0031. The basic recipient unit in this study is economic families of two or more persons. This grouping unit can be viewed as sharing resources and hence economic well-being. It is also the basis of a common measure of the so-called Middle Class in the literature as the middle three quintiles of family income. We also look at both total family income as well as a family market income (i.e., family income receipts before government transfers).

Figures 1-5 highlight several key features of how the distribution of family income has changed in Canada since 1976. Figure 1 illustrates how mean and median (real) family incomes have changed. For the first twenty years of this period, real incomes grew very little and experience marked cyclical changes. From 1976 to 1996, median family income slipped slightly from 71.4 to 69.4 thousand (constant 2016) dollars, and mean incomes rose slightly from 80.1 to 80.4 thousand dollars. Since then, the median has gone up by 28.7 percent to $89.3 thousand in 2016 and the mean has increased by 33.0 percent to $106.9 thousand (all in 2016 dollars). This pattern is rather different from the typical U.S.-based narrative of declining wages and income levels in the labour market. Evidently, we have a distinctive pattern in Canada to examine.

Figure 2 shows corresponding changes in aggregate inequality in family incomes (as measured by the conventional Gini coefficient). In this case, roughly speaking, the opposite pattern occurred. The Gini coefficient of family income went up from 0.313 in 1980 to 0.362 in 2000 and has since plateaued or drifted down a bit to 0.347 by 2016. For market income, the shift up in inequality in the early 1980s and early 1990s was even more dramatic. Again, clear cyclical patterns are evident with rises in recessionary periods (with slack labour markets) and declines over periods of sustained economic growth (and accompanying tighter labour markets).

Figures 3 and 4 illustrate changes in the five quintile shares of total and market family incomes since 1976. The i'th quintile income share is the proportion of all family incomes in the economy being received by families in the i'th 20 percent of families ranked from lowest to highest income levels. So the first or bottom quintile share is the fraction of all family incomes going to the poorest 20 percent of families, and the fifth or top quintile share is the income share of the highest-income 20 percent of families. Figure 3 shows that the income shares of the second and third quintiles (i.e., the lower-middle set of families ranked by income) have noticeably slipped since the late 1970s, while the share of the top 20 percent of families has risen. Between 1977 and 2013, for example, the second quintile share (Q2) slipped from 13.2 percent to 11.2 percent and Q3 slipped similarly from 18.5 percent to 16.6 percent, while the Q5 share went up from 37.8 percent to 42.8 percent. If one defines the Middle Class to be the middle three quintiles (or central 60 percent) of families in the economy, the middle-class share fell from 56.1 percent to 51.1 percent over this period (Figure 5). Clearly, there has been a major shift of resources in the economy from the middle and lower-middle-income families to those toward the top end. (The Q1 share of market income experiences quite volatile shifts because of its small base of market incomes which does not include transfers such as CPP and EI.)

3. Basic Quintile Income Share Model

We begin by updating the basic family income quintile share model from McWatters and Beach (1990) which, in turn, followed from Buse (1982). The dependent variables are the set of family income quintile shares.

The methodology followed in the present approach advances on that of fitting specific density functions to income distribution histogram data and then relating the estimated underlying parameter values of the fitted functions to macroeconomic variables (Metcalf, 1969; Thurow, 1970; Gottschalk and Danziger, 1985) in that the present income share approach involves regressions which are much easier to interpret intuitively and allows one to identify effects that may be felt over only limited ranges of incomes in the distribution. The approach also simplifies and improves on the indirect quantile approach of Beach (1976, 1977) in that income share regressions are estimated directly from raw Statcan data without the messiness of prior interpolated construction of the dependent variables. An income share approach also allows one to improve the economic efficiency with limited numbers of observations by exploiting underlying adding-up constraints.

3.1 A Basic Model of Quintile Shares

Since the major source of income for most families is earnings obtained from working in the labour market, the initial set of variables operate through the labour market. The first captures labour market attachment. Since different patterns in such attachment have occurred since the 1970s, separate variables are entered for male and female labour force participation rates, PRM and PRW, from CANSIM Table 282-0002). Greater labour market attachment generally increases family incomes, and there is likely to be more sensitivity to such variation over lower regions of the income distribution, so one would expect, for most income shares, a positive effect of PRM that generally decreases as one moves up the distribution. One should keep in mind that participation rates can vary for a range of reasons. In the case of PRM, demographics have been important over the sample period as the large Baby Boom generation has aged, first entering the full-time labour market in the 1970s and early 1980s and then retiring out of it starting by the 2010s. There has been a large literature on worker displacement and discouraged worker effects on older workers (especially males), especially in more isolated communities when a major plant closes, and on the general lack of growth of median male wages in the economy that could otherwise pull such workers back into the labour force. The advent of the so-called “gig economy”, on the other hand, offers opportunities for part-time or intermittent work which could increase incomes.

The female participation rate saw big increases in the 1980s and many baby boomers entered the labour market, especially married boomers. Female wages have also broadly risen over the sample period, generous day-care subsidies have occurred in the province of Quebec, and a general shift in the economy towards more service-sector jobs have all helped raise PRW. Older female workers are now also starting to ease out of the labour market into retirement or part-time/intermittent work. Since women still generally have lower earnings levels than men, one would expect a somewhat weaker effect of PRW than that of PRM on income shares in the distribution. The sign of the effect of PRW on income *shares*, however, is unclear. If the big increases in female participation rates occurred among higher-educated and professionally trained women who generally tend to marry similarly skilled higher-earning men, the effect would be to raise the income share of higher-income families and hence decrease the share among lower-income families.

Unemployment tends to disproportionately hit lower-income households. So one would expect a negative effect on lower-income shares that generally attenuates as one moves up the distribution. The unemployment rate (from CANSIM Table 282-0008) reflects business cycle patterns that we have already seen from the above graphs have been quite noticeable on both income levels and overall income inequality, and it is a leading measure of overall labour market tightness or slack and its consequences. It also reflects both disemployment (for a variety of reasons explored further below) as well as shifts to involuntary part-time work. We would expect stronger unemployment effects on market income shares than on total family income shares (which include the buffering effect of government transfers, although this buffering effect was weakened in the mid-1990s).

The Consumer Price Index or CP (from CANSIM Table 326-0021) can also pick up business cycle effects and hence tightness or slack in the economy operating through the output market. To the extent that a more rapidly growing economy may disproportionately benefit lower-skilled and lower-income households, one would generally expect a positive effect on lower-income shares that again attenuates as one moves up the distribution. On the other hand, higher inflation rates result in higher (nominal) interest rates that disproportionately benefit older families with larger financial savings towards the higher-income regions of the distribution.

Changing employment structure of the economy can also be expected to have distributional effects. The service sector generally has lower mean and more dispersed wages as compared to the manufacturing sector. So a shift of employment from the latter to the former would tend to widen income inequality and reduce median wages overall. We try to capture this with the ratio of manufacturing employment to service sector employment (from CANSIM Table 282-0002), labelled MS. This shift has been a major focus of attention in the literature in modelling more explicitly how it arises from (i) automation and technological change on the one hand vs (ii) globalization and international trade on the other. We return to this in Section 7 below. A higher proportion of manufacturing employment would be expected to increase income shares in the middle and lower-middle ranges of the distribution and correspondingly decrease them elsewhere.

The final variable in our Basic Model is a simple time trend. This is not elegant and will be returned to in later sections below, but we wish, initially, to replicated the model specification used in McWatters and Beach (1990) which was estimated over a much earlier period. The trend variable T captures slower-moving on-going background effects not fully captured by the above set of regressors. For example, it could pick up demographic and generational changes separate from participation rates such as rising education and skill levels in the workplace, structural evolution of the industry/occupation mix of a maturing developed economy, trends in average hours worked or part-time work, increased incidence of divorce and single-parent households, and changes in public and private pension coverages and generosity and social security arrangements for those outside the labour market.

Summary statistics of all variables used in this paper appear in Appendix Table A0.

3.2 Unrestricted Estimates of Quintile Income Shares

Table 1 contains OLS regression results for the five quintile family income shares and the middle-class share (i.e., the sum of the middle three quintile shares). Regressors and summary regression statistics are listed down the left-hand side. For comparison with McWatters and Beach (1990) results, the equations are specified in double-log form. So the rate coefficients are interpreted as elasticities and the trend coefficient as a proportional change in the respective income shares. Corresponding results for 1965-1987 from McWatters and Beach (1990) are presented in Appendix Table A1.

The goodness-of-fit statistics (R^2 and F-stat) in Table 1 are reassuringly high, and the Durbin-Watson and (first-order) Breusch-Pagan statistics consistently indicate no significant autocorrelation. The coefficient patterns are also remarkably consistent across the first four quintile share regressions and the middle-class regression. The coefficient pattern for Q5, the top quintile, is distinctly quite different from the rest – which should not be surprising since the shares must all add up.

As expected, the unemployment rate has negative effects that are statistically significant among lower quintiles, and the effects attenuate as one moves up the income distribution, indeed leading to a significant positive effect on the top quintile share. The men's participation rate has very strong positive and significant effects that also attenuate as one moves up the distribution, resulting with a balancing negative share effect at the top end. Women's participation rate changes have their strongest (negative) effects also in the lower two quintiles, with a strong balancing positive effect on the top income share. The participation rate effects are thus disequalizing at the lower and top ends of the distribution as the declining male participation rate reduces lower (and middle) quintile shares and balancing raises the top share, and rising female participation rates reinforce this effect (found also in Wolfson, 1986). Essentially, females in lower-income households have traditionally had to work in the labour market, so that the increased female participation occurred more among higher-income households. As expected, the elasticities for PRW, while strong and typically significant, are smaller than the elasticities for PRM.

CPI increases are indeed positive and statistically significant across lower and middle income quintiles, and again their effect falls off as one moves up the distribution. The MS effect, however, has not turned out as a priori expected. We expected a positive effect over lower and middle ranges of the distribution for the reasons given above. But the effects turn out to be consistently (and highly significantly) negative over all quintiles but the top. What appears to be happening is that the major decline in the ratio of manufacturing employment to service sector employment since 1976 is proxying for other things going on in the economy and labour market that will need to be looked at further. The time trend turns out to have a consistently (and significant) negative effect on all quintiles but the top, perhaps reflecting the general decline in income shares other than that of top incomes – as seen earlier in Figures 3 and 4 – as high-income households were the big winners over the last 40 years, even controlling for labour market involvement.

In the case of the income share of the Middle Class – last column in Table 1 – the findings are fully consistent with what has been happening to the individual middle income quintiles. Unemployment has a negative (though not statistically significant at a 95% level of confidence) effect. Higher male participations rates increase the MC share, while higher female participation rates reduce the MC share (though not by quite as much). CPI increases are associated with a higher share and MS declines also increase the share. Meanwhile, the net trend in the MC share has been significantly negative by about a half of a percentage point a year.

The quintile share regressions have also been estimated in simple linear specifications. The results are presented in Appendix Table A2. They show exactly the same coefficient patterns as in Table 1 and again the goodness-of-fit statistics are quite good.

It would be useful to formally test between the linear and log-log specifications for the income share regressions. One such test is based on the Box-Cox transformation which incorporates both specifications as nested special cases. However, a bit of basic reasoning about maximum likelihood estimation of this general non-linear approach found in Davidson and MacKinnon (2004, pp. 437-443) in some situations allows one to reach a formal test conclusion without actually undertaking the non-linear maximum likelihood estimation (MLE). From the simple geometry of MLE, if

$$2[l(\text{log}) - l(\text{linear})] \tag{1}$$

exceeds the critical level on the chi-square distribution with one degree of freedom, where *l*(log) is the value of the log likelihood function at the value of its double-log estimates and *l*(linear) is the value of the log likelihood function at its linear specification estimates, then it must certainly be the case that one can reject double-log specification at a specified level of confidence. It turns out that this situation works perfectly with our reported results. The critical value of the chi-squared distribution with one degree of freedom at a 5 percent level of significance is 3.84 and at a 1 percent level is 6.63. The log likelihood values for the double-log and linear regression estimates are reported in the bottom line of Tables 1 and A2. The calculated values of (1) for the five quintile income shares are:

2(112.34 – 34.68) = 155.32

2(124.49 – 22.28) = 204.42

2(134.76 – 15.48) = 238.56

2(149.71 – 18.05) =263.32

2(127.73 – 27.45) = 310.36,

all of which well exceed even the 1 percent critical value. Thus essentially all of the further work in this paper will focus just on the double-log specification.

Comparison of Table 1 results with those from McWatters and Beach (1990) reproduced in Appendix Table A1 shows results that are much stronger (as indicated by R-squared and F-statistics) and also shows some interesting similarities and differences in coefficient patterns. The coefficient patterns for the two participation rate variables and for CP are actually quite similar in sign with generally much more significant results in Table 1. But this is not the case for the U, MS, and T regressors. This reflects the two quite different time periods covered (1965-1987 vs 1976-2016) and the much larger number of observations used (16 vs 41 observations), but also that the survey samples underlying the data points in the earlier study had some differences as Statistics Canada extended their methodology and enlarged its household survey coverage. So one would expect the more recent results to be more consistent and reliable.

3.3 Restricted Estimates of Quintile Income Shares

Even with 41 observations to work with, however, it would be useful to find ways to further increase the statistical efficiency – and hence reliability – of the model estimates. One approach is to explicitly impose adding-up restrictions on the coefficient estimates reflecting that the five quintile shares always sum to one (or 100 percent). In the case of the linear specification, such restrictions would be quite straightforward to imposed within the framework of treating all five quintile share equations as a set of seemingly unrelated regression equations. It is less straightforward in a double log specification, but can still be undertaken as follows. If *Qj* is the j'th quintile share, then the following identity holds:

Q1 + Q2 + … + Q5 = 100,

and hence for regressor x_i,

$$\frac{\partial Q1}{\partial x_i} + \cdots + \frac{\partial Q5}{\partial x_i} = 0. \qquad (2)$$

In a linear specification, this amounts to

$$\beta_i(1) + \beta_i(2) + \cdots + \beta_i(5) = 0$$

where $\beta_i(j)$ is the regression coefficient on regressor x_i in the j'th quintile share equation. In a log-log specification, the regression coefficient on regressor $ln\ x_i$ in quintile share equation *j* is the elasticity

$$\eta_i(j) = \frac{\partial lnQj}{\partial lnx_i} = \left(\frac{x_i}{Qj}\right)\frac{\partial Qj}{\partial x_i}$$

$$\therefore \qquad \frac{\partial Q_j}{\partial x_i} = \left(\frac{Q_j}{x_i}\right) \bullet \eta_i(j)\ . \qquad (3)$$

Therefore from (2) above,

$$\left(\frac{Q_1}{x_i}\right)\eta_i(1) + \left(\frac{Q_2}{x_i}\right)\eta_i(2) + \cdots + \left(\frac{Q_5}{x_i}\right)\eta_i(5) = 0 \qquad (4a)$$

or more simply,

$$Q1 \bullet \eta_i(1) + Q2 \bullet \eta_i(2) + \cdots + Q5 \bullet \eta_i(5) = 0 \qquad (4b)$$

for regressor x_i (corresponding to variables U, PRM, PRW, CP, and MS). Similar reasoning for the trend variable T leads to

$$Q1 \bullet \propto (1) + Q2 \bullet \propto (2) + \cdots + Q5 \bullet \propto (5) = 0 \qquad (5)$$

where $\propto (j)$ is the coefficient on the T regressor in the j'th quintile share equation.

To implement the cross-equation adding-up restrictions in (4) and (5), one can evaluate all the variable values at their sample means. Thus, while the adding-up restrictions are exact in the linear share specifications, they are approximate in the double-log share specifications.

A further source of efficiency gain when one is working with a limited number of observations is to impose zero-coefficient restrictions. In the present case, this increases estimation efficiency by the imposition of any coefficient restrictions. But additionally, once any such restrictions are imposed, the set of regressors is no longer the same across the set of quintile share equations, and efficiency gains are obtained from the joint multi-equation seemingly unrelated regression equation (SURE) systems estimation procedure beyond what was obtained in the simple OLS regressions in Table 1. In the present study, the methodology we follow involves two-steps: (1) run the five quintile share regressions imposing the six above adding-up restrictions by a SURE system estimation technique; then (2) set to zero all coefficients whose adding-up constrained estimates turn out to have an absolute value of their t-ratio that is less than one and re-estimate the adding-up constrained system of share equations once again by the restricted SURE estimation technique. This is actually a rather weak condition being imposed on the results. The results are referred to as restricted estimates in the rest of this paper.

Restricted estimates of the Basic Model are presented in Table 2. It turns out here that only one coefficient gets set to zero. It is perhaps not surprising then that the restricted results in Table 2 are really very similar to those in Table 1, but show higher (absolute) t-ratios and lower standard error of estimates of the five regressions. (The middle-class equation does not enter the restricted estimation approach followed.) The coefficients all retain their same signs and patterns across the share equations, and indeed their magnitudes remains pretty much the same as well. But, because of the additional information brought to bear in their estimation, they are more reliable.

For readers' interest, restricted estimates for the linear specification of the share equations appear in Appendix Table A3. In this case, the efficiency gains appear to be greater due to five imposed coefficient restrictions. But again, the estimated coefficients differ very little from their corresponding unrestricted estimates, and all the previous coefficient patterns carry through.

4. Basic Decile Income Share Model

Statistics Canada CANSIM Table 206-0031 also provides *decile* income share data since 1976. So it would be sensible to estimate the Basic Model of the previous section on these data as well in order to check for consistency of the above patterns of results and to examine possible refinements of how the patterns change across different regions of the family income distribution. We refer to the decile income shares as D1, D2, …, D10.

Unrestricted OLS estimates of the decile share equation appear in Table 3 over two pages. Again all decile equations are individually statistically significant and do not show consistent signs of autocorrelation. With respect to the regression coefficients, all the previous patterns carry through. Within the top quintile, the distinctive Q5 coefficient results appear to be driven principally by the D10 or top decile income group of families.

Table 4 presents corresponding restricted decile share estimates of the Basic Model. Here seven zero-coefficient restrictions occur concentrated in the D8 and D9 share equations. Again, all the regressions are individually highly statistically significant and show generally good fits. And, again, the estimated coefficients change relatively little from those in Table 3, but show higher (absolute) t-ratios and smaller regression standard errors. So all the previous coefficient patterns carry through.

5. Basic Model Applied to Market Income Shares

Statistics Canada also provides distributional data on the receipts of *market* income of families. Market income is total income less government transfers, and hence consists essentially of earned income (i.e., wages and salaries and net self-employment income) from the labour market and investment income from capital markets (i.e., interest, rent and dividend income as well as annuities and private pension income). Except for retirees, labour market earnings exceeds investment income for almost all families. It would thus make sense to estimate our Basic Model for shares of market income as a more direct test of the labour market variables. One would expect generally similar patterns of share regression coefficients as already found for total income shares, but larger effects in the case of the primary labour market variables. These results for unrestricted quintile share estimates appear in Table 5. (Since the concept of Middle Class is typically defined in terms of the total income of families rather than just market income receipts, there is no MC column in Table 5.)

The overall fits of the market income share equations (in terms of R^2 and F-statistics) have actually improved from results in Table 1, especially in the case of the bottom quintile equation. It is also the case that the coefficient responses on U, PRM, PRW, and CP over the lower three quintiles (Q1 to Q3) are substantially larger than for total income in Table 1. Indeed, the participation rate responses in Q1 and Q2 are extremely high – indicating how sensitive family market incomes in this region of the distribution are to labour market involvement. The disequalizing effect of participation rate changes is even stronger than found earlier in Table 1.

The declining employment share of manufacturing is estimated to reduce both bottom and top quintiles of market income, while increasing the middle quintile shares – again quite different from what initially would be expected. However, its pattern is quite consistent across both quintile and decile estimates for both family income and market income distributions. Now year-to-year changes in MS incorporate both cyclical and on-going evolving labour market developments. Other regressors in the share equations are doing a good job picking up the cyclical aspects of MS changes. But the ratio of manufacturing to service sector employment in Canada has declined dramatically over this period (from 0.2918 in 1976 to 0.1190 in 2016). So MS may be picking up other evolving labour market developments such as the growing education and skill levels of workers; growth in the financial, housing construction, and natural resources sectors; and growing share of urban employment over this forty-year period – all of which are associated with higher labour market incomes favouring the broad mid ranges of the earnings distribution. This is then reflected by the negative MS coefficients over Q2-Q5 in Table A6 (and over D4-D9 in Table A8). A possible test of this interpretation of these MS results would be a comparison to such model estimates for the United States which has not experienced such major sectoral shifts in housing and natural resources sectors.

The time trend also shows mixed effects, indicating net increases at the two ends of the market income distribution, but statistically significant net declines over the Q3 and Q4 portions of the distribution. This pattern is consistent with a declining share of middle-class earners in Canada over this period (Beach, 2016), where a number of former middle-class earners slipped down the distribution because of on-going job displacements (thus raising the lower earnings shares) while some advanced up the distribution because of upskilling and shifts to higher-paying service jobs (thus reducing the Q4 share of market income).

Basic Model estimates for market income has also been obtained in a linear specification with results provided in Appendix Table A4. Again, a Box-Cox-based argument strongly rejects the linear specification in favour of the double-log specification in Table 5. The pattern of coefficients is also essentially identical with that already found in Table 5, so need not be reviewed further.

Restricted estimates of the Basic Model for family market income are also provided in Table 6. As can be seen, there are four zero-coefficient restrictions. While the estimated coefficients differ very little from those in Table 5, their t-ratios are higher and the standard errors of the regressions are lower, so again the results are yet more reliable. The similar patterns of coefficients to what has already been found in Table 5 thus reinforce the latter results.

Decile estimates for the Basic Model applied to family market income are presented in Table 7, with the same layout as used previously. Again, these provide further refinement and reinforcement to the quintile share results in Table 5. One can clearly see the declining pattern of U and PRM coefficient estimates across deciles, and similarly so (though to a lesser extent) of CP effects as well. Again, the distinctive pattern of effects in the Q5 share results is essentially being driven by the similar pattern of effects in the D10 share equation at the very top end of the market income distribution. On the other hand, the D1 results are rather weak, reflecting the very great sensitivity of bottom decile results to the family head's labour market attachment and perhaps also that many members of this bottom income group include retirees receiving private pensions (and hence capital income) and single-parents who work only intermittently in the labour market.

Restricted estimates for the decile Basic Model applied to family market income appear in Table 8. Here there are nine zero-coefficient restrictions imposed, and these have the effect of quite substantially improving the reliability (or t-ratios) of the estimates – particularly so for the key business cycle regressors U and CP. The restriction methodology being used evidently offers substantially greater efficiency gains for the decile model estimates than for the quintile estimates. The estimated coefficients themselves change very little by imposition of the restrictions, so that all the previous coefficient patterns carry through in Table 8 as well.

6. A Test of the Distributional Gains from Growth

One of the premises of the macroeconomic literature of the 1960s and early 1970s was that economic growth had a trickle-down effect on the employment and wage opportunities of lower-skilled workers so that "a rising tide lifts all boats" (Blank and Blinder, 1986; Danziger and Gottschalk, 1986; Gottschalk, 1997). More recently, a literature has also developed examining the linkages between economic growth and income inequality (Ostry et al., 2014;

Stiglitz, 2012, 2015; Summers and Balls, 2015). To focus attention explicitly on how growth has indeed affected inequality in terms of income shares in Canada since 1976 and hence look at the distributional gains (and losses) from such growth, we replace the simple time trend variable in our Basic Model by a time series of annual real GDP (more specifically real GDP based on a chained 2007 price-adjusted series from Statistics Canada's Table 36-10-0222-01 – formerly CANSIM Table 384-0038). The result is referred to as a Growth-Revised Basic Model.

Quintile share estimates for family income of the growth- revised model are presented in the Table 9. (Unfortunately, the limited number of observations does not allow one to include both a simple time trend and the real GDP or RGDP variable together.) Since we are looking at family total income again, the table also includes a column for Middle Class share results. The revised model doesn't fit quite as well (in terms of the summary regression statistics), so the time trend in Table 1 was picking up some further effects beyond simple economic growth. The estimated coefficient patterns for the revised model in Table 9 are essentially the same as reported earlier in Table 1.

As to the distributional effects of economic growth since 1976, it is clearly evident (from the ln RGDP row) in Table 9 that all quintiles but the top lost out statistically significantly while the Q5 families were the big winners. Note, of course, we are not saying that real incomes did not see increases in Q1 to Q4 over this period, but that the increases were proportionately larger in the top quintile group. Alternatively stated, for quintile share j,

$$Qj = (.20)\, Ym(j) \,/\, Ym \qquad (6)$$

where *Ym(j)* is the mean income of quintile *j* families and *Ym* is the overall mean income of all families. So both *Ym(j)* and *Ym* may well have increased over the sample period – see Figure 1 above – but *Ym(j)* did not go up as fast as *Ym* for some quintile groups.

Restricted growth-revised model estimates are presented in Appendix Table A5. Here the adding up and four zero-coefficient restrictions improve efficiency of the estimates, but the same estimated coefficient patterns again carry through. And the same distributional inference of economic growth is reached.

Growth-revised model estimates for market income quintiles are provided in Table 10 and corresponding restricted market income estimates appear in Appendix Table A6. As was found before, the regressions fit significantly better with generally stronger effects (for variables U, PRM, PRW, and CP) for market income shares (in Table 10) than for total income shares (in Table 9). Also, the patterns of estimated coefficients in Table 10 are identical to those found earlier for the Basic Model applied to market income shares (in Table 5), especially with respect to the reported coefficients on MS and on RGDP vs the simple time trend. In the case of the restricted growth-revised model for market income in Table A6, there are only two zero-coefficient restrictions, so not surprisingly, the results in Table A6 are essentially the same as in Table 10.

Decile share equations have also been estimated for the Growth-Revised Basic Model, but only the restricted set of results are provided for brevity in Appendix Table A7 for total income and Table A8 for market income. (These will provide the basis for further calculations later in the paper.)

The principal motivation for this section has been to examine the relative distributional gains from economic growth. This has been represented by the RGDP coefficients in the Growth-Revised Basic Model estimates. Table 11 highlights the detailed findings on this issue from the decile share regressions. Appendix Tables A7 and A8 are the basis of the results labelled “fully restricted” in the third and sixth rows of Table 11. OLS results (not reported in this paper) appear in rows one and four. And the "partially restricted" results (not reported as well) are those obtained from imposing only the adding-up restrictions and not the zero-coefficient restrictions and appear in rows two and five of Table 11.

Clearly, the gains from economic growth are not distributionally neutral. Not surprisingly, the growth effects are generally much stronger (except for D10) within the market income distribution than among total family incomes as transfers buffer such market effects. The most interesting thing to notice, though, is the different growth effect patterns across decile groups between the distributions of market income and of total income. With market income, the pattern follows a ski-jump shape – large positive gains for D1 and D2, relative losses over the D4-D9 range, and again a positive (but much smaller) gain at the top decile, D10. This pattern is consistent with workers – especially full-time males – shifting out of jobs around the middle of the earnings distribution and moving down (i.e., deskilling) and some up (i.e., up-skilling) the earnings distribution (Beach, 2016). The ski-jump shape suggests that the former effect greatly dominates the latter effect. Clearly, such a major hollowing-out distributional effect warrants further inquiry. Also changing is the demographic evolution of increasing numbers of retirees who have some private pension (i.e., capital) incomes which are typically relatively low compared to workers' earnings, and hence they tend to concentrate towards the lower end of the market income distribution.

The shape of the net growth effects across deciles of total family incomes is that of an ogive curve or cumulative distribution function. The effects are negative across all deciles D1-D9 (with distinctly stronger negative effects for the D1 group) and then strongly positive for the top decile group, D10. The pattern thus shows the buffering effect of government transfers towards the lower end of the distribution. The proportion of total personal or household income arising from investment or capital income has also been rising since the 1970s (Beach, 2016) – the converse of falling labour's share – and this goes largely to high-income households, so this also reinforces the positive coefficient for D10. Recall also that the distribution of total family incomes includes low-income families who are living just on government transfers (such as CPP, EI, disability benefits or income assistance welfare payments), whereas the market income distribution does not, and these transfer incomes have generally gone up in real terms over the sample period, but not greatly.

A more formal test of "growth neutrality" can be expressed in terms of requiring all RGDP coefficients to be the same across quantile share equations. Given the adding-up restrictions, this amounts to

$H_0 : \beta_G(1) = \ldots = \beta_G(5) = 0$

vs H_1 : not H_0 .

where $\beta_G(j)$ is the RGDP coefficient in (the log-log) j'th income share equation. The H_1 or unrestricted estimates are the same as already been reported in Tables 9, 10, and the OLS rows of Table 11. The H_0 or restricted estimates are obtained by simply deleting the RGDP regressors. The likelihood ratio test approach is based on the test statistic

$2(l_U - l_R) \sim \chi_5^2$ asymptotically,

where l_U and l_R are the unrestricted and restricted log-likelihood values, respectively, of the sets of share equations estimated jointly by a SURE procedure. An analogous approach is used to test for growth neutrality in the case of decile share equations.

The estimated test statistics are:

Quintile shares for total income – 20.68
Decile shares for total income – 40.10

Quintile shares for market income – 46.22

Decile shares for market income –	55.26

The critical χ^2 values at the 99% level of confidence are 15.1 for 5 degrees of freedom and 23.2 for 10 degrees of freedom. Alternatively, a test of growth coefficient equality without imposing the adding-up restriction (i.e., not requiring that the common growth coefficients all be zero) results in an even stronger set of similar test statistics:

Quintile shares for total income –	37.82
Decile shares for total income –	78.82
Quintile shares for market income –	136.46
Decile shares for market income –	171.62.

Clearly, distributional neutrality of how the real economic growth is shared is very strongly rejected in all eight cases.

7. Testing Globalization, Automation and Labour Share Effects: A New Basic Model

The distinctive pattern of the coefficients on MS across distributional groups suggests that more attention should be turned to the systematic labour market changes that have been going on over the last four decades The strong pattern of RGDP coefficients across distributional groups of market income are also suggestive of major deskilling and up-skilling changes going on in the Canadian labour market over this period as well. The vast literature – largely U.S.-based – on employment changes since the 1970s has focused on two major explanatory hypotheses. In one, automation or technological change in the work place arises from the digital revolution and the advent of robots and AI (Acemoglu and Autor, 2011; Acemoglu and Restrepo, 2018a, 2018b). In the other, globalization and the off-shoring of especially goods manufacturing over seas to lower-labour-cost economies and the growing complexity of international supply networks (Acemoglu et al., 2016; Autor et al., 2014; Hammels et al., 2018).

Interest has recently focused on a third set of factors that have been reflected in a decreasing labour income share of GDP. As summarized in Beach (2016), these factors include a rising degree of industrial concentration and of superstar firms that employ relatively few domestic workers for their sales and capitalization rates, a growing role of "intangible capital", and various institutional or policy-related factors such as deregulation, weakened fall-back options for less-skilled workers, antiquated workplace regulations in an era of a "gig economy", and weakened union power (De Nardo, Fortin and Lemieux, 1996; Autor et al., 2017).

Previous empirical investigations of these hypotheses have largely been based on multiple cross-sections of microdata to reveal on-going changes in employment patterns by skill level, sex, region and industry/employment sector (e.g., Green and Sand, 2015; Warman and Worswick, 2015). The present study looks at these effects directly on the distribution of income within an income share framework, and hence is a direct test of the possible distributional effects of these explanations. It thus serves as a complement to the above studies. It is also a test of these explanations on the distribution of *family* incomes, where the family (with typically multiple earners) is viewed as the basic unit of shared resources and hence economic well-being.

7.1 Trying to Capture Automation, Globalization, and Labour Share Effects

In place of MS, we consider several more specific or targeted variables.

First, to address the automation effect (which is viewed as operating through occupations), we create three new variables. One, called AutoLower, targets employment growth towards the lower end of the occupation skill scale. It is measured by the level of employment in business and personal services and repairs occupations divided by total employment. Another, called AutoUpper targets employment growth towards the upper end of the occupation skill distribution. It is measured by the level of employment in managerial and administrative and professional/technical/scientific occupations divided by total employment. (For further details, see Appendix B.) The data series for these variables for 1987 on come from CANSIM Table 14-10-0297-01 (formerly Table 282-0142). Earlier years' data come from the March Labour Force Surveys over 1976-86. Since classification categories changed slightly between these two sources, we add an intercept-shift control dummy variable D7686 (which takes a value of one over the earlier period, and zero otherwise).

Secondly, to address the globalization effect (which is viewed as operating through industry sectors), we use two new variables. One, called GlobLow, is the share of Canada's merchandise imports from essentially China, India, Indonesia and Bangladesh – as proxied by share of imports from countries not in the EU or other OECD countries – in order to pick up trade effects from low-wage countries (from CANSIM Table 14-10-0023-01, formerly Table 282-0008). The other new variable is the Canada-U.S. foreign exchange rate (from CANSIM Table 10-10-0009-1, formerly Table 176-0064), measured such that a low Canadian dollar is less than 100, to pick up trade effects from non-developing countries.

Thirdly, labour share is calculated as compensation of Employees (v62295563) plus Net Mixed Income (v62295571) divided by GDP at Market Prices (v62295576).

Initial OLS regressions were run on quintile income shares with the regressors listed in Tables 9 and 10 – except for ln MS – but now including the additional six variables to pick up automation, globalization and labour share effects. The labour share coefficients (and corresponding t-ratios) from these regressions are as follows:

	Q1	Q2	Q3	Q4	Q5
Total Income -	-0.1645 (0.71)	0.1201 (0.75)	0.0610 (0.49)	0.0026 (0.03)	-0.0571 (0.37)
Market Income -	-0.3218 (0.53)	0.0658 (0.33)	0.0474 (0.39)	-0.0408 (0.47)	-0.0583 (0.39)

One would expect positive coefficients over Q1-Q4 (or perhaps over Q2-Q4 for Market Income) and negative coefficients for the Q5 regressions. The estimated sign pattern generally holds. But none of the above coefficients are remotely statistically significant. This perhaps reflects that the labour share for Canada declined relatively little over the sample period compared to the U.S. experience (Beach, 2016) or the factors behind the declining labour share are just too difficult to tease out from such aggregate income share regressions (with relatively few observations compared to large microdata sets). In any case, it seemed not worth pursuing further. Consequently, we will henceforth focus on the possible automation and globalization effects alone.

What will be referred to as the New Basic Model includes these five new automation/globalization variables (with non-dummy variables in log form), and deletes the previous MS variable. The RGDP regressor is retained to pick up broad growth effects as discussed in the previous section.

7.2 Estimates of New Basic Model for Family Income

As the automation and globalization variable names suggest, specific regressors are directed to either the lower or upper regions of the income distribution. More specifically, the

GlobLow, AutoLower (and D7686) are applied just to the Q1 and Q2 quintile share regressions (plus to Q5 because of the adding-up restrictions), while FX, AutoUpper (and D7686) are applied just to the middle (Q3) and upper (Q4, Q5) quintiles. The full set of cross-equation adding-up restrictions are also applied, so estimates are obtained by the system-wide SURE estimation procedure.

In order to look at the potential explanatory power of the new automation and globalization variables, one can add such variable individually one at a time to the basic set of core variables in Tables 9 and 10 and look at the resulting changes in the RMSE or standard error of the regression of each quintile regression equation. The reductions in this statistic are then summed for the respective automation and globalization variables (or blocks of variables in share equation Q5), and the percentages of each of these new regressors in the summed reduction in RMSE are found to be as follows:

	Q1	Q2	Q3	Q4	Q5
Family Income:					
- Globalization	55.0	44.4	67.2	87.8	66.3
- Automation	45.0	55.6	32.8	12.2	33.7
Market Income:					
- Globalization	64.4	71.7	34.3	90.4	72.4
- Automation	35.6	28.3	65.7	9.6	27.6

Evidently, there is more explanatory potential in adding the globalization variables than in adding the automation variables in all but two of the equations. Given the importance of international trade in the Canadian economy, perhaps this should not be surprising.

Quintile share regression estimates of the New Basic Model for family total income are presented in Table 12. Compared to the Growth-Revised Basic Model estimates seen earlier in Table 9, the R^2 values are generally similar while the standard errors of the regressions are noticeably lower. That is, the new regressors generally absorb or account for some explanatory power, but their distinct effects are often not reliably estimated, in part because of collinearity between the GlobLow, AutoLower and AutoUpper regressors. Again, no significant autocorrelation appears to be present.

The individual coefficients in Table 12 for PRM, PRW and CP turn out to be stronger (with the same pattern as before) and more reliably estimated compared with Table 9. But the effects of U and RGDP are much weakened, have flipped in sign, and turn out to be all statistically not significant. As well, only four of the 30 new coefficient estimates to account for possible automation and globalization effects have a statistically significant value at a 95 percent level of confidence (or seven at a 90 percent level). However, it does appear that both the globalization and automation variables do have some statistically significant effects over the middle and upper regions of the family income distribution. Trade among developed economies (as represented by the foreign exchange rate, FX, variable) appears to benefit the middle and fourth quintile shares (with a balancing decline at the top end). Automation, broadly represented, also is estimated to have benefitted the Q3 and Q4 shares (again with a balancing decline in Q5). In terms of coefficient elasticities, the automation effect appears to be considerably stronger than the trade effect (i.e., 7 percent vs. 2 percent elasticity responses). None of the new variables appears to have any statistically significant effect on the lower income shares where many families include retirees, disabled and single mothers, all with relatively weak attachment to the labour market.

Restricted estimates of this model based on zeroing out all coefficients with t-ratios less than one (in absolute value) are presented in Table 13. Essentially the same patterns of results hold as in the previous table, but with the non-zero estimated values much more reliable tied down. Again, significant automation and trade effects show up over the middle and upper regions of the family income distribution, participation and inflation rates persist very strongly, and the unemployment and GDP growth rates appear not at all statistically significant. And again, the automation effects are estimated to be considerably stronger than the globalization effects, and neither has any detectable effect over the lower two income quintiles.

Finer detail on these patterns of estimates are provided in the corresponding decile share estimates presented in Appendix Tables A9 and A10. In this case, the new regressors targeted at lower incomes appear in the D1-D4 (and D10) equations, and those aimed at upper incomes occur in equations D5-D9 (and D10). Again, the same patterns show through, with no statistically significant globalization or automation effects over the lower four decile equations, but consistently significant effects over the middle and upper regions (D5-D10). And again, the automation elasticities generally exceed the trade elasticities. Appendix Table A10 presents further restricted decile estimates based on zeroing out previously very unreliable coefficient estimates. The same patterns recur and are more securely tied down, especially so for the AutoUpper effect over equations D6-D8.

7.3 Estimates of the New Basic Model for Market Income

Estimates of the New Basic Model for family market income are presented in Table 14. Perhaps not surprisingly, this model fits market share equations much better than it did the total family income share equations earlier in Table 12 (in terms of both R^2 and F-statistics). This makes sense since the new automation and globalization variables all refer to what has been happening in the labour market. The R^2s are also higher with the addition of the new variables than for the Growth-Revised Basic Model estimates for market income in Table 10.

The unemployment rate and real GDP variables now do show some statistically significant effects, where unemployment rate increases depress the lower two quintile shares and higher GDP significantly raises these shares of market income. They are also much larger than for total income. In addition, the PRM, PRW and CP effects over the Q1-Q3 equations are much larger for market income (most of which comes from labour market activity) than for total family income.

Now the automation and globalization effects come through more noticeably in Table 14 for market income. Eight of these coefficients turns out statistically significant at the 95 percent level of confidence (nine at the 90 percent level). Not much is detected over the lower two quintile regressions, although the GlobLow variable does appear to have a significant positive effect on the Q1 share. Over the middle and upper regions of the distribution, however, both the automation and globalization variables show strong highly statistically significant effects. Both effects increase the Q3 and Q4 income shares, while reducing the top share. If the Canadian dollar is viewed as an energy currency, then higher energy prices benefit the energy sector with its (on average) well paid energy workers and related businesses. And more automated work places put more value on worker training and technical skills. This is the same pattern as found for total income, but the elasticity effects are much larger here for market income and more reliably estimated. This funding is very much consistent with the result in Beach (2016, Table 4) of a much stronger upskilling effect of distributional change since 2000 in the earnings distribution than of displacement or downskilling. Again, the elasticity effects of automation (.09 - .18) are substantially larger than for globalization (.03 - .04) for the Q3-Q5 share equations.

Restricted estimates of the market income share equations where low-reliability coefficients are dropped are presented in Table 15. These show exactly the same set of patterns as already highlighted, except for a stronger contrast now of the distributional effects of GDP growth across market income shares.

Again, finer detail of these patterns are found in the decile market income estimates in the Appendix Tables A11 (without imposing zero-coefficient restrictions) and A12 (with these additional restrictions). They are completely consistent with the quintile market income estimates. But they do show some significant GlobLow positive effects over the lowest two market income deciles and corresponding negative effects over D3 and D4. That is, growing imports of products from low-wage countries are consistent with a detectable deskilling or displacement of workers from the lower-middle range of the earnings distribution to the bottom two deciles (Beach, 2016).

7.4 Pooled Regression Estimates of Automation and Globalization Effects

A problem is trying to tie down automation and globalization effects in a model of Canadian family income distribution is the paucity of consistent raw data on income share – annual data only available back to 1976, or only 41 observations. However, we have observed that the pattern of automation and trade effects is very similar between total income and market income distributions of families. One way, then, to exploit this finding is to pool both total income and market income share data, so that there are 82 observations to bring to bear together on estimating the effects.

Pooling of the two series in a flexible fashion can be done by allowing separate distinct effects for the core variables between total income and market income, but constraining the automation and trade effects to be the same between the two income regimes. Cross-equation adding-up constraints with total-income share weights apply to the core regressors over the total-income share observations and cross-equation adding-up constraints with market-income share weights apply to the core regressors over the market-income share observations. Working out the math then implies that the adding-up constraint weights applied to the five common automation and globalization regressors is the simple average of the respective total-income and market-income share weights. The resulting set of pooled SURE regression estimates are presented in Table 16.

Since separate effects over the core variables are allowed to differ between the two income regimes, it should not be surprising that they reveal similar patterns as in the previous two sections 7.2 and 7.3. But with all 82 observations brought to bear on estimating (common) automation and trade effects, there are now 11 statistically significant automation and trade coefficients (at the 95 percent level of confidence). Once again, there is not much significant on these effects over the lower two quintiles shares, though GlobLow and AutoLower do show up with statistically significant effects on Q1. The former appears to be an anomaly (which we shall return to in two paragraphs), and the latter is consistent with deskilling and displacement concerns of automation.

Over the middle and upper quintile equations, however, very significant automation and trade effects are evident in exactly the same pattern as already observed in sections 7.2 and 7.3 with positive FX coefficients and positive AutoUpper coefficients over Q3 and Q4, and the reverse over the top Q5 share equation. Indeed, the FX and AutoUpper coefficients in this pooled regression specification lie, respectively, between their separate values in the early Table 12 and 14. And once again, the automation elasticity effects are substantially greater than the trade elasticity effects over Q3-Q5 share equations.

Restricted estimates of the pooled results where low-reliability coefficients are constrained to zero appear in Table 17. In this case, no significant automation or trade effects are found over the lower two quintiles. Highly statistically significant effects for FX and AutoUpper are again found for the upper three quintiles with very similar magnitudes as in Tables 13, 15 and 16.

8. Estimated Effects on Overall Inequality and Income Gaps

8.1 Effects on the Gini Coefficient

Any measure of overall income inequality is a useful summarizing device to look at aggregate distributional effects. Such measures are standard recognized dependent variables for economic analysis. Among the standard measures available, Statistics Canada provides data series (from the same sources as the income share data) on the Gini coefficient. So this is the summary inequality measure used in our empirical analysis.

Gini coefficient regression estimates (in double-log format) for both forms of income and for all three models examined in this study are provided in Table 18. In all cases, the R^2s are very high and F-statistics are highly statistically significant, with all three models fitting rather better for market income than for total income.

The core variables PRM, PRW, and CP all come through highly statistically significant and consistent in their patterns. The participation rate variables show elastic responses indicating the sensitivity of overall income inequality to involvement in the labour market. Increased male participation rates strongly reduce income inequality across families in the economy. Higher female participation rates, however, have historically favoured higher-income families and thus had a disequalizing effect. Since the 1970s the former have somewhat declined and the latter risen strongly, so their joint effect in accounting for rising family income inequality has been substantial. On the other hand, higher CP is consistently reflective of wider labour market involvement and reduced income inequality.

The effects of U and RGDP are mixed, depending on the specific model estimated. In the Basic and Growth-Revised Models, higher unemployment significantly and consistently raises overall inequality. Once the specific globalization and automation regressors are introduced, however, the unemployment rate ceases to have a significant effect. Again, in the Basic and Growth-Revised Models, the trend and RGDP variables have consistently positive effects – though highly statistically significant only for total income and positive but not significant for market income estimates. Real GDP turns out not significant once the globalization and automation variables are added in the third model. In the (simpler) first two models, higher MS values have increased inequality on net as higher-paying sectors such as the energy sector have greatly benefitted. (That the MS effect shows up more strongly for total income than for market income may reflect that the former distribution includes many lower-income retirees and single-parent households on income assistance who would not benefit at all from this sectoral growth effect.)

Among the globalization and automation variables in the New Basic Model, only FX shows up with statistically significant (disequalizing) effects – again consistent with the energy sectoral growth explanation over this period. The rest of the globalization and automation variables have been seen to have impacts across only limited ranges of the distributions and they apparently don't aggregate up to a statistically significant effect overall. Their lack of individual significance also reflects the high collinearity among the GlobLow, AutoLower and AutoUpper regressors when all entered jointly.

To the extent that aggregate income inequality is a (negative) input to general social welfare or economic well-being in the economy (Atkinson, 1970), the above aggregate inequality effects have corresponding impacts on overall economic well-being of families as a whole in Canada.

One could also empirically analyze distributional effects on an entire Lorenz curve since the latter is constructed directly from income shares (see Appendix C). Identifying how an entire Lorenz curve shifts with the various explanatory variables allows one to make inferences on a whole range of summary inequality measures beyond just the Gini coefficient (Cowell, 2000).

8.2 Effects on Income Gaps

The income share approach of this paper also allows one to look at the effects of the various explanatory variables on income gaps between different regions of the income distribution. Figures 3 and 4, for example, illustrate how the top quintile group appears to be pulling away from the rest of the distribution. So how has the income gap between middle and upper incomes been affected by these variables, and has the lower income gap between middle and lower incomes been affected as well?

To investigate this matter, let the income gap Gap(i,j) between mean incomes in quintiles i and j be

$$\text{Gap}(i,j) = \text{Ym}(i) / \text{Ym}(j) .$$

Therefore,

$$\ln[\text{Gap}(i,j)] = \ln[\text{Ym}(i) / \text{Ym}(j)]$$

$= \ln[Ni \bullet Ym(i) / Nj \bullet Ym(j)]$

$= \ln[Qi / Qj]$

where Ni and Nj are the number of families in quintiles i and j. But, in the case of income quintiles, by construction Ni = Nj. Thus Qi = Ni • Ym(i) over total income is the income share of quintile group i. Therefore,

$$\ln[Gap(i,j)] = \ln(Qi) - \ln(Qj)$$

$$= [X_i \ \eta(i) + u_i] - [X_j \ \eta(j) + u_j]$$

$$= [X_i \ \eta(i) - X_j \ \eta(j)] + (u_i - u_j) \qquad (7)$$

where $X_i \ \eta(i) + u_i$ is the right-hand side of the (log-log) regression equation for quintile group i, $\eta(i)$ is the vector of regression coefficients in the regression equation for ln(Qi), and u_i is the vector of regression error terms in the income share regression for quintile i. Thus,

$$\frac{\partial \ln[Gap(i,j)]}{\partial ln x_l} = \frac{\partial \ln(Qi)}{2 ln x_l} - \frac{\partial \ln(Qj)}{2 ln x_l}$$

$$= \gamma(i)_l - \gamma(j)_l \, . \qquad (8)$$

So we have an alternative interpretation of the (double-log) income share regression coefficients. The difference in regression coefficients of the (double-log) income share regressions indicate the proportional effect of some specified regressor (x_l) on the relative income gap between two quintile groups. (Indeed, being able to convert easily from the share effects to income-gap effects is a further reason to prefer the (double-) log specification of the estimated quintile share equations.)

A list of these estimated gap effects for the mean income between the top (Q5) and bottom (Q1) quintiles is provided in Table 19 for the core recurring variables. The latter are listed down the left-hand side. The different income concepts and models estimated are arrayed as separate columns across the top of the table. The reported effects are based on the restricted versions of each model as they seem to be the most reliable estimates. A positive entry value indicates that an increase in the corresponding regressor widens the Q5-Q1 relative income gap, while a negative entry value says that an increase in that variable is found to narrow the gap. Again the (non-T) entries are to be interpreted in elasticity terms.

What the table shows is that higher unemployment widens the gap between Q5 and Q1, increases in the male participation rate very strongly reduce the gap, rises in the female participation rate have (also strongly) widen the gap, and greater increases in output – as manifested through real GDP increases or higher CPI rates – reduce the Q5-Q1 relative income gap. The effects, not surprisingly are also much stronger for the market income gap than for that of total family income.

Tables 20 and 21 present similar sets of results for the lower income gap (Q3-Q1) and the upper income gap (Q5-Q3), respectively. Because of how these gap effects are calculated (from equation (8)), the sum of the entry items in Tables 20 and 21 equals the corresponding entry item in Table 19. So Tables 20 and 21 offer an exact decomposition of the Q5-Q1 relative gap effects into the portion arising over the lower half of the distribution and that arising over the upper half. In the case of market income, perhaps not surprisingly, the three core labour market variables (U, PRM, and PRW) show generally much stronger effects on the lower income gap than on the upper income gap, as well as stronger benefits of RGDP increases. Interestingly, in the case of total family income, all the variables show stronger effects on the upper income gap rather than over the lower gap. What this seems to suggest is that non-labour market factors – not picked up by the current models – may have been operating in the background that are blunting or confusing the straight labour market participation rates and cyclical variables – such as the rising shares of capital or investment income (and its converse of a declining labour share) and of transfer income over the last four decades, the role of institutional factors such as a rise in the size of the public sector and slow decline in private-sector unionization rates, as well as evolving demographic factors such as more retirees and single-parent households with weak or little attachment to the labour market.

9. Summary and Conclusions

This paper has presented an empirical model of family income distribution in Canada based on estimating quintile (and decile) income shares of total and market incomes over 1976-2016. It looks at the (reduced-form) impacts of labour market attachment and business cycle variables as well as the effects of economic growth and globalization/automation developments in the labour market. It is estimated in a way to exploit opportunities for statistical efficiency with the limited number of observations presently available. The model is also extended to estimating the effects of these variables on the summary Gini coefficient of family income and on key income gaps across the family income distribution.

9.1 Overview of Major Findings

The study has found several major results. First, the analysis shows very strong labour market attachment and business cycle effects that, not surprisingly, are most marked on market income shares. As expect, the unemployment rate (U) has negative effects (on income shares) that are statistically significant among lower quintiles, and the effects attenuate as one moves up the income distribution, indeed leading to a significant positive effect on the top quintile share. The men’s participation rate (PRM) has very strong positive and significant effects that also attenuate as one moves up the distribution, resulting with a balancing negative share effect at the top end. Women's participation rate (PRW) changes have their strongest (negative) effects also in the lower two quintiles, with a strong balancing positive effect on the top income share. The two participation rate effects have thus had reinforcing distributional effects, as the declining male participation rate reduced lower (and middle) quintile shares and thus raised the top share, and rising female participation rates also reduced lower (and middle) quintile shares and thus raised the top share as well. The impact elasticities for PRW, while strong and very significant, are smaller than the impact elasticities for PRM. Finally CPI increases, as an indicator of output market tightness are positive and statistically significant across lower and middle income quintiles, and again their effect on income shares falls off as one moves up the distribution. (All effects highlighted in Tables 5, 6, 10, and A6 for market income.) The resulting overall distributional effects of these variables on the Gini coefficient then is that higher unemployment falling PRM and rising PRW increase inequality, and higher CPI reduces income inequality (all highly statistically significant; see Table 16).

Second, the (net) gains from economic growth have been formally tested and have been found to not be distributionally neutral, and they suggest major on-going changes in the distribution. With market income, the economic growth effects are U-shaped across quintiles – positive over the lower two and top quintile and negative over the third and fourth quintiles – or a ski-jump-shaped pattern across deciles – large positive gains for the bottom two deciles, relative losses over deciles four to nine, and again a positive (but much smaller) gain for the top decile. This pattern is consistent with workers – especially full-time males – shifting out of jobs around the middle of the earnings distribution and moving down (i.e., deskilling) and some up (i.e., up-skilling) the earnings distribution (Beach, 2016). The ski-jump shape suggests that the former effect dominates the latter effect. The result is a "hollowing out" of traditional middle-class jobs. Also changing is the demographic evolution of increasing numbers of retirees who receive some private pensions and part-time casual incomes that are typically low compared to traditional full-time earnings levels. With total family income, the net growth effects are negative over all four lower quintiles, but positive for the top quintile share. Across decile groups, the net growth effects follow an ogive or cumulative distribution curve pattern (with distinctly strong negative effects for the bottom decile and strong positive effects for the top income decile share). The distribution of total family incomes includes low-income families who are living just on government transfers that are excluded from the market income distribution. Capital's share of total income in the economy has also been rising since the 1970s, predominantly benefiting high-income households (see Tables 9, 10, A5 and A6).

Third, the ratio of manufacturing to service sector employment (MS) has a counter-intuitive effect of increasing income inequality that points to important sectoral shifts on-going in the Canadian labour market. Since manufacturing employment generally shows higher mean earnings levels and lower dispersion of earnings than service sector employment, one would initially expect positive effects of this variable on middle quintiles income shares and negative elsewhere. Empirically, it is found that MS has negative effects over middle quintile shares and a positive effect on the Gini coefficient. The ratio of manufacturing to service sector employment in Canada has declined dramatically from 0.292 in 1976 to 0.119 in 2016. This suggests that MS may be picking up other evolving labour market developments such as the growing education and skill level of workers; growth in the financial, housing construction and natural resources sectors such as energy; and the steadily growing share of urban employment over the entire period – all of which are associated with higher labour market incomes favouring the mid and upper-mid ranges of the earnings distribution (see Tables 5, 6, 10, A6, and 16).

Fourth, the previous two sets of results suggest that more attention should be turned to longer-running systematic labour market developments over the last four decades. To do so, the paper makes an initial attempt to test for any presence of automation / technological change effects and globalization / off-shoring international trade effects on the Canadian income distribution. The globalization and automation variables indeed show some interesting effects on the distribution of family income. Both sets of variables have some statistically significant effects over the middle and upper regions of the family income distribution. A higher Canadian exchange rate has consistent positive effects over the D5-D9 decile share range (and Q3-Q4 quintile shares) of the distribution. If the Canadian dollar is viewed as an energy currency, then higher oil and gas prices benefit the energy sector with its relatively well paid workers and related businesses in construction, finance and various downstream industries. On the other hand, a larger proportion of employment in higher-wage service occupations (consistent with advancing automation and corresponding up-skilling of workers) also occurs over the D5-D9 decile range (and Q3-Q4 quintile range) of the distribution. In terms of coefficient elasticities, the automation effect appears to be considerable stronger than the trade effect. Over the lower income shares, some worker displacement effects of growing globalization are also detected within the D1-D4 decile shares of the market income distribution (see Tables 12-15 and A9-A12).

Fifth, the regression results also provide direct estimates of the effects of the determining variables on key income gaps in the distribution. Higher unemployment, for example, widens the relative gap between the mean incomes of the top and bottom quintiles, increases in the male participation rate very strongly reduce the gap, rises in the female participation rate also strongly widen the gap, and greater output growth – as manifested by real GDP increases or higher CPI rates – reduce the Q5-Q1 relative income gap. The effects are much stronger for the market income gap than for total family income. In the case of market income, the core labour market variables (U, PRM, and PRW) show much stronger effects on the lower income gap (mean income of Q3 over mean income of Q1) than on the upper income gap (mean income of Q5 over mean income of Q3), as well as stronger benefits of real GDP increases (see Tables 19-21).

9.2 Tentative Policy Implications

Several policy conclusions tentatively follow from the broad results of this paper. Since the empirical findings are largely reduced-form in nature, one has to be wary of suggesting implications for detailed policies. A first general conclusion is the distributional importance of supporting and maintaining healthy job opportunities and a full-employment economy with a low-unemployment labour market so as to help bring back many formerly discouraged workers into the labour market. These disproportionately benefit households of limited economic means and help foster inclusion within the Canadian economy. Second, efforts to increase overall male labour market involvement can have very strong equity or distributional benefits as well as providing efficiency gains for the economy as a whole. For example, the Working Income Tax Benefit could be enhanced in order to make paid work more attractive to less-skilled workers. Pension rules could be relaxed to allow workers to continue working part-time while accessing a partial pension and allowing employers to make use of these workers' experience.

The paper's findings of possible job displacement effects from middle to lower income quintiles and of positive automation and trade effects in the middle-upper regions of the distribution underline the importance of two broad directions of policy: modernizing or updating the income social safety net and enhancing education and skill training opportunities of workers in a growing digital economy. For example, two provinces – Ontario and British Columbia – have been looking more closely at possibly bringing in a Basic Income program, and current EI rules could be relaxed to make EI more accessible to vulnerable workers (such as part-time and temporary non-seasonal workers) in today's gig economy. Policies (offering incentives on both sides of the labour market) could encourage lifelong learning and skills upgrading throughout a working career rather than just at the beginning of a career as a way of smoothing the transition of the Canadian economy toward a higher value-added operation. And investment in public transit could be very much enhanced so low-income and immigrant workers can better afford to commute to higher-paying job opportunities.

Findings on past non-neutrality of growth argue for more inclusive growth efforts. Strong long-run growth in sectors such as housing construction and energy and natural resources development which benefit non-high-skilled workers has helped support middle-income portions of the distribution. Again, infrastructure investment, for example, would have strong distributional benefits to the Canadian economy. And finally, the Canadian dollar foreign exchange rate is not just an aggregate market price, but also has significant distributional effects on the economy.

9.3 Extensions of the Modelling Approach

The work in this paper could also be extended potentially in several directions. Several additional independent variables could be considered as more years of income share data become available. Labour market factors such as the female-to-male wage ratio, average hours worked (separately for male and female workers), and non-standard employment rates could try to pick up the closeness or degree of labour market involvement. Institutional variables such as average minimum wage rates (perhaps relative to average wages) and private-sector (or overall) unionization rates can have quite mixed effects on family incomes. And demographic variables such as average age of workers (or overall average age) and immigration rates could also have long-run effects, though they probably require a rather longer period of data to be able to reasonably detect. It would also be useful if the income shares data reported by Statistics Canada could be reported to at least one additional decimal place to help support regression analysis such as done in this study (income shares are very robustly estimated).

Second, one could apply the empirical approach of this study to examine corresponding distributional effects on the income share of *individuals*, both overall and separately for men and women. This could potentially tie down labour market effects more precisely than detected for family income. If Statistics Canada provided corresponding income share data for Canada broken down separately by major region, one could also use the regional variation to help tie down various labour market (and other) effects as well.

Third, one could undertake estimating a similar model of family income distribution for the United States. (To the authors' awareness, no similar such model has been estimated for the U.S. – or any other developed country.) In this case, Bureau of the Census income share series go back further than for Canada, so that tieing down some major effects may offer considerable opportunity for more detailed analysis, especially with respect to automation vs globalization/trade effects on the distribution of income. One could thus usefully compare similar models for the two economies in order to elicit further distributional insights.

Fourth, Statistics Canada could broaden their coverage of distributional data by providing *population shares* in additional to income shares. By construction, the proportion of families within each quintile group is exactly 20 percent. But if one identified distributional groups by whether their incomes fall within some range of, say, the median family income level – e.g., below 50 percent of the median, between 50 and 100 percent of the median, between 100 and 150 percent of the median, between 150 and 200 percent, and above twice the median – one could compute the proportion of the population within each of these groups as well as the share of income within each group. This would allow an analyst to separately identify changes in the size or population of each such group from changes in their relative incomes, and empirically analyze both of their population shares and income shares separately. So one could distinguish, for example, between changes in the size of the Middle Class from changes in their relative incomes over time. One can be viewed as a quantity effect and the other a (relative) price effect. And there is a large body of economics that can be called upon to help interpret different patterns of price and quantity changes and what could be driving these changes.

Fifth, while a direct effect of the labour share variable turns out to be not at all statistically significant in a set of income share regressions, the analysis suggests an alternative approach to incorporating its effect in a distributional analysis. Only a portion of total output (real GDP) in the economy goes to the household sector in the form of total Personal Income. This is what the income share regressions distribute among separate households in the economy. The missing link between macroeconomic analysis (which examines determinants of GDP levels and growth rates) and the distribution this total pie going to the household sector is to build a formal model of the determinants of the household sector income share in the economy. Various economic factors have potentially influenced this share – such as, again, the growth of globalization and advances in software and automation in the economy – but among these would be labour share since all labour income goes to households. Indeed, since automation and globalization would be expected to affect the labour share as well, one could formulate a two-equation model of household sector income with one equation determining labour share and a second equation determining the household sector income share (where the former would feed into the latter in recursive fashion). Such a model would serve to explicitly link macro analysis (and issues of overall economic output and efficiency) on the one hand with distribution analysis (and issues of equity outcomes) on the other. This could provide the basis for a more empirically-based analysis of possible trade-offs between efficiency and equity concerns in the Canadian economy.

Table 1
Basic Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**MC**
ln U	-0.0692* (2.08)	-0.0598* (2.42)	-0.0256 (1.33)	-0.0106 (0.79)	0.0493* (2.16)	-0.0268 (1.65)
ln PRM	1.4021* (3.42)	1.4811* (4.86)	0.6856* (2.89)	0.0510 (0.31)	-1.0210* (3.63)	0.5802* (2.91)
ln PRW	-0.6219 (1.65)	-0.9546* (3.40)	-0.5325* (2.43)	-0.1802 (1.19)	0.7468* (2.88)	-0.4686* (2.55)
ln CP	0.3229* (2.69)	0.2614* (2.93)	0.1714* (2.47)	0.0809 (1.68)	-0.2566* (3.11)	0.1502* (2.57)
ln MS	-0.1565* (3.10)	-0.1014* (2.70)	-0.0935* (3.20)	-0.0933* (4.59)	0.1440* (4.15)	-0.0954* (3.88)
T	-0.0068* (2.89)	-0.0043* (2.44)	-0.0050* (3.69)	-0.0043* (4.55)	0.0068* (4.22)	-0.0045* (3.95)
c	-3.0814* (2.57)	-1.1301 (1.27)	1.3092 (1.89)	3.2796* (6.81)	6.1962* (7.52)	2.7043* (4.63)
R-sq.	0.6575	0.9470	0.9401	0.8483	0.9322	0.9348
F	10.88*	101.2*	88.97*	31.68*	77.88*	81.27*
S.E. Reg.	0.01716	0.01276	0.00993	0.00690	0.01179	0.00836
dw	1.76	1.42	1.55	1.75	1.64	1.45
BP	0.207	1.769	0.780	0.126	0.122	1.383
log lik	112.34	124.49	134.76	149.71	127.73	141.83

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table 2
Restricted Basic Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	-0.0756* (2.59)	-0.0639* (2.90)	-0.0289 (1.68)	-0.0126 (1.05)	0.0496* (2.39)
ln PRM	1.4526* (4.10)	1.4541* (6.49)	0.6407* (4.91)	--	-0.9159* (6.25)
ln PRW	-0.6637* (2.02)	-0.9397* (4.14)	-0.5041* (3.20)	-0.1464 (1.62)	0.6732* (3.62)
ln CP	0.3340* (3.19)	0.2566* (3.49)	0.1628* (3.11)	0.0710* (2.23)	-0.2356* (3.78)
ln MS	-0.1539* (3.48)	-0.1028* (3.16)	-0.0958* (3.89)	-0.0960* (5.78)	0.1495* (5.04)
T	-0.0068* (3.28)	-0.0044* (2.88)	-0.0052* (4.47)	-0.0044* (5.68)	0.0071* (5.07)
c	-3.1612* (3.04)	-1.0448 (1.48)	1.4311* (2.98)	3.4084* (13.2)	5.9525* (10.5)
"R-sq."	0.6554	0.9468	0.9399	0.8476	0.9319
chi-sq.	86.73*	786.40*	688.21*	233.79*	584.24*
S.E. Reg.	0.01567	0.01164	0.00906	0.00629	0.01076

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table 3(a)
Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	**D2**	**D3**	**D4**	**D5**
ln U	-0.1476* (2.93)	-0.0244* (0.76)	-0.0560* (1.99)	-0.0629* (2.61)	-0.0333 (1.46)
ln PRM	1.6977* (2.74)	1.2547* (3.19)	1.6446* (4.74)	1.3504* (4.55)	0.8990* (3.20)
ln PRW	-0.7000* (1.22)	-0.5937* (1.64)	-1.0271* (3.21)	-0.8963* (3.28)	-0.5869* (2.27)
ln CP	0.5138* (2.83)	0.2226 (1.93)	0.2663* (2.62)	0.2574* (2.96)	0.1779* (2.16)
ln MS	-0.3058* (4.00)	-0.0706 (1.46)	-0.0719 (1.68)	-0.1250* (3.42)	-0.0966* (2.79)
T	-0.0136* (3.80)	-0.0030 (1.32)	-0.0027* (1.34)	-0.0055* (3.25)	-0.0049* (3.01)
c	-5.8347* (3.21)	-2.6008* (2.26)	-2.3667* (2.33)	-1.3786 (1.59)	-0.1869 (0.23)
R-sq.	0.6733	0.7210	0.9282	0.9520	0.9368
F	11.68*	14.64*	73.28*	112.5*	84.04*
S.E. Reg.	0.02599	0.01647	0.01454	0.01242	0.01176
dw	1.88	1.80	1.44	1.54	1.35
BP	0.049	0.015	1.277	1.187	2.53
log lik	95.308	114.02	119.12	125.58	127.82

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table 3(b)
Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	-0.0191 (1.10)	-0.0146 (0.95)	-0.0071 (0.54)	0.0058 (0.45)	0.0754 (1.85)
ln PRM	0.5036* (2.35)	0.1851 (0.98)	-0.0641 (0.40)	-0.2293 (1.43)	-1.5147* (3.01)
ln PRW	-0.4864* (2.46)	-0.2568 (1.48)	-0.1148 (0.77)	0.1282 (0.87)	1.1248* (2.42)
ln CP	0.1660* (2.64)	0.1018 (1.85)	0.0631 (1.34)	-0.0135 (0.29)	-0.4036* (2.74)
ln MS	-0.0908* (3.43)	-0.0865* (3.73)	-0.0989* (4.97)	-0.0917* (4.64)	0.2841* (4.58)
T	-0.0052* (4.20)	-0.0045* (4.15)	-0.0042* (4.48)	-0.0024* (2.63)	0.0124* (4.27)
c	1.3067* (2.08)	2.1670* (3.93)	2.9524* (6.26)	3.1596* (6.74)	7.0147* (4.77)
R-sq.	0.9364	0.8870	0.7275	0.7284	0.9121
F	83.48*	44.48*	18.80*	15.20*	58.83*
S.E. Reg.	0.00898	0.00788	0.00675	0.00671	0.02106
dw	1.88	1.53	2.01	2.42	1.66
BP	0.038	1.251	0.192	2.891	0.056
log lik	138.59	144.22	150.56	150.81	103.94

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table 4(a)
Restricted Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	**D2**	**D3**	**D4**	**D5**
ln U	-0.1474* (3.45)	-0.0249 (0.99)	-0.0541* (2.46)	-0.0649* (3.64)	-0.0362* (2.33)
ln PRM	1.6496* (3.09)	1.1142* (3.94)	1.4904* (6.24)	1.2176* (6.97)	0.7715* (6.29)
ln PRW	-0.5977 (1.23)	-0.3919 (1.34)	-0.8165* (3.21)	-0.7308* (3.50)	-0.4380* (2.37)
ln CP	0.5018* (3.25)	0.1588 (1.70)	0.1976* (2.43)	0.2022* (3.01)	0.1213* (2.03)
ln MS	-0.3056* (4.60)	-0.0762 (1.8)	-0.0799* (2.22)	-0.1301* (4.40)	-0.1018* (3.74)
T	-0.0141* (4.60)	-0.0029 (1.61)	-0.0025 (1.62)	-0.0055* (4.37)	-0.0046* (4.26)
c	-5.9793* (3.77)	-2.5428* (3.30)	-2.2740* (3.62)	-1.2409* (3.12)	--
“R-sq.”	0.6697	0.7162	0.9269	0.9507	n.a.
chi-sq.	100.9*	124.8*	563.3*	927.7*	n.a.
S.E. Reg.	0.02380	0.01513	0.01337	0.01147	0.01098

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

n.a. – not applicable

Source: Statistics Canada CANSIM series

Table 4(b)
Restricted Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	-0.0191 (1.72)	-0.0144 (1.77)	--	--	0.0698* (3.19)
ln PRM	0.4610* (4.17)	0.2023* (2.32)	--	-0.0918 (1.14)	-1.3938* (6.94)
ln PRW	-0.3809* (2.93)	-0.1847 (1.95)	--	--	0.8340* (3.23)
ln CP	0.1216* (2.91)	0.0652* (2.13)	0.0136 (1.94)	--	-0.2813* (3.35)
ln MS	-0.0925* (4.54)	-0.0848* (5.07)	-0.0967* (7.51)	-0.0831* (5.95)	0.2920* (6.42)
T	-0.0047* (5.72)	-0.0038* (5.88)	-0.0031* (8.31)	-0.0015* (3.99)	0.0109* (6.44)
c	1.2144* (4.86)	1.9492* (8.69)	2.3955* (75.2)	3.0342* (8.62)	7.1891* (18.3)
"R-sq."	0.9322	0.8742	0.7301	0.6319	0.9057
chi-sq.	633.2*	345.5*	113.5*	68.87*	529.9*
S.E. Reg.	0.00845	0.00757	0.00664	0.00712	0.01986

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table 5
Basic Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	-0.2916* (2.81)	-0.1171* (3.84)	-0.0481* (2.38)	-0.0019 (0.13)	0.0698* (3.25)
ln PRM	12.769* (9.99)	4.0186* (10.7)	0.7845* (3.14)	-0.3709* (2.18)	-1.6924* (6.39)
ln PRW	-4.0518* (3.44)	-1.9771* (5.71)	-0.6770* (2.94)	-0.0507 (0.32)	0.9206* (3.77)
ln CP	0.6456 (1.72)	0.4492* (4.08)	0.2364* (3.23)	0.0888 (1.78)	-0.2556* (3.30)
ln MS	0.3338* (2.12)	-0.00367 (0.79)	-0.1400* (4.55)	-0.1199* (5.72)	0.1170* (3.58)
T	0.0429* (5.83)	0.0015 (0.70)	-0.0079* (5.53)	-0.0069* (7.08)	0.0042* (2.79)
c	-40.197* (10.3)	-8.7734* (7.98)	1.2156 (1.66)	4.5841* (9.22)	8.4336* (10.9)
R-sq.	0.9266	0.9770	0.9614	0.8839	0.9625
F	71.55*	241.1*	141.2*	43.15*	145.5*
S.E. Reg.	0.05352	0.01573	0.01045	0.00712	0.01109
dw	2.03	1.94	1.19*	1.76	1.67
BP	0.032	0.133	5.226*	0.246	0.008
log lik	65.69	115.90	132.66	148.42	130.24

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table 6
Restricted Basic Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	-0.3714* (5.12)	-0.1471* (9.53)	-0.0545* (4.81)	--	0.0771* (9.37)
ln PRM	12.815* (12.0)	4.0461* (12.28)	0.7374* (4.08)	-0.4254* (4.78)	-1.7374* (9.75)
ln PRW	-4.8551* (5.10)	-2.3588* (8.13)	-0.7264* (5.11)	--	1.1145* (7.93)
ln CP	0.9366* (3.16)	0.5985* (6.90)	0.2615* (5.80)	0.0753* (8.86)	-0.3377* (7.89)
ln MS	0.3912* (3.67)	--	-0.1293* (6.45)	-0.1183* (9.06)	0.0936* (8.05)
T	0.0395* (8.21)	--	-0.0084* (9.77)	-0.0069* (15.6)	0.0048* (10.8)
c	-38.085* (12.3)	-7.8465* (8.81)	1.5479* (2.58)	4.6715* (11.8)	8.1366* (14.6)
"R-sq."	0.9220	0.9731	0.9601	0.8829	0.9567
chi-sq.	561.4*	1476.*	1053.*	308.2*	1236.*
S.E. Reg.	0.05025	0.01550	0.00968	0.00651	0.01085

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table 7(a)
Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	**D2**	**D3**	**D4**	**D5**
ln U	-0.3743 (0.54)	-0.2459* (3.10)	-0.1509* (3.75)	-0.0927* (3.34)	-0.0595* (2.63)
ln PRM	24.648* (2.88)	9.9896* (10.2)	5.5694* (11.2)	2.9457* (8.62)	1.3130* (4.70)
ln PRW	-1.3220 (0.17)	-3.5174* (3.91)	-2.5469* (5.57)	-1.5774* (5.00)	-0.8895* (3.45)
ln CP	-0.1146 (0.05)	0.5603* (1.96)	0.5448* (3.75)	0.3820* (3.81)	0.2722* (3.33)
ln MS	-0.2185 (0.21)	0.2161 (1.80)	0.0154 (0.25)	-0.0714 (1.69)	-0.1344* (3.90)
T	0.0824 (1.67)	0.0302* (5.37)	0.0068* (2.38)	-0.0021 (1.05)	-0.0071* (4.41)
c	-102.80* (4.10)	-30.159* (10.6)	-14.400* (9.92)	-6.0432* (6.04)	-1.1382 (1.39)
R-sq.	0.5312	0.9415	0.9713	0.9759	0.9681
F	6.42*	91.27*	191.5*	229.3*	172.0*
S.E. Reg.	0.35879	0.04087	0.02077	0.01432	0.01169
dw	2.35	1.87	2.06	1.80	1.47
BP	1.336	0.043	0.474	0.003	1.824
log lik	-12.32	76.75	104.50	119.74	128.07

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table 7(b)
Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	-0.0388 (1.97)	-0.0030 (0.19)	-0.0009 (0.06)	0.0208 (1.31)	0.0983 (2.48)
ln PRM	0.3555 (1.47)	-0.1462 (0.76)	-0.5616* (3.23)	-0.8671* (4.43)	-2.2019* (4.52)
ln PRW	-0.5044* (2.26)	-0.2204 (1.24)	0.0918 (0.57)	0.2187 (1.21)	1.3417* (2.98)
ln CP	0.2082* (2.93)	0.1344* (2.39)	0.0507 (1.00)	0.0144 (0.25)	-0.4157* (2.91)
ln MS	-0.1443* (4.83)	-0.1086* (4.59)	-0.1291* (6.02)	-0.1193* (4.94)	0.2546* (4.23)
T	-0.0087* (6.20)	-0.0071* (6.47)	-0.0067* (6.74)	-0.0054* (4.80)	0.0099* (3.52)
c	1.8763* (2.65)	3.3428* (5.95)	4.3668* (8.59)	5.4800* (9.57)	9.1980* (6.45)
R-sq.	0.9467	0.9167	0.8379	0.9051	0.9387
F	100.6*	62.39*	29.29*	54.06*	86.83*
S.E. Reg.	0.01015	0.00804	0.00728	0.00820	0.02042
dw	1.05*	1.55	1.90	1.94	1.70
BP	7.900*	1.524	0.014	0.006	0.002
log lik	133.88	143.44	147.49	142.62	105.21

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table 8(a)
Restricted Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	**D2**	**D3**	**D4**	**D5**
ln U	-0.9208* (2.75)	-0.2668* (4.54)	-0.1563* (5.52)	-0.0939* (4.87)	-0.0581* (4.03)
ln PRM	23.024* (5.07)	9.9965* (12.8)	5.6380* (14.6)	3.0517* (12.2)	1.4574* (8.11)
ln PRW	--	-3.6270* (5.18)	-2.6186* (7.05)	-1.6498* (6.62)	-0.9914* (5.33)
ln CP	--	0.6331* (2.80)	0.5834* (4.80)	0.4084* (5.13)	0.2972* (5.06)
ln MS	--	0.1837* (3.01)	--	-0.0725* (2.89)	-0.1296* (5.19)
T	0.0625* (4.35)	0.0279* (7.73)	0.0060* (4.06)	-0.0021 (1.68)	-0.0067* (6.18)
c	-99.738* (4.94)	-30.025* (12.1)	-14.572* (11.9)	-6.3206* (8.03)	-1.4602* (2.53)
"R-sq."	0.4865	0.9409	0.9709	0.9758	0.9678
chi-sq.	58.68*	656.0*	1395.*	1717.*	1301.*
S.E. Reg.	0.34197	0.03741	0.01904	0.01308	0.01070

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table 8(b)
Restricted Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	-0.0354* (3.49)	--	--	0.0260* (3.94)	0.0892* (5.63)
ln PRM	0.4963* (3.95)	--	-0.4514* (5.84)	-0.8326* (8.47)	-2.4660* (12.0)
ln PRW	-0.5953* (4.17)	-0.3200* (4.27)	--	0.2291* (6.88)	1.5410* (6.78)
ln CP	0.2295* (5.19)	0.1576* (7.09)	0.0710* (8.59)	--	-0.4930* (6.80)
ln MS	-0.1376* (6.30)	-0.1008* (6.45)	-0.1239* (9.22)	-0.1149* (6.71)	0.2551* (8.07)
T	-0.0082* (9.61)	-0.0066* (14.5)	-0.0064* (14.4)	-0.0048* (7.45)	0.0100* (7.83)
c	1.5381* (3.56)	3.0099* (13.2)	4.1736* (12.1)	5.3367* (12.8)	9.8857* (12.3)
"R-sq."	0.9460	0.9148	0.8337	0.9030	0.9349
chi-sq.	745.1*	439.2*	209.9*	384.6*	810.3*
S.E. Reg.	0.00930	0.00740	0.00671	0.00755	0.01917

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table 9
Growth-Revised Basic Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**MC**
ln U	-0.0693 (1.75)	-0.0674* (2.36)	-0.0364 (1.64)	-0.0193 (1.24)	0.0584* (2.15)	-0.0360 (1.91)
ln PRM	1.5165* (3.62)	1.5195* (5.02)	0.7228* (3.07)	0.0850 (0.51)	-1.0960* (3.80)	0.6158* (3.09)
ln PRW	-0.4776 (1.20)	-0.8503* (2.96)	-0.4064 (1.82)	-0.0731 (0.47)	0.5856* (2.15)	-0.3561 (1.89)
ln CP	0.2829* (2.31)	0.2396* (2.71)	0.1466* (2.13)	0.0594 (1.23)	-0.2205* (2.62)	0.1276* (2.19)
ln MS	-0.0988* (2.45)	-0.0707* (2.42)	-0.0587* (2.58)	-0.0631* (3.96)	0.0927* (3.34)	-0.0637* (3.32)
ln RGDP	-0.1972* (2.31)	-0.1425* (2.31)	-0.1723* (3.59)	-0.1463* (4.35)	0.2202* (3.75)	-0.1538* (3.79)
c	1.4438 (0.49)	2.3106 (1.09)	5.5046* (3.33)	6.8325* (5.89)	0.9395 (0.46)	6.4401* (3.79)
R-sq.	0.6314	0.9462	0.9392	0.8431	0.9269	0.9332
F	9.71*	99.57*	87.47*	30.45*	71.85*	79.12*
S.E. Reg.	0.01780	0.01286	0.01001	0.00701	0.01224	0.00846
dw	1.74	1.45	1.58	1.77	1.64	1.49
BP	0.357	1.544	0.603	0.053	0.180	1.047
log lik	110.84	124.17	134.44	149.02	126.20	141.31

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table 10
Growth-Revised Basic Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	-0.1584 (1.40)	-0.0957* (2.78)	-0.0591* (2.40)	-0.0163 (1.00)	0.0704* (2.77)
ln PRM	12.638* (10.56)	4.0882* (11.23)	0.8698* (3.33)	-0.3183 (1.84)	-1.7612* (6.53)
ln PRW	-5.2004* (4.59)	-2.0478* (5.94)	-0.4888* (1.97)	0.1221 (0.74)	0.8293* (3.25)
ln CP	0.8382* (2.40)	0.4485* (4.22)	0.1945* (2.55)	0.0545 (1.08)	-0.2309* (2.93)
ln MS	0.0685 (0.59)	-0.0337 (0.96)	-0.0806* (3.20)	-0.0718* (4.30)	0.0814* (3.13)
ln RGDP	1.5687* (6.43)	0.0967 (1.30)	-0.2568* (4.82)	-0.2359* (6.68)	0.1245* (2.27)
c	-79.196* (9.43)	-11.476* (4.49)	7.3544* (4.01)	10.322* (8.48)	5.5638* (2.94)
R-sq.	0.9338	0.9778	0.9565	0.8758	0.9600
F	79.94*	249.7*	124.5*	39.96*	135.97*
S.E. Reg.	0.05083	0.01546	0.01110	0.00736	0.01145

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table 11(a)
Coefficients on ln RGDP in Growth-Revised Basic Decile Model
Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	**D2**	**D3**	**D4**	**D5**
Total Income					
OLS	-0.3998* (3.03)	-0.0842 (1.06)	-0.0848 (1.21)	-0.1887* (3.14)	-0.1637* (2.87)
Partially Restricted	-0.3817* (3.22)	-0.0713 (1.00)	-0.0814 (1.28)	-0.1789* (3.34)	-0.1566* (3.06)
Fully Restricted	-0.2760* (6.74)	-0.0658* (3.30)	-0.0663* (3.57)	-0.1376* (5.61)	-0.1050* (5.21)
Market Income					
OLS	3.2624 (1.92)	1.1015* (5.86)	0.2760* (2.85)	-0.0250 (0.36)	-0.2166* (3.68)
Partially Restricted	3.5744* (2.57)	1.0965* (6.42)	0.2715* (3.10)	-0.0259 (0.41)	-0.2160* (3.97)
Fully Restricted	2.5606* (5.90)	0.9986* (9.26)	-.2484* (5.07)	--	-0.2183* (8.67)

*Significant at 95% level of confidence.

Note: The coefficients for the "partially restricted" results are based on imposing just the cross-equation adding-up restrictions, while the "fully restricted" include both adding-up and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table 11(b)
Coefficients on ln RGDP in Growth-Revised Basic Decile Model
Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
Total Income					
OLS	-0.1796* (4.15)	-0.1573* (4.17)	-0.1369* (4.09)	-0.0817* (2.52)	0.3987* (3.80)
Partially Restricted	-0.1762* (4.49)	-0.1514* (4.48)	-0.1367* (4.48)	-0.0825* (2.78)	0.4077* (4.29)
Fully Restricted	-0.1304* (7.71)	-0.1073* (7.67)	-0.0793* (8.58)	-0.0570* (5.32)	0.2868* (13.9)
Market Income					
OLS	-0.2898* (5.70)	-0.2415* (6.03)	-0.2317* (6.49)	-0.1890* (4.81)	0.3058* (3.01)
Partially Restricted	-0.2898* (6.24)	-0.2412* (6.56)	-0.2314* (7.01)	-0.1884* (5.16)	0.3202* (3.64)
Fully Restricted	-0.3067* (13.0)	-0.2570* (12.2)	-0.2683* (16.3)	-0.2125* (15.3)	0.3824* (20.6)

*Significant at 95% level of confidence.

Note: The coefficients for the "partially restricted" results are based on imposing just the cross-equation adding-up restrictions, while the "fully restricted" include both adding-up and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table 12
New Basic Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	Q2	Q3	Q4	Q5
ln U	0.0048 (0.11)	0.0041 (0.14)	0.0131 (0.59)	0.0257 (1.67)	-0.0224 (0.81)
ln PRM	2.6117* (4.52)	2.4822* (6.20)	1.4978* (4.81)	0.7424* (3.44)	-2.1847* (5.62)
ln PRW	-1.3775* (3.11)	-1.5740* (5.15)	-1.0627* (4.49)	-0.6843* (4.18)	1.5147* (5.12)
ln CP	0.4214* (3.63)	0.3525* (4.56)	0.2208* (3.80)	0.1390* (3.46)	-0.3408* (4.65)
ln RGDP	0.0683 (0.61)	0.0724 (0.94)	0.0134 (0.22)	0.0154 (0.37)	-0.0461 (0.61)
ln Glob Low	-0.0584 (0.69)	-0.0172 (0.31)	--	--	0.0139 (0.53)
ln FX	--	--	0.0126 (1.56)	0.0294* (3.95)	-0.0224* (3.16)
D7686	0.0106 (0.12)	0.0022 (0.05)	-0.0151 (1.72)	-0.0119 (1.95)	0.0096 (0.40)
ln Auto Lower	-0.0296 (0.10)	-0.0732 (0.54)	--	--	0.0259 (0.35)
ln Auto Upper	--	--	0.0772 (1.89)	0.0727* (2.55)	-0.0748* (2.34)
c	-7.6577 (1.83)	-5.5442* (1.96)	-0.4999 (0.23)	1.8040 (1.20)	9.6951* (3.57)
"R-sq."	0.5875	0.9466	0.9390	0.8514	0.9241
chi-sq.	61.92*	733.6*	648.9*	236.7*	524.8*
S.E. Reg.	0.01715	0.01166	0.00913	0.00621	0.01135

*Significant at 95% level of confidence.
Source: Statistics Canada CANSIM series
Note: These estimates are based on imposing cross-equation adding-up restrictions.

Table 13
Restricted New Basic Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	--	--	--	0.0000 (n.a.)	--
ln PRM	2.0431* (6.29)	1.7966* (8.63)	1.4565* (14.1)	0.8263* (7.78)	-1.9295* (12.6)
ln PRW	-0.8977* (2.99)	-1.0449* (4.80)	-1.0374* (6.89)	-0.8085* (6.89)	1.3488* (7.00)
ln CP	0.3434* (3.86)	0.2532* (4.03)	0.2263* (5.65)	0.1793* (5.51)	-0.3257* (6.12)
ln RGDP	--	--	--	--	--
ln Glob Low	--	--	--	--	--
ln FX	--	--	0.0146 (1.56)	0.0311* (3.57)	-0.0242* (2.91)
D7686	--	--	-0.0004 (0.16)	-0.0021 (1.06)	--
ln Auto Lower	--	--	--	--	--
ln Auto Upper	--	--	0.1033* (6.60)	0.1082* (7.34)	-0.1064* (7.69)
c	-4.8457* (5.36)	-2.1363* (4.04)	--	2.3206* (8.98)	7.7692* (27.6)
"R-sq."	0.5556	0.9326	n.a.	0.8208	0.9153
chi-sq.	63.28*	611.4*	n.a.	216.4*	659.1*
S.E. Reg.	0.01780	0.01310	0.00956	0.00682	0.01199

*Significant at 95% level of confidence.
Source: Statistics Canada CANSIM series
Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Table 14
New Basic Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	-0.3788* (3.55)	-0.0530 (1.50)	0.0266 (1.25)	0.0380* (2.55)	0.0028 (0.12)
ln PRM	8.7879* (6.07)	4.7475* (9.76)	2.2761* (7.62)	0.4733* (2.26)	-2.7666* (8.45)
ln PRW	-2.5465* (2.29)	-2.5440* (6.85)	-1.6540* (7.28)	-0.6144* (3.86)	1.7271* (6.92)
ln CP	0.6373* (2.19)	0.5068* (5.34)	0.3115* (5.60)	0.1581* (4.04)	-0.3646* (5.85)
ln RGDP	0.7856* (2.81)	0.2479* (2.64)	0.0660 (1.14)	-0.0513 (1.26)	-0.1004 (1.59)
ln Glob Low	0.4198* (1.97)	-0.0657 (0.97)	--	--	-0.0091 (0.35)
ln FX	--	--	0.0332* (4.89)	0.0412* (6.21)	-0.0359* (6.56)
D7686	0.0452 (0.21)	0.0113 (0.20)	-0.0213* (2.51)	-0.0114 (1.92)	0.0055 (0.21)
ln Auto Lower	-0.3196 (0.44)	0.0075 (0.04)	--	--	0.0169 (0.20)
ln Auto Upper	--	--	0.1826* (4.68)	0.0919* (3.33)	-0.1223* (4.31)
c	-51.059* (4.86)	-16.780* (4.85)	-3.1220 (1.51)	4.5187* (3.10)	12.873* (5.61)
"R-sq."	0.9428	0.9780	0.9659	0.8884	0.9557
chi-sq	729.7*	1825.*	1228.*	391.3*	1037.*
S.E. Reg.	0.04303	0.01401	0.00894	0.00635	0.01097

*Significant at 95% level of confidence.
Source: Statistics Canada CANSIM series
Note: These estimates are based on imposing cross-equation adding-up restrictions.

Table 15
Restricted New Basic Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	-0.1697* (2.06)	-0.0516* (3.60)	0.0165 (1.80)	0.0277* (2.90)	--
ln PRM	11.979* (12.1)	4.2432* (13.6)	1.7326* (7.66)	0.0767 (0.45)	-2.4019* (10.7)
ln PRW	-4.4771* (5.16)	-2.1270* (8.15)	-1.2346* (6.70)	-0.3187* (2.27)	1.4140* (7.61)
ln CP	0.6200* (2.19)	0.4380* (5.54)	0.2708* (5.62)	0.1338* (3.65)	-0.3182* (6.38)
ln RGDP	1.5137* (9.72)	0.1889* (5.45)	-0.0177 (0.57)	-0.1170* (4.18)	-0.0598* (2.62)
ln Glob Low	0.0000 (n.a.)	--	--	--	--
ln FX	--	--	0.0352* (4.20)	0.0425* (5.71)	-0.0374* (5.63)
D7686	--	--	-0.0091* (2.88)	-0.0019 (0.81)	--
ln Auto Lower	--	--	--	--	--
ln Auto Upper	--	--	0.1084* (4.23)	0.0387 (1.70)	-0.0637* (3.14)
c	-76.893* (12.7)	-14.373* (9.35)	-0.1102 (0.09)	6.8696* (6.69)	11.332* (11.2)
"R-sq."	0.9326	0.9766	0.9614	0.8728	0.9527
chi-sq.	606.5*	1759.*	1199.*	363.2*	986.0*
S.E. Reg.	0.04671	0.01447	0.00952	.00678	0.01135

*Significant at 95% level of confidence.
Source: Statistics Canada CANSIM series
Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Table 16
New Basic Model Estimates of Pooled Family and Market Income Shares, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	Q2	Q3	Q4	Q5
Family Income Coefficients					
ln U	-0.0935 (1.85)	-0.0031 (0.12)	0.0242 (1.19)	0.0264 (1.89)	-0.0105 (0.43)
ln PRM	1.1634 (1.95)	2.4663* (7.76)	1.7143* (6.62)	0.7261* (4.05)	-2.0430* (6.90)
ln PRW	-0.4105 (0.85)	-1.5769* (6.10)	-1.2268* (5.89)	-0.6822* (4.75)	1.4374* (5.98)
ln CP	0.4213* (2.81)	0.3508* (4.56)	0.2231* (3.79)	0.1393* (3.45)	-0.3414* (4.79)
ln RGDP	-0.2513* (2.36)	0.0774 (1.29)	0.0598 (1.25)	0.0121 (0.36)	-0.0160 (0.30)
c	3.1391 (0.74)	-5.5058* (2.51)	-1.9931 (1.14)	1.9638 (1.61)	8.5586* (4.23)
Market Income Coefficients					
ln U	-0.2160* (2.87)	-0.0329 (1.18)	0.0160 (0.82)	0.0354* (2.62)	-0.0058 (0.29)
ln PRM	11.593* (13.2)	4.9787* (14.8)	2.0186* (8.03)	0.4128* (2.37)	-2.8501* (11.4)
ln PRW	-4.2820* (5.96)	-2.6518* (9.65)	-1.4628* (7.25)	-0.5674* (4.08)	1.7527* (8.67)
ln CP	0.7924* (3.52)	0.5390* (6.53)	0.3087* (5.44)	0.1551* (3.99)	-0.3784* (6.45)
ln RGDP	1.3005* (8.38)	0.2719* (4.46)	0.0095 (0.20)	-0.0629 (1.93)	-0.1076* (2.35)
c	-71.420* (11.7)	-18.354* (7.93)	-1.3087 (0.77)	4.8970* (4.13)	13.538* (7.96)

Auto/Glob Coefficients					
Ln Glob Low	0.1680* (2.62)	-0.0338 (0.99)	--	--	-0.0084 (0.68)
ln FX	--	--	0.0238* (4.37)	0.0361* (7.03)	-0.0302* (6.59)
D7686	0.0675 (1.32)	0.0145 (0.61)	-0.0194* (3.13)	-0.0116* (2.73)	0.0015 (0.15)
ln Auto Lower	-0.3192* (2.10)	-0.0756 (0.99)	--	--	0.0526* (1.96)
ln Auto Upper	--	--	0.1232* (4.37)	0.0765* (3.88)	-0.0934* (4.40)
S.E. Reg.	0.03478	0.01310	0.00915	.00627	0.01112

*Significant at 95% level of confidence.
Source: Statistics Canada CANSIM series
Note: The restricted estimates are based on imposing cross-equation adding-up restrictions.

Table 17
Restricted New Basic Model Estimates of Pooled Family and Market Income Shares, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	Q2	Q3	Q4	Q5
Family Income Coefficients					
ln U	-0.0590* (2.33)	--	0.0034 (0.47)	0.0130* (3.07)	--
ln PRM	1.0060* (5.95)	1.8088* (7.37)	1.5284* (7.76)	0.7178* (5.28)	-1.7437* (8.59)
ln PRW	--	-0.9780* (4.77)	-1.1281* (6.48)	-0.7086* (5.71)	1.1738* (6.60)
ln CP	0.1853* (4.80)	0.2163* (3.55)	0.2272* (4.46)	0.1533* (4.30)	-0.2763* (5.23)
ln RGDP	-0.1141* (3.76)	0.0315* (2.55)	0.0191 (1.48)	--	--
c	--	-3.1735* (3.57)	-0.4464 (0.63)	2.4240* (6.46)	7.4694* (12.2)
Market Income Coefficients					
ln U	-0.1625* (3.31)	-0.0463* (3.47)	--	0.0362* (4.35)	--
ln PRM	11.421* (14.2)	4.2587* (17.8)	1.6635* (15.8)	0.3097* (2.64)	-2.4766* (18.9)
ln PRW	-4.0392* (5.98)	-2.1747* (9.53)	-1.2841* (8.40)	-0.5096* (4.37)	1.5257* (9.89)
ln CP	0.5599* (2.72)	0.4281* (6.28)	0.2592* (6.40)	0.1236* (3.69)	-0.3022* (7.17)
ln RGDP	1.4733* (14.1)	0.2220* (7.36)	--	-0.0452* (2.52)	-0.1123* (12.3)
c	-74.860* (17.0)	-15.134* (12.2)	--	4.7656* (7.10)	12.518* (29.0)

Auto/Glob Coefficients					
Ln Glob Low	0.0000 (n.a.)	--	--	--	--
ln FX	--	--	0.0268* (4.05)	0.0375* (6.55)	-0.0322* (5.97)
D7686	0.0434 (1.52)	--	-0.0071* (2.02)	-0.0070* (2.44)	--
ln Auto Lower	0.0208 (0.29)	--	--	--	-0.0021 (0.29)
ln Auto Upper	--	--	0.1187* (8.16)	0.0843* (6.65)	-0.0960* (8.33)
S.E. Reg.	0.03571	0.01400	0.00964	.00646	0.01170

*Significant at 95% level of confidence.
Source: Statistics Canada CANSIM series
Note: These estimates are based on imposing cross-equation adding-up restrictions as well as zero-coefficient restrictions on coefficient estimates in Table 16 that had t-ratios less than one.

Table 18
Gini Coefficient Estimates for Family Income, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Total Income			**Market Income**		
	Basic Model	**Growth Revised**	**New Basic Model**	**Basic Model**	**Growth Revised**	**New Basic Model**
ln U	0.08077* (2.82)	0.09844* (2.90)	-0.03451 (0.80)	0.1067* (4.31)	0.1046* (3.63)	0.03533 (0.94)
ln PRM	-1.5601* (4.43)	-1.6528* (4.60)	-3.5158* (6.04)	-2.5309* (8.31)	-2.5875* (8.48)	-3.6107* (7.17)
ln PRW	1.0071* (3.10)	0.7606* (2.24)	2.3794* (5.27)	1.1565* (4.11)	1.1014* (3.81)	2.1301* (5.45)
ln CP	-0.3809* (3.69)	-0.3292* (3.14)	-0.5462* (4.57)	-0.2960* (3.31)	-0.2786* (3.13)	-0.3887* (3.76)
ln MS	0.2329* (5.36)	0.1599* (4.62)	--	0.1365 (0.63)	0.1113* (3.78)	--
T	0.01014* (5.00)	--	--	0.00278 (1.59)	--	--
ln RGDP	--	0.3369* (4.60)	-0.1064 (0.92)	--	0.0752 (1.21)	-0.1854 (1.85)
C	3.2287* (3.13)	-4.8981 (1.94)	9.6223* (2.25)	6.5756* (7.37)	4.8989* (2.29)	12.2376* (3.31)
ln Glob Low	--	--	1.8611 (0.14)	--	--	-0.0875 (0.01)
ln FX	--	--	-0.0653* (2.30)	--	--	-0.04628 (1.88)
D7686	--	--	0.0174 (0.18)	--	--	0.0732 (0.86)
ln Auto Lower	--	--	-1.7950 (0.14)	--	--	-0.0609 (0.01)
ln Auto Upper	--	--	1.6960 (0.13)	--	--	-0.2151 (0.02)
R-sq.	0.9288	0.9238	0.9203	0.9650	0.9639	0.9608
F	73.90*	68.73*	34.64*	156.1*	151.5*	73.55*
S.E. Reg.	0.01475	0.01525	0.01661	0.01277	0.01295	0.01438

*Significant at 95% level of confidence.
Source: Statistics Canada CANSIM series

Table 19
Estimated Responsiveness of the Q5 to Q1 Relative Mean Income Gap

	Total Income				Market Income			
	Basic Model	**Growth Revised**	**New Basic Model**	**NBM Pooled**	**Basic Model**	**Growth Revised**	**New Basic Model**	**NBM Pooled**
U	0.1252	0.1252	--	0.0590	0.4485	0.2553	0.1697	0.1625
PRM	-2.3685	-2.6111	-3.7291	-2.7497	-14.552	-14.053	-14.381	-13.898
PRW	1.3369	0.9941	2.2465	1.1738	5.9696	5.6395	5.8911	5.5649
CP	-0.5696	-0.4778	-0.6691	-0.4616	-1.2743	-0.9663	-0.9382	-0.8621
MS	0.3034	0.1925	--	--	-0.2976	0.0730	--	--
T	0.0139	--	--	--	-0.0347	--	--	--
RGDP	--	0.4053	--	0.1141	--	-1.3671	-1.5735	-1.5856

Notes: 1. Each entry is the elasticity of (Q5 mean income / Q1 mean income) to each respective LHS variable, except for T where the entries are the differences in proportional growth rates.

2. Based on restricted estimates in Tables 2, 6; A5, A6; 13, 15; 17. "NBM pooled" means the pooled version of the New Basic Model.

Table 20
Estimated Responsiveness of the Q1 to Q3 Relative Mean Income Gap

	Total Income				**Market Income**			
	Basic Model	**Growth Revised**	**New Basic Model**	**NBM Pooled**	**Basic Model**	**Growth Revised**	**New Basic Model**	**NBM Pooled**
U	0.0467	0.0156	--	0.0624	0.3169	0.1300	0.1862	0.1625
PRM	-0.8119	-1.0306	-0.5866	0.5224	-12.078	-11.144	-10.246	-9.7575
PRW	0.1596	0.2071	-0.1397	-1.1281	4.1287	4.0282	3.2425	2.7551
CP	-0.1712	-0.1559	-0.1171	0.0419	-0.6751	-0.4467	-0.3492	-0.3007
MS	0.0581	0.0213	--	--	-0.5205	-0.0732	--	--
T	0.0016	--	--	--	-0.0479	--	--	--
RGDP	--	-0.0327	--	0.1332	--	-1.7361	-1.5314	-1.4733

Notes: 1. Each entry is the elasticity of (Q3 mean income / Q1 mean income) to each respective LHS variable, except for T where the entries are the differences in proportional growth rates.

2. Based on restricted estimates in Tables 2, 6; A5, A6; 13, 15; 17.

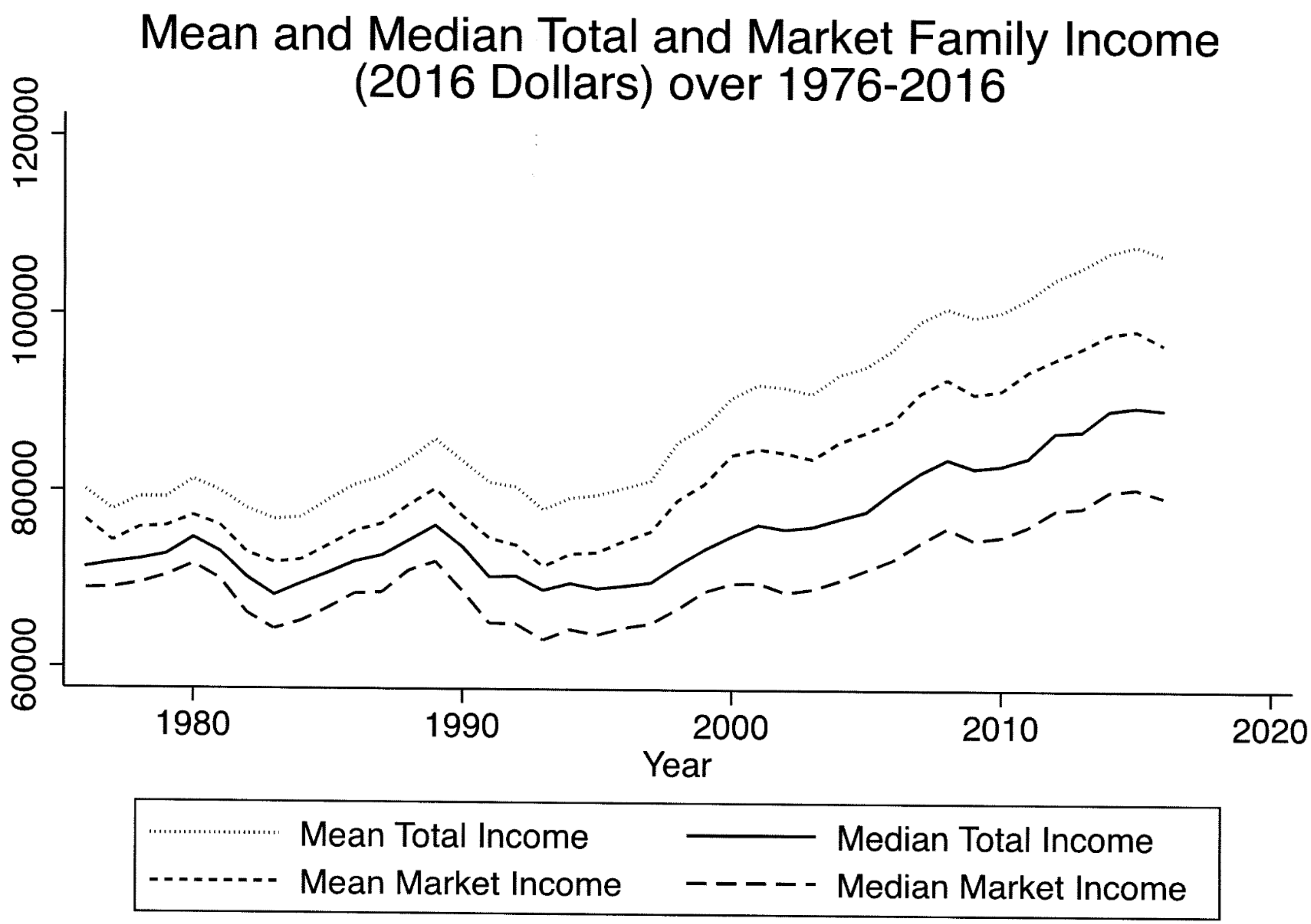
Table 21
Estimated Responsiveness of the Q5 to Q3 Relative Mean Income Gap

	Total Income				Market Income			
	Basic Model	**Growth Revised**	**New Basic Model**	**NBM Pooled**	**Basic Model**	**Growth Revised**	**New Basic Model**	**NBM Pooled**
U	0.0785	0.1096	--	-0.0034	0.1316	0.1253	-0.0165	--
PRM	-1.5566	-1.5805	-3.3860	-3.2721	-2.4748	-2.9095	-4.1345	-4.1401
PRW	1.1773	0.7870	2.3862	2.3019	1.8409	1.6113	2.6436	2.8098
CP	-0.3984	-0.3219	-0.5520	-0.5035	-0.5992	-0.5196	-0.5890	-0.5614
MS	0.2453	0.1712	--	--	0.2229	0.1462	--	--
T	0.0123	--	--	--	0.0132	--	--	--
RGDP	--	0.4380	--	-0.0191	--	0.3690	-0.0421	-0.1123

Notes: 1. Each entry is the elasticity of (Q5 mean income / Q3 mean income) to each respective LHS variable, except for T where the entries are the differences in proportional growth rates.

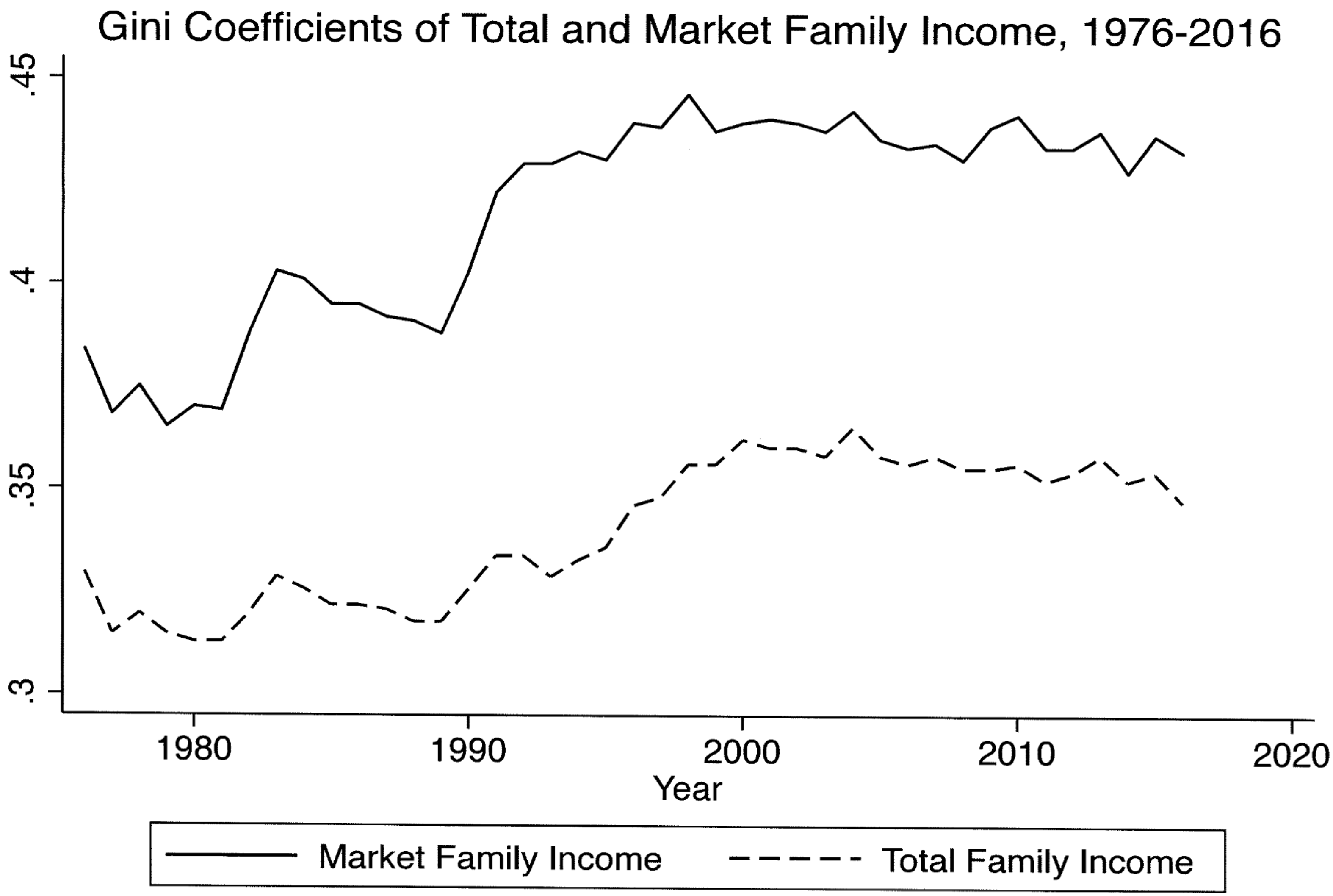
2. Based on restricted estimates in Tables 2, 6; A5, A6; 13, 15; 17.

Figure 1



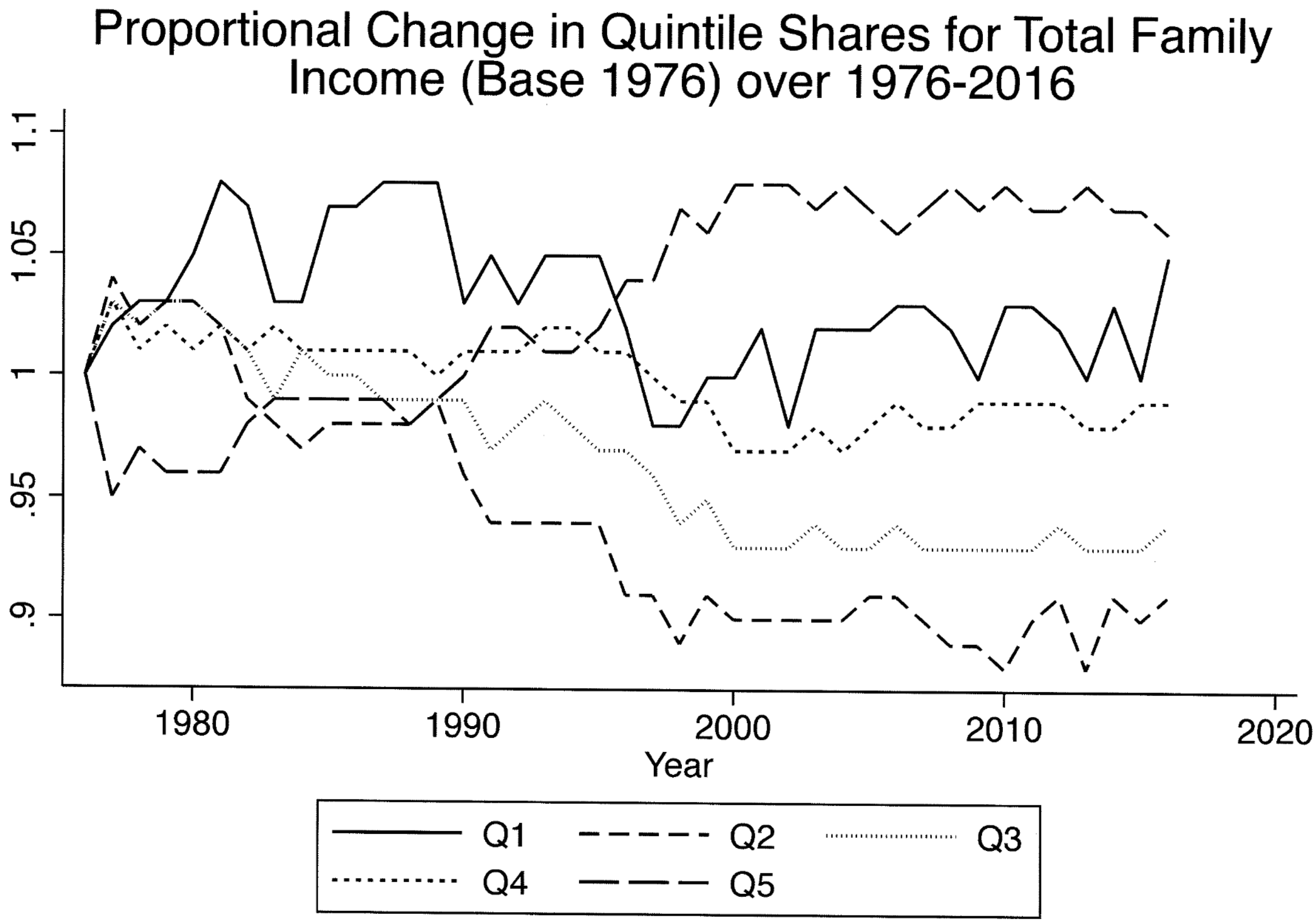
Mean and Median Total and Market Family Income
(2016 Dollars) over 1976-2016
120000
100000
80000
60000
1980
1990
2000
2010
2020
Year
Mean Total Income
Median Total Income
Mean Market Income
Median Market Income

Figure 2



Gini Coefficients of Total and Market Family Income, 1976-2016
.45
.4
.35
.3
1980
1990
2000
2010
2020
Year
Market Family Income
Total Family Income

Figure 3



Proportional Change in Quintile Shares for Total Family Income (Base 1976) over 1976-2016
1.1
1.05
1
.95
.9
1980
1990
2000
2010
2020
Year
Q1
Q2
Q3
Q4
Q5

Figure 4

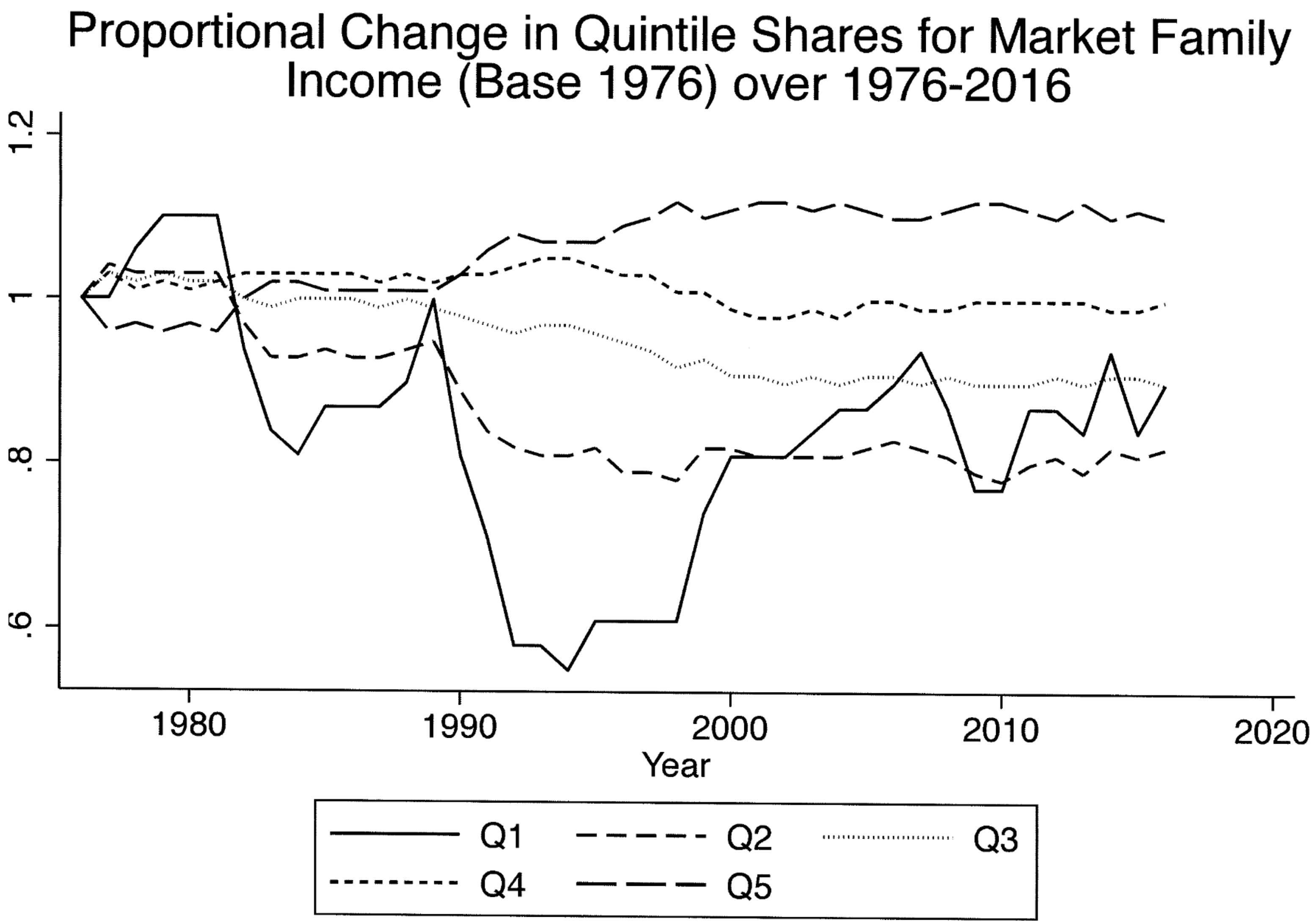
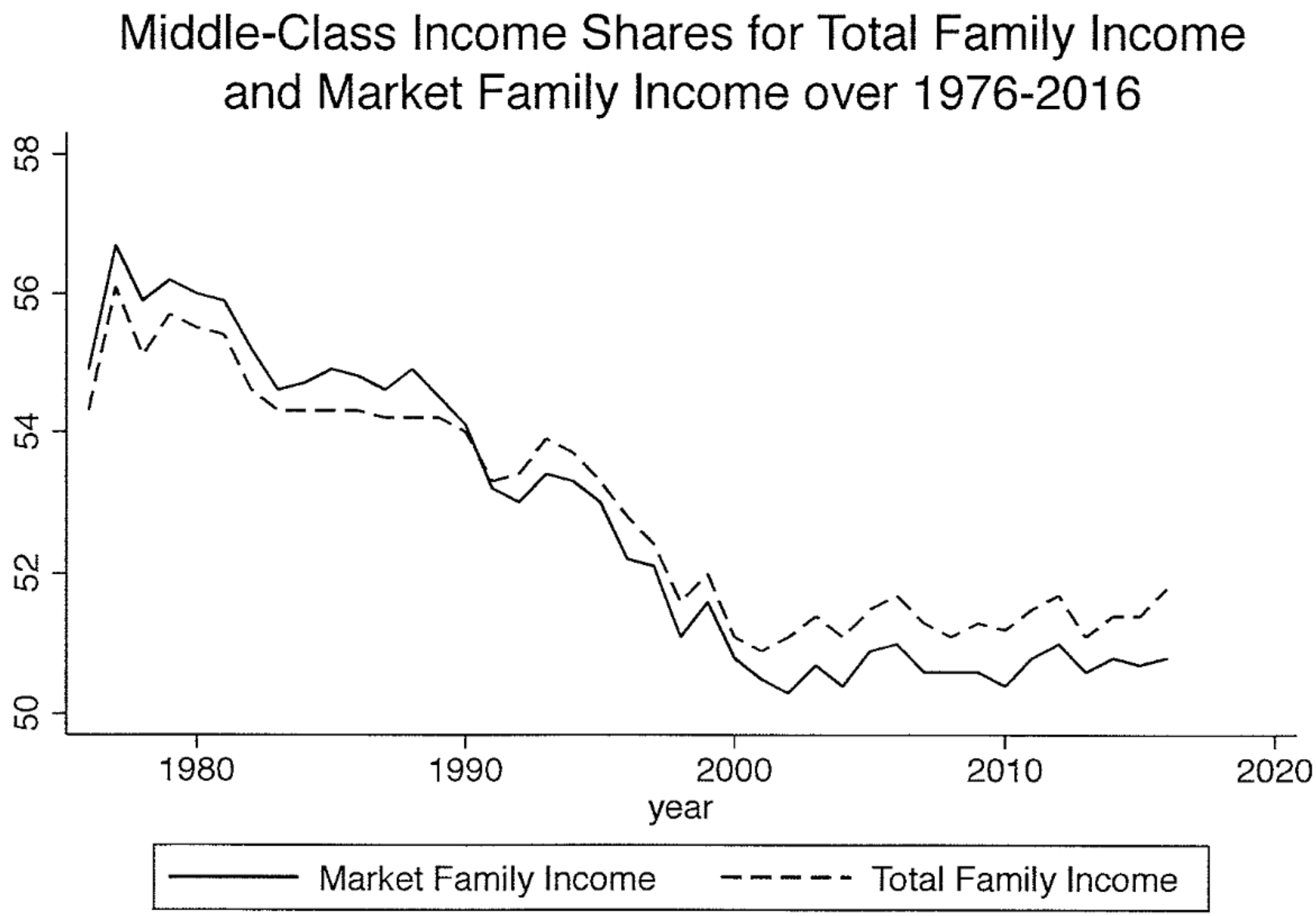

Proportional Change in Quintile Shares for Market Family Income (Base 1976) over 1976-2016
1.2
1
.8
.6
1980
1990
2000
2010
2020
Year
Q1
Q2
Q3
Q4
Q5

Figure 5


Middle-Class Income Shares for Total Family Income
and Market Family Income over 1976-2016
58
56
54
52
50
1980
1990
2000
2010
2020
year
Market Family Income
Total Family Income

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Appendix A – Appendix Tables

Table A0
Summary Statistics of All Regression Variables
(1976-2016)

	Mean	**Std. Dev.**	**Min.**	**Max.**
a) Total Family Income Shares				
Q1	6.188	0.1676	5.9	6.5
Q2	11.937	0.6184	11.2	13.2
Q3	17.302	0.6502	16.6	18.5
Q4	23.676	0.3859	22.9	24.4
Q5	40.866	1.6952	37.8	43.0
D1	2.229	0.0929	2.0	2.4
D2	3.959	0.1140	3.8	4.2
D3	5.302	0.2697	5.0	5.9
D4	6.634	0.3511	6.2	7.3
D5	7.963	0.3462	7.6	8.6
D6	9.339	0.3073	9.0	9.9
D7	10.890	0.2354	10.5	11.3
D8	12.785	0.1652	12.4	13.1
D9	15.544	0.1845	15.1	16.0
D10	25.322	1.6469	22.3	27.6
b) Family Market Income Shares				
Q1	2.600	0.4489	1.7	3.4
Q2	10.412	1.0332	9.3	12.5
Q3	17.320	0.8533	16.3	18.8
Q4	25.007	0.4824	24.3	26.0
Q5	44.654	2.317	40.2	47.1
D1	0.293	0.1311	0.0*	0.5
D2	2.307	0.3594	1.7	3.0
D3	4.307	0.5076	3.8	5.3
D4	6.105	0.5343	5.5	7.2
D5	7.810	0.4763	7.3	8.7
D6	9.510	0.3852	9.0	10.1
D7	11.388	0.2917	11.0	11.8
D8	13.620	0.2283	13.3	14.2
D9	16.802	0.4102	15.8	17.5
D10	27.851	2.0787	23.8	30.5

c) **Independent Variables**				
U	8.315	1.599	6.0	12.0
PRM	74.105	2.605	70.3	78.4
PRW	57.602	4.693	45.7	62.6
CP	86.268	28.08	31.1	128.4
MS	0.2014	0.05110	0.1189	0.2918
T	21.	11.98	1	41
RGDP	1194.2	352.7	678.2	1801.4
Glob Low	1.0742	0.2854	0.8192	1.6709
FX	0.8174	0.1032	0.6368	1.0139
D7686				
Auto Lower	0.1328	0.01728	0.0891	0.1513
Auto Upper	0.1380	0.01657	0.1199	0.1754
L. Share	0.6082	0.01871	0.5762	0.6458

Source: Statistics Canada CANSIM series (see text).
*Approximated by small positive number (0.05 for two observations) in log regressions.

Table A1
Quintile Share Regression Estimates for Family Income,
1965-1987
(estimated t-ratios in parenthesis)

	Q1	Q2	Q3	Q4	Q5	MC
ln U	-0.1158 (0.97)	0.1058* (2.19)	0.0956* (2.01)	0.0509 (1.71)	-0.1175* (2.82)	0.0787* (2.26)
ln PRM	3.8590 (1.32)	4.4960* (3.81)	1.6569 (1.43)	1.0143 (1.39)	-3.3609* (3.30)	2.0485* (2.40)
ln PRW	-1.1661 (0.88)	-1.4565* (2.72)	-0.5709 (1.09)	-0.1548 (0.47)	1.0078* (2.18)	-0.5998 (1.55)
ln CP	0.0009 (0.05)	0.0128 (1.73)	0.0050 (0.69)	-0.0020 (0.45)	-0.0003 (0.05)	0.0036 (0.68)
ln MS	-0.4893 (1.24)	0.0922 (0.58)	0.2706 (1.74)	0.0320 (0.33)	-0.0809 (0.59)	0.1248 (1.09)
T	0.0280 (0.85)	0.0339* (2.56)	0.0166 (1.28)	0.0044 (0.54)	-0.0239* (2.09)	0.0154 (1.61)
C	-11.24 (1.28)	-12.02* (3.39)	-2.223 (0.64)	-0.7644 (0.35)	14.88* (4.85)	-2.8329 (1.10)
R-sq.	0.6611	0.8705	0.5002	0.7478	0.6514	0.6172
F	4.226*	14.57*	2.168	6.426*	4.049*	3.493*
S.E. Reg.	0.02547	0.01026	0.01009	0.00633	0.00860	0.00741

*Significant at 95% level of confidence.

Source: McWatters and Beach (1990).

Table A2
Linear Basic Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	Q2	Q3	Q4	Q5
U	-0.0271 (1.16)	-0.0599 (1.89)	-0.0239 (0.64)	-0.0154 (0.44)	0.1347 (1.27)
PRM	0.1099* (3.78)	0.2328* (5.92)	0.1560* (3.36)	0.0281 (0.64)	-0.5216* (3.94)
PRW	-0.0363 (1.11)	-0.1713* (3.87)	-0.1234* (2.36)	-0.0556 (1.13)	0.3807* (2.55)
CP	0.0343 (1.93)	0.0608* (2.52)	0.0486 (1.71)	0.0259 (0.97)	-0.1693* (2.09)
MS	-3.5252 (1.46)	-3.2772 (1.00)	-6.2970 (1.63)	-11.88* (3.28)	25.36* (2.30)
T	-0.0661* (2.57)	-0.0964* (2.77)	-0.1149* (2.80)	-0.1097* (2.84)	0.3912* (3.34)
C	-0.5029 (0.23)	2.4873 (0.83)	12.536* (3.54)	27.381* (8.23)	57.759* (5.72)
R-sq.	0.6066	0.9471	0.9333	0.8329	0.9203
F	8.74*	101.4*	79.27*	28.25*	65.45*
S.E. Reg.	0.11405	0.15432	0.18216	0.17108	0.51902
Dw	1.56	1.46	1.49	1.66	1.45
BP	1.017	0.617	0.652	0.180	0.527
log lik	34.68	22.28	15.48	18.05	-27.45

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table A3
Linear Restricted Basic Model of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
U	-0.0266 (1.61)	-0.0354* (2.22)	--	--	0.0620* (2.20)
PRM	0.1008* (9.48)	0.2528* (19.7)	0.1513* (7.88)	--	-0.5048* (15.2)
PRW	-0.0277 (1.02)	-0.1664* (4.72)	-0.0997* (2.56)	-0.0195 (0.60)	0.3133* (2.84)
CP	0.0302* (2.04)	0.0583* (3.12)	0.0362 (1.77)	0.0073 (0.42)	-0.1320* (2.27)
MS	-3.7541* (2.10)	-1.4435 (0.60)	-5.2353 (1.82)	-11.914* (4.43)	22.347* (2.76)
T	-0.0623* (2.82)	-0.0789* (3.02)	-0.0895* (3.46)	-0.0842* (3.62)	0.3149* (4.07)
C	--	--	11.648* (8.52)	28.333* (31.5)	59.988* (31.2)
“R-sq.”	n.a.	n.a.	0.9319	0.8282	0.9186
chi-sq.	n.a.	n.a.	613.6*	200.1*	760.1*
S.E. Reg.	0.10404	0.14265	0.16762	0.15797	0.47762

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

n.a. – not applicable

Source: Statistics Canada CANSIM series

Table A4
Linear Basic Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	Q2	Q3	Q4	Q5
U	-0.0706* (2.70)	-0.0918* (2.53)	-0.0574 (1.39)	0.0059 (0.15)	0.2288* (2.13)
PRM	0.3542* (10.9)	0.4827* (10.7)	0.1807* (3.51)	-0.0878 (1.83)	-0.9089* (6.80)
PRW	-0.1085* (2.96)	-0.2229* (4.38)	-0.1489* (2.57)	-0.0336 (0.62)	0.4643* (3.08)
CP	0.0116 (0.58)	0.0432 (1.56)	0.0636* (2.02)	0.0485 (1.65)	-0.1437 (1.75)
MS	4.6732 (1.73)	0.1777 (0.05)	-10.099* (2.36)	-15.206* (3.82)	22.878* (2.06)
T	0.0886* (3.08)	-0.0006 (0.01)	-0.1699* (3.73)	-0.2043* (4.82)	0.2653* (2.24)
C	-20.612* (8.31)	-15.506* (4.50)	13.098* (3.34)	36.566* (10.00)	85.581* (8.39)
R-sq.	0.9314	0.9750	0.9525	0.8710	0.9564
F	76.98*	221.2*	113.6*	38.26*	124.4*
S.E. Reg.	0.12749	0.17714	0.20176	0.18793	0.52453
Dw	2.05	1.60	1.07*	1.69	1.41
BP	0.097	0.097	5.487*	0.235	0.687
log lik	30.11	16.62	11.29	14.20	-27.88

*Significant at 95% level of confidence.

Source: Statistics Canada CANSIM series

Table A5
Restricted Growth-Revised Basic Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	-0.0605* (2.86)	-0.0743* (4.75)	-0.0449* (4.23)	-0.0256* (2.86)	0.0647* (5.26)
ln PRM	1.6633* (5.74)	1.4655* (7.24)	0.6327* (5.22)	--	-0.9478* (7.43)
ln PRW	-0.5388 (1.62)	-0.7986* (3.86)	-0.3317* (2.74)	--	0.4553* (3.36)
ln CP	0.2870* (2.72)	0.2281* (3.49)	0.1311* (3.35)	0.0435* (4.55)	-0.1908* (4.26)
ln MS	-0.0880* (2.94)	-0.0759* (3.69)	-0.0667* (4.59)	-0.0704* (6.96)	0.1045* (5.98)
ln RGDP	-0.1597* (6.00)	-0.1551* (6.35)	-0.1924* (13.8)	-0.1634* (10.2)	0.2456* (19.3)
C	--	2.7387* (3.45)	6.2221* (15.1)	7.4478* (17.9)	--
"R-sq."	n.a.	0.9459	0.9386	0.8410	n.a.
chi-sq.	n.a.	784.5*	809.6*	292.7*	n.a.
S.E. Reg.	0.01630	0.01173	0.00916	0.00643	0.01121

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table A6
Restricted Growth-Revised Basic Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	Q1	**Q2**	**Q3**	**Q4**	**Q5**
ln U	-0.1893* (2.06)	-0.0992* (3.26)	-0.0593* (2.65)	-0.0158 (1.06)	0.0660* (3.05)
ln PRM	12.123* (12.3)	4.1299* (13.4)	0.9792* (5.12)	-0.2113* (2.26)	-1.9303* (10.6)
ln PRW	-4.6430* (5.34)	-2.0914* (7.53)	-0.6148* (4.01)	--	0.9965* (7.00)
ln CP	0.6781* (2.34)	0.4648* (5.24)	0.2314* (4.63)	0.0903* (6.02)	-0.2882* (6.04)
ln MS	--	-0.0375 (1.47)	-0.0732* (3.42)	-0.0640* (4.88)	0.0730* (3.76)
ln RGDP	1.4854* (8.79)	0.0889 (1.42)	-0.2507* (5.21)	-0.2290* (7.19)	0.1183* (2.58)
C	-76.269* (11.9)	-11.334* (5.14)	7.0740* (4.30)	10.019* (9.23)	6.0348* (3.83)
“R-sq.”	0.9323	0.9778	0.9561	0.8735	0.9572
chi-sq.	606.5*	1809.*	904.5*	279.9*	1052.*
S.E. Reg.	0.04681	0.01409	0.01015	0.00676	0.01078

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table A7(a)
Restricted Growth-Revised Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	**D2**	**D3**	**D4**	**D5**
ln U	-0.0823* (3.11)	--	-0.0428* (4.09)	-0.0528* (4.01)	-0.0218 (1.84)
ln PRM	1.6812* (7.29)	0.7792* (4.33)	1.3116* (6.88)	1.2551* (6.92)	0.8747* (5.43)
ln PRW	--	-0.1138 (0.46)	-0.6832* (2.86)	-0.6176* (2.98)	-0.3879* (2.09)
ln CP	0.2533* (6.68)	0.0494 (0.67)	0.1409 (1.92)	0.1527* (2.38)	0.0913 (1.59)
ln MS	-0.1761* (4.08)	-0.0563* (2.00)	-0.0607* (2.51)	-0.0824* (4.02)	-0.0563* (3.02)
ln RGDP	-0.2760* (6.74)	-0.0658* (3.30)	-0.0663* (3.57)	-0.1376* (5.61)	-0.1050* (5.21)
C	--	--	--	2.1144* (2.99)	2.3485* (4.36)
"R-sq."	n.a.	n.a.	n.a.	0.9480	0.9302
chi-sq.	n.a.	n.a.	n.a.	880.7*	646.1*
S.E. Reg.	0.02569	0.01578	0.01373	0.01178	0.01126

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table A7(b)
Restricted Growth-Revised Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	-0.0153 (1.62)	-0.0138 (1.76)	--	--	0.0485* (4.28)
ln PRM	0.5230* (4.37)	0.2727* (2.87)	--	-0.0556 (0.99)	-1.4244* (7.03)
ln PRW	-0.3208* (2.41)	-0.1703 (1.68)	--	0.0539* (2.42)	0.6031* (2.44)
ln CP	0.0990* (2.41)	0.0586 (1.86)	--	--	-0.1900* (2.52)
ln MS	-0.0504* (3.57)	-0.0489* (4.15)	-0.0638* (6.04)	-0.0687* (6.86)	0.1903* (6.08)
ln RGDP	-0.1304* (7.71)	-0.1073* (7.67)	-0.0793* (8.58)	-0.0570* (5.32)	0.2868* (13.9)
C	4.4156* (8.95)	4.5745* (11.2)	4.6462* (19.3)	4.2337* (10.6)	--
"R-sq."	0.9294	0.8708	0.6803	0.6928	n.a.
chi-sq.	645.5*	370.0*	94.0*	93.8*	n.a.
S.E. Reg.	0.00862	0.00768	0.00723	0.00650	0.02098

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table A8(a)
Restricted Growth-Revised Basic Decile Model Estimates of Family Market Income Distribution,
1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	**D2**	**D3**	**D4**	**D5**
ln U	--	-0.1870* (3.23)	-0.1258* (4.28)	-0.0652* (4.97)	-0.0649* (4.25)
ln PRM	21.002* (5.61)	9.0746* (12.9)	5.3142* (14.9)	2.9850* (13.0)	1.3750* (8.00)
ln PRW	--	-3.9101* (6.27)	-2.6917* (8.19)	-1.5161* (6.79)	-0.6809* (4.05)
ln CP	--	0.5945* (2.96)	0.5677* (5.40)	0.3453* (5.03)	0.2219* (4.20)
ln MS	--	--	--	-0.0226 (1.35)	-0.0726* (4.49)
ln RGDP	2.5606* (5.90)	0.9986* (9.26)	0.2484* (5.07)	--	-0.2183 (8.67)
C	-162.75* (5.90)	-52.349* (12.5)	-19.649 (10.6)	-6.3209* (10.3)	3.9960* (4.68)
"R-sq."	0.4622	0.9446	0.9719	0.9747	0.9635
chi-sq.	35.03*	705.3*	148.1*	1674.*	1189.*
S.E. Reg.	0.34997	0.03622	0.01870	0.01337	0.01138

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table A8(b)
Restricted Growth-Revised Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	-0.0600* (4.50)	-0.0223* (2.06)	-0.0278* (4.06)	--	0.1106* (6.49)
ln PRM	0.4215* (3.31)	--	-0.6001* (9.18)	-0.8194* (11.1)	-2.1904* (12.4)
ln PRW	-0.2390 (1.92)	--	0.3703* (11.5)	0.3576* (11.2)	0.9483* (5.27)
ln CP	0.1613* (4.04)	0.1000* (8.34)	--	--	-0.3709* (6.42)
ln MS	-0.0860* (5.87)	-0.0687* (5.73)	-0.1007* (9.29)	-0.0912* (8.59)	0.1871* (8.38)
ln RGDP	-0.3067* (13.0)	-0.2570* (12.2)	-0.2683* (16.3)	-0.2125* (15.3)	0.3823* (20.6)
C	9.1967* (12.4)	9.0632* (16.5)	11.038* (19.3)	10.651* (19.4)	--
"R-sq."	0.9409	0.9044	0.8224	0.9032	n.a.
chi-sq.	788.9*	504.1*	346.1*	451.6*	n.a.
S.E. Reg.	0.00973	0.00784	0.00694	0.00754	0.02052

*Significant at 95% level of confidence.

Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.

Source: Statistics Canada CANSIM series

Table A9(a)
New Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	**D2**	**D3**	**D4**	**D5**
ln U	-0.0524 (0.73)	0.0267 (0.72)	0.0021 (0.06)	-0.0052 (0.18)	0.0102 (0.39)
ln PRM	3.4365* (3.61)	2.0844* (4.11)	2.4703* (5.57)	2.4390* (6.04)	1.8037* (4.92)
ln PRW	-1.9220 (2.63)	-1.0739* (2.77)	-1.5425* (4.56)	-1.6383* (5.32)	-1.1950* (4.28)
ln CP	0.5941* (3.10)	0.2895* (2.93)	0.3333* (3.91)	0.3204* (4.14)	0.2291* (3.35)
ln RGDP	0.0127 (0.07)	0.0899 (0.92)	0.0849 (0.99)	0.0587 (0.75)	0.0460 (0.65)
ln Glob Low	-0.1352 (0.97)	-0.0386 (0.55)	-0.0041 (0.07)	-0.0640 (1.17)	--
ln FX	--	--	--	--	0.0137 (1.72)
D7686	-0.1401 (0.98)	0.0364 (0.62)	-0.0159 (0.38)	-0.0663 (1.84)	-0.0148 (1.43)
ln Auto Lower	0.4509 (0.95)	-0.1111 (0.57)	-0.0379 (0.27)	0.1649 (1.34)	--
ln Auto Upper	--	--	--	--	0.0987* (2.06)
c	-8.1222 (1.18)	-7.2998* (2.02)	-6.6179* (2.12)	-4.6523 (1.64)	-2.9477 (1.16)
"R-sq."	0.5420	0.7218	0.9331	0.9466	0.9363
chi-sq.	51.76*	109.0*	576.0*	747.6*	618.7*
S.E. Reg.	0.02803	0.01498	0.01278	0.01194	0.01076

*Significant at 95% level of confidence.
Note: These estimates are based on imposing cross-equation adding-up restrictions.
Source: Statistics Canada CANSIM series

Table A9(b)
New Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	0.0146 (0.72)	0.0210 (1.25)	0.0282 (1.84)	0.0447* (2.89)	-0.0579 (1.17)
ln PRM	1.2088* (4.25)	0.9639* (4.09)	0.5287* (2.45)	0.3040 (1.40)	-3.6659* (5.26)
ln PRW	-0.9381* (4.36)	-0.7945* (4.44)	-0.5869* (3.59)	-0.3689* (2.24)	2.6756* (5.05)
ln CP	0.2118* (4.01)	0.1523* (3.47)	0.1281* (3.19)	0.0694 (1.71)	-0.5742* (4.39)
ln RGDP	-0.0193 (0.35)	0.0225 (0.49)	0.0036 (0.009)	0.0494 (1.17)	-0.0975 (0.72)
ln Glob Low	--	--	--	--	0.0356 (0.86)
ln FX	0.0192* (2.39)	0.0241* (3.23)	0.0435* (5.65)	0.0475* (5.23)	-0.0728* (4.74)
D7686	-0.0149* (1.87)	-0.0138* (2.07)	-0.0094 (1.54)	-0.0110 (1.78)	0.0521 (1.47)
ln Auto Lower	--	--	--	--	-0.0576 (0.55)
ln Auto Upper	0.0626 (1.68)	0.0894* (2.98)	0.0650* (2.28)	0.0466 (1.61)	-0.1540* (2.40)
c	0.5375 (0.27)	0.3079 (0.19)	2.0702 (1.38)	1.2656 (0.83)	13.069* (2.69)
"R-sq."	0.9368	0.8968	0.7671	0.7149	0.9027
chi-sq.	612.0*	361.4*	148.5*	114.1*	401.8*
S.E. Reg.	0.00816	0.00686	0.00617	0.00626	0.02018

*Significant at 95% level of confidence.
Note: These estimates are based on imposing cross-equation adding-up restrictions.
Source: Statistics Canada CANSIM series

Table A10(a)
Restricted New Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	D2	D3	D4	D5
ln U	--	--	--	--	--
ln PRM	2.5237* (4.58)	1.3598* (5.15)	1.3537* (5.42)	1.8140* (8.94)	1.4240* (9.36)
ln PRW	-0.9696* (1.98)	-0.6484* (2.54)	-0.8470* (3.44)	-1.1587* (5.54)	-0.9655* (5.28)
ln CP	0.4534* (3.09)	0.2026* (2.71)	0.1769* (2.46)	0.2609* (4.41)	0.1967* (3.94)
ln RGDP	--	--	--	--	--
ln Glob Low	--	--	--	0.0000 (n.a.)	--
ln FX	--	--	--	--	0.0139 (1.72)
D7686	--	--	--	-0.0156* (2.70)	-0.0042 (0.78)
ln Auto Lower	--	--	--	0.0000 (n.a.)	--
ln Auto Upper	--	--	--	--	0.0802* (5.61)
c	-8.1282* (5.18)	-2.7422* (3.85)	-1.5069* (2.26)	-2.3677* (4.78)	-0.8433* (2.72)
“R-sq.”	0.5081	0.6981	0.9106	0.9431	0.9342
chi-sq.	40.11*	99.89*	428.3*	739.1*	691.4*
S.E. Reg.	0.02904	0.01560	0.01478	0.01232	0.01093

*Significant at 95% level of confidence.
Note: These estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.
Source: Statistics Canada CANSIM series

Table A10(b)
Restricted New Basic Decile Model Estimates of Family Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	--	0.0070 (1.06)	0.0201* (3.47)	0.0154 (1.27)	-0.0226* (2.10)
ln PRM	1.3658* (13.5)	1.2265* (11.9)	0.5178* (4.41)	1.0645* (6.86)	-3.5874* (12.4)
ln PRW	-1.1058* (7.57)	-0.9270* (6.53)	-0.6107* (4.74)	-0.7527* (3.63)	2.5482* (7.03)
ln CP	0.2360* (6.19)	0.2234* (6.20)	0.1333* (3.88)	0.2585* (5.02)	-0.6480* (6.68)
ln RGDP	--	--	--	0.0000 (n.a.)	--
ln Glob Low	--	--	--	--	--
ln FX	0.0193* (2.13)	0.0171* (2.00)	0.0423* (5.14)	0.0330* (2.38)	-0.0604* (3.52)
D7686	-0.0128* (2.47)	-0.0164* (3.29)	-0.0053 (1.18)	-0.0235* (3.16)	0.0314* (3.00)
ln Auto Lower	--	--	--	--	--
ln Auto Upper	0.0970* (6.20)	0.0621* (3.45)	0.0793* (4.61)	-0.0270 (0.89)	-0.1111* (3.28)
c	--	--	2.3354* (9.04)	--	11.000* (22.0)
"R-sq."	n.a.	n.a.	0.7614	n.a.	0.8967
chi-sq.	n.a.	n.a.	149.4*	n.a.	590.7*
S.E. Reg.	0.00858	0.00755	0.00624	0.00987	0.02079

*Significant at 95% level of confidence.
Note: The restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.
Source: Statistics Canada CANSIM series

Table A11(a)
New Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	D2	D3	D4	D5
ln U	-0.5775 (0.81)	-0.2614* (3.05)	-0.0949* (2.05)	-0.0217 (0.67)	0.0192 (0.77)
ln PRM	15.0819 (1.57)	7.7425* (6.61)	5.8592* (9.24)	3.9721* (8.87)	2.7771* (7.92)
ln PRW	1.5783 (0.21)	-2.8091* (3.13)	-2.9421* (6.06)	-2.2804* (6.67)	-1.8604* (6.97)
ln CP	-0.1964 (0.10)	0.6545* (2.81)	0.6188* (4.91)	0.4179* (4.86)	0.3349* (5.12)
ln RGDP	1.9034 (1.03)	0.6267* (2.78)	0.3334* (2.73)	0.1891* (2.19)	0.1056 (1.56)
ln Glob Low	1.9623 (1.38)	0.3120 (1.85)	-0.0146 (0.16)	-0.1092 (1.79)	--
ln FX	--	--	--	--	0.0279* (3.83)
D7686	-0.6164 (0.41)	0.0539 (0.34)	0.0322 (0.38)	-0.0257 (0.62)	-0.0216* (2.18)
ln Auto Lower	-0.4542 (0.09)	-0.3317 (0.63)	-0.0733 (0.26)	0.1314 (0.93)	--
ln Auto Upper	--	--	--	--	0.1844* (4.03)
c	-124.150 (1.78)	-41.542* (4.93)	-23.783* (5.22)	-12.826* (4.07)	-6.4259* (2.64)
"R-sq."	0.5145	0.9524	0.9728	0.9765	0.9710
chi-sq.	85.35*	816.8*	147.1*	1700.*	1397.*
S.E. Reg.	0.33249	0.03360	0.01841	0.01288	0.01016

*Significant at 95% level of confidence.
Note: These estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.
Source: Statistics Canada CANSIM series

Table A11(b)
New Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	**D7**	**D8**	**D9**	**D10**
ln U	0.0322 (1.57)	0.0316 (1.82)	0.0428* (2.69)	0.0704* (3.95)	-0.0455 (1.03)
ln PRM	1.7909* (6.19)	0.6567* (2.70)	0.2490 (1.11)	-0.0059 (0.02)	-4.3537* (7.01)
ln PRW	-1.4273* (6.49)	-0.7188* (3.88)	-0.4782* (2.82)	-0.4186* (2.20)	2.9603* (6.26)
ln CP	0.2789* (5.17)	0.1766* (3.89)	0.1305* (3.14)	0.1026* (2.20)	-0.6266* (5.35)
ln RGDP	0.0256 (0.46)	-0.0627 (1.33)	-0.0496 (1.15)	0.0058 (0.12)	-0.1569 (1.31)
ln Glob Low	--	--	--	--	-0.0203 (0.49)
ln FX	0.0346* (4.55)	0.0330* (4.48)	0.0475* (6.50)	0.0446* (5.67)	-0.0833* (6.83)
D7686	-0.0246* (3.01)	-0.0101 (1.46)	-0.0156* (2.46)	-0.0187* (2.64)	0.0324 (0.83)
ln Auto Lower	--	--	--	--	0.0148 (0.12)
ln Auto Upper	0.1676* (4.42)	0.1041* (3.25)	0.0720* (2.45)	0.0725* (2.20)	-0.2305* (3.69)
c	-1.3261 (0.66)	3.6347* (2.14)	4.3491* (2.80)	3.9434* (2.26)	16.819* (3.88)
"R-sq."	0.9553	0.9230	0.8459	0.9120	0.9281
chi-sq.	915.4*	514.4*	261.1*	450.3*	643.2*
S.E. Reg.	0.00846	0.00704	0.00646	0.00719	0.02014

*Significant at 95% level of confidence.
Note: These restricted estimates are based on imposing cross-equation adding-up restrictions.
Source: Statistics Canada CANSIM series

Table A12(a)
Restricted New Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D1	D2	D3	D4	D5
ln U	--	-0.2063* (3.43)	-0.0906* (3.31)	--	--
ln PRM	20.1383* (5.52)	8.2641* (10.8)	5.5674* (15.0)	3.8398* (13.9)	2.3495* (11.4)
ln PRW	--	-3.1899* (5.01)	-2.7504* (8.15)	-2.1201* (8.33)	-1.6144* (7.97)
ln CP	--	0.5165* (2.70)	0.5464* (5.16)	0.3895* (5.82)	0.3218* (6.66)
ln RGDP	2.9436* (7.39)	0.8579* (6.58)	0.3265* (5.97)	0.2037* (7.70)	0.0354 (1.47)
ln Glob Low	0.5375* (2.21)	0.0962* (2.93)	--	-0.0621* (4.93)	--
ln FX	--	--	--	--	0.0331* (3.78)
D7686	--	--	--	--	-0.0082 (1.81)
ln Auto Lower	--	--	--	--	--
ln Auto Upper	--	--	--	--	0.1418* (5.42)
c	-169.69* (6.55)	-47.491* (9.30)	-22.649* (10.5)	-13.502* (11.3)	-3.6226* (3.96)
"R-sq."	0.5256	0.9497	0.9725	0.9757	0.9693
chi-sq.	60.72*	797.5*	1505.*	1732.*	1516.*
S.E. Reg.	0.32870	0.03453	0.01850	0.01309	0.01045

*Significant at 95% level of confidence.
Note: These estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.
Source: Statistics Canada CANSIM series

Table A12(b)
Restricted New Basic Decile Model Estimates of Family Market Income Distribution, 1976-2016
(estimated absolute t-ratios in parenthesis)

	D6	D7	D8	D9	D10
ln U	0.0252* (3.33)	0.0198 (1.89)	0.0262* (2.62)	0.0660* (8.34)	-0.0383* (2.54)
ln PRM	1.5169* (14.0)	0.4125* (2.99)	0.0493 (0.38)	--	-3.9685* (16.4)
ln PRW	-1.2641* (8.39)	-0.5806* (4.26)	-0.3762* (3.16)	-0.4300* (5.71)	2.7194* (9.53)
ln CP	0.2543* (6.58)	0.1663* (4.86)	0.1373* (4.82)	0.1190* (7.75)	-0.5967* (7.89)
ln RGDP	--	-0.0962* (4.00)	-0.0904* (3.77)	--	-0.1235* (4.12)
ln Glob Low	--	--	--	--	--
ln FX	0.0383* (4.66)	0.0378* (4.42)	0.0523* (6.02)	0.0475* (5.36)	-0.0921* (6.20)
D7686	-0.0122* (3.76)	0.0038 (1.23)	-0.0015 (0.49)	-0.0089* (2.85)	--
ln Auto Lower	--	--	--	--	--
ln Auto Upper	0.1565* (8.25)	0.0938* (4.18)	0.0590* (2.57)	0.0710* (3.49)	-0.2033* (5.61)
c	--	5.1026* (5.87)	5.9059* (6.69)	4.0577* (14.7)	15.094* (12.9)
“R-sq.”	n.a.	0.9140	0.8225	0.9022	0.9201
chi-sq.	n.a.	503.7*	224.0*	428.0*	892.0*
S.E. Reg.	0.00876	0.00743	0.00694	0.00758	0.02124

*Significant at 95% level of confidence.
Note: These restricted estimates are based on imposing both adding-up restrictions and zero-coefficient restrictions.
Source: Statistics Canada CANSIM series

Appendix B

Construction of the Globalization and Automation Variables

GlobLow is the share of Canada's merchandise imports from countries not in the EU or other OECD countries (from CANSIM Table 14-10-0023-01, formerly Table 282-0008).

The foreign exchange rate variable, FX, was created from the series in CANSIM Table 10-10-0009-01 (formerly Table 176-0064) entitled "Foreign exchange rates in Canadian dollars, Bank of Canada monthly" by taking the inverse of the average rate for each year after calculating the annual average rate from the monthly data.

The variable AutoUpper is calculated as the ratio $a = a_1/a_2$. For the Labour Force Survey years 1976-1986, a_1 includes managerial and administrative occupations + natural sciences, engineering and math occupations; and a_2 is total employment. For 1987-2016, data come from CANSIM Table 14-10-0297-01 (formerly Table 282-0142), and a_1 consists of managerial and administrative occupations + occupations in natural sciences, engineering and math.

The variable AutoLower is calculated as the ratio $b = b_1/a_2$. For the Labour Force Survey years 1976-1986, b_1 includes artistic, literary, recreational and related occupations + service occupations; and a_2 is defined as above. For 1987-2016, b_1 consists of sales and service occupations – retail sales supervisors and specialized sales occupations – sales representatives and sales-persons – wholesale and retail trade occupations – sales support occupations; and a_2 is defined as above.

The intercept shift dummy D7686 takes a value of one over the earlier period and zero otherwise.

Appendix C

Estimating Distributional Effects on Lorenz Curves

Since the ordinates of a Lorenz curve are cumulative income shares, one can use the empirical analysis of this paper to also work out how key labour market and related variables have corresponding effects on an entire Lorenz curve. This is of interest because (i) strong distributional inferences can be drawn if an entire Lorenz curve shifts uniformly in or out in response to some variable change, and (ii) distributional inferences for a whole set of summary inequality measures – not just the Gini coefficient results reported in this paper – can be drawn for the effects of the variable on overall income inequality if a Lorenz curve shifts uniformly in or out (Cowell, 2000). So this appendix shows how one can use the results of this paper to determine the empirical effects of the variables considered on the ordinates of a Lorenz curve.

Using the same notation as in section 3.3 of the paper, let Qj be the j'th quintile income share, so that

Q1 + Q2 + … + Q5 = 100.

The j'th ordinate of the Lorenz curve is then

$$LCj = \sum_{k=1}^{j} Qk \, . \qquad \text{(C1)}$$

If x_i is the i'th regressor variable in a quintile share regression, then

$$\frac{\partial LCj}{\partial x_i} = \sum_{k=1}^{j} \frac{\partial Qk}{\partial x_i} \, . \qquad \text{(C2)}$$

From eq (3) of the text

$$\frac{\partial Qk}{\partial x_i} = \left(\frac{Qk}{x_i}\right) \bullet \eta_i(k) \qquad \text{(C3)}$$

where $\eta_i(k)$ is the regression coefficient on x_i in a log-log regression for quintile share Qk. Eq (C3) can be estimated by using the regression coefficient estimates for $\eta_i(k)$ and evaluating the variables in the ratio (Qk/x_i) at their sample means. Then simply plug in these estimates for expression (C3) into equation (C2) to get the estimated effect of variable x_i on Lorenz curve ordinate LCj.