Cyclicality of Income-Growth Distribution and the Role of Monetary Policy*

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Preliminary

Abstract

This paper contributes to the growing literature on the implications of monetary policy for income inequality by asking the questions: how does monetary policy impact the distribution of household income growth and how would the policy interact with the business-cycle implications for the distribution? We use comprehensive income information from the Canadian administrative tax records to document how income changes with the business cycle, estimate the impacts of monetary policy shocks on income changes by the income distribution and by the major source of income, and assess how much monetary policy accounts for the income changes across the income distribution. Our findings confirm and broaden those of the literature in that the mean and the skewness of the income-growth distribution is significantly pro-cyclical, while the variance is weakly so, and hence, not counter-cyclical. We find that monetary policy tightening persistently lowers the growth of income for high income households more than for lower income households, reducing income inequality. Finally, monetary policy impacts the income of households with non-professional business and investment income as the major income source more than those with labour earnings.

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1 Introduction

There is a reasonable consensus among central banks in advanced economies that price stability is the most important contribution to economic well-being that monetary policy can make. At the same time, increased focus on inequality in recent years has raised important questions about how monetary policy actions in pursuit of inflation targets might affect income inequality. The answer is not *a fait accompli* given that the effects of monetary policy on income are complex and uncertain (Bernanke, 2015; Draghi, 2015). For instance, tightening monetary policy can increase inequality because the poor will find it relatively more difficult to maintain or find jobs, but it can also reduce inequality because investment income—received more by the rich—is harder hit that other sources of income.

Because of the complex and offsetting effects of monetary policy, determining net effects is clearly an empirical question. While there are multiple and growing empirical studies in the literature (e.g., Furceri et al., 2016; Coibion et al., 2017; Holm et al., 2021; Amberg et al., 2022; Andersen et al., 2023), there is no study that looks at how monetary policy might alter the overarching dynamics of income inequality over the business cycle. In addition, there is no comprehensive study based on large Canadian income-tax data.

This paper uses Statistic Canada's Longitudinal Administrative Databank (LAD) to contribute to this literature along three dimensions: i) document how different moments of income-growth distribution are correlated with the business cycle; ii) estimate the impacts of monetary policy shocks on income growth by the level of household income and by major source of income iii) assess how monetary policy amplifies or dampens the dynamics of income-growth distribution over the business cycle. The LAD data set has several advantages for this study. It is a panel dataset that covers 20% of all tax filers in Canada, including details on multiple different sources of income at both the individual and family level. It also has a long history, running from 1982, allowing us to capture a relatively long period of monetary policy variations.[1]

[1]Given that the data do not allow us to study those who did not file taxes, the results are limited to

With regards to the first dimension, we follow the Busch et al. (2022) study that uses administrative and survey data from multiple countries to estimate the correlations between the GDP growth and the skewness of the income-growth distribution. Relative to Busch et. al., however, our data set has a larger sample size and a longer time series covering almost 4 decades of data, and measures a broader set of market income (e.g., investment and private retirement income is also included). Our findings confirm Busch et al. (2022) in that the skewness of the income-growth distribution is pro-cyclical and that the variance is not counter-cyclical. A break down of the skewness measure shows that movements in both tails of the distribution contribute to the pro-cyclicality of the skewness. When analyzing the skewness by income sources, we find that multiple sources contribute to the observed pro-cyclical skwenwss of market income with investment income exhibiting the highest pro-cyclicality. Furthermore, conditional on the level of income, we find that the income growth of both the low and high income households displays higher positive correlations with GDP growth when compared with their middle income peers.

With regards to the second dimension, we use the panel local projections method developed by Jordà (2005). Our monetary policy shock estimates come from extending the work of Champagne and Sekkel (2018), which uses narrative evidence with real-time data and forecasts from the Bank of Canada, up to 2019. Our sample period (1982 to 2019) includes only conventional monetary policy actions, with no quantitative easing or tightening.[2] We estimate the impact of monetary policy shocks across several dimensions: average income, by income decile, and by major source of market income (wages, salaries and commissions; non-professional business; professional business; investment; and other income).

We find that monetary policy tightening decreases the average income growth over multiple years, as one would expect.[3] We also find that there are larger and more persistent declines in income for the high-income households, reducing income inequality. Moreover,

dynamics on the intensive margin of the income process.

[2]The Bank of Canada did not engage in quantitative easing before 2020.

[3]Our analysis of the impact of monetary policy is symmetric between loosening and tightening such that the results can be flipped when discussing monetary policy loosening.

there are larger declines for households with non-professional business or investment income as the major source of income.

This latter result is consistent with other studies, which find the variation in income sources across the distribution is a key driver behind the distributional consequences of monetary policy actions (Coibion et al., 2017). This underscores the importance of heterogeneity in inequality dynamics, as household income and balance sheet composition play a determinant role in shaping their outcomes following a shock.

Andersen et al. (2023) similarly find that monetary policy is felt most by high income earners in Denmark, such that monetary policy expansion increases income inequality. Their result works through the capital income channel whereas our result relies on labor income as well as non-professional business and investment income. Amberg et al. (2022) find a U-shaped response in the distribution of income to monetary policy shocks in Sweden – both the top and bottom earners are more sensitive to monetary policies than the middle. In contrast, Holm et al. (2021) find that indirect effects on labor income build up over time and eventually outweigh direct effects on financial income, so in the medium- and long-run, stimulative monetary policy reduces inequality.

Finally, the distinction between non-professional business and professional business income in our paper is novel in the literature. We find that monetary policy impacts households with professional business income as their major source of income similarly to those with wage, salary and commission income as the major source of income. In contrast, the income growth of household whose major income source is from non-professional businesses declines similarly to those with investment income as the major source of income when monetary policy tightens.

We use these results to explore the third dimension about how monetary policy amplifies or dampens the dynamics of income-growth distributions over the business cycle. Specifically, we use the estimates of the correlations between income-growth distributions and GDP growth together with those of the income-growth implications of monetary policy shocks.

Our results indicate that monetary policy at the one-year horizon counters the pro-cyclical skewness of the income-growth distribution, thereby stabilizing the income-level distribution or income inequality over the business cycle.

Our paper builds on a few strands of literature in addition to those discussed so far. First, there is a long history of the literature highlighting the importance of understanding inequality by documenting the distribution of income and wealth in the United States since the 1990s (e.g, Díaz-Giménez et al., 1997; Budría et al., 2002; Piketty and Saez, 2003; Díaz-Giménez et al., 2011; Moritz and Ríos-Rull, 2016; Saez and Zucman, 2016). We add to this literature by documenting the historical evolution of income inequality in Canada since 1982. Burkinshaw et al. (2022) also compares income and wealth inequality between Canada and the United States. Second, Castañeda et al. (1998) documented the correlations of detrended output with the family-income shares earned by the quintiles of the income distribution. The contemporaneous correlation between detrended output and the income share monotonically decreases as the quintile moves up for the lowest to the fifth (excluding the top 5%), and then the correlation increases for the top 5%. Although our approach and data differ from theirs, we analyze a similar question. Section 3.1 discusses our estimation results of the contemporaneous correlation between GDP growth and income growth by the deciles of income. Interestingly, we find a consistent pattern with that from Castañeda et al. (1998) that the correlation monotonically decreases from the first decile of the income distribution to the ninth, and then increases for the tenth decile.

The rest of the paper starts with a description of the data and stylized facts (Section 2), before turning to the relationship between the business cycle and the income-growth distribution (Section 3). Sections 4 and 5 cover our estimates of monetary policy shocks and their effects on income inequality. Section 6 discusses the impacts of monetary policy on the skewness of the income-growth distribution over the business cycle. The final section presents conclusions and avenues for further study.

2 Income tax data and stylized facts

This section describes the micro-data on individual and family income that we use for the analysis and discusses the Canadian inequality facts from the literature and the dataset.

2.1 Income tax data

The micro-data analysis uses the administrative dataset called "Longitudinal Administrative Databank" (LAD) from Statistics Canada, the federal agency in charge of official statistics in Canada. LAD is a panel dataset of individuals, comprising of a 20% sample of the following categories of individuals: all individual tax filers, those who received Federal child benefits, filers' non-filing spouse, filers' non-filing children. Statistics Canada constructs cross-sectionally representatative census families by identifying the reported matches for spouse and each child from the individual filer's information. When a family member is a tax filer but not selected in the original 20% sample, Statistics Canada incorporates additional information for him/her when constructing a family-level variable. We construct a family-panel dataset over time based on the identification numbers of each couple or the parents.[4]

LAD contains detailed income and demographic information about the individuals.[5] One advantage of this dataset is its long history. Our sample covers the period from 1982 to 2019, 38 years of individual and family income information. This is especially beneficial for the analysis using monetary policy shocks as a longer history allows us to capture more variations in these shocks through time for better identification of their impacts.[6] The 20% sample has grown over the period with 3.2 million people in 1982, 4.05 million in 1992, 4.7 million in 2002 and 5.3 million in 2012.

[4]Individuals report and identify their spouse and common-law partner in their tax file each year. We assume that a new family starts whenever the paired identification numbers of a couple change. Single-parent families or unattached individuals constitute a household with their identification number over time as long as their status does not change.

[5]See Appendix A for more details on the source of the dataset.

[6]Similar studies analyzing the impact of monetary policy shocks using administrative tax data, e.g., Amberg et al. (2022), Andersen et al. (2023) and Holm et al. (2021), typically work with a shorter period of available annual data, e.g., 20-plus years.

More specifically, income information in LAD includes total income consisting of both taxable and non-taxable income, market income which is pre-tax income excluding government transfers, and after-tax income. We use market income as the main income variable for the analysis as our question is on the fundamental sources of income inequality before the government policies intervene. Furthermore, LAD provides a detailed breakdown of market income. We categorize them into the following five sources: wage, salary and commission (WSC), non-professional business (Bus), professional business (Prof), investment (Inv) and other (Other).

LAD provides income information on two distinct types of businesses, non-professional and professional. Non-professional business is defined as solo-proprietors without a regulatory governing body, and professional business as solo-proprietors with a regulatory governing body. In later sections, this paper shows that the type of business owned by tax filers is correlated with the level of their income and has important implications for the effects of monetary policy shocks.[7] Investment income consists of dividend, income from limited partnership, rental income and capital gains/losses. Other income includes spousal/child support, scholarships/grants and private retirement income. Market income can be negative as it is measured net of any losses or expenses associated with business and/or investment income.

For the rest of the paper, we use household as the unit of data observations. We define a household to be one of the census families or an unattached individual. In addition, we define the head of the household to be the one with the highest market income if it is for a couple. Household income is defined to be the sum of income earned by all its members. The sample for the analysis consists of those with the age of the household head between 18 and 65 and the household income above the federal "Personal Basic Amount". The Personal Basic Amount specifies the non-refundable tax credits for each filer, ranging from $6,000 in early 80s to $12,000 in 2019. Furthermore, households below $0 and above -$1,000 of

[7] Other papers using administrative tax data, e.g., Amberg et al. (2022), Andersen et al. (2023) and Holm et al. (2021), do not analyze this dimension of heterogeneity.

income are excluded from the sample. These restrictions allow us to avoid the outliers in the income-growth space by eliminating the small numbers in the denominator. All values of income from the dataset are deflated by the CPI inflation for the analysis.

2.2 Income inequality facts

Income inequality measured by the Gini coefficient in Canada increased substantially during the 1980s and first half of the 1990s, but has been relatively stable over the past 25 years. The largest and most persistent increases in the Gini coefficient occurred during the recessions in the 1980s and 1990s (Figure 1).[8] The Gini coefficient based on market income is more than 10% higher in 2019 than it was in 1976, even after its slight decline in the last few years of observations. This reflects mainly the fact that, during the recessions in the 1980s and early 1990s, the Gini coefficient rose sharply and did not return to pre-recession levels but remained close to the new higher level even after the recession had passed. The Gini is much lower and rises less when household income is adjusted for the effects of transfers and taxes. This points to the contribution of automatic stabilizers and discretionary fiscal actions (note in Figure 1 the sharp increase in transfers as a share of gross domestic product during recessions). It also reflects the use of tax policy to mitigate the business cycle's harm on lower-income families.[9]

Although it is a commonly-used metric of inequality, the Gini coefficient masks important changes in relative incomes over time, especially those that occur in the tails of the distribution. Our data set shows that, even over periods when the Gini was relatively stable, there have been important changes in the income distribution over time. Figure 2 shows real household market income by decile over the last four decades. It is striking that income in the middle deciles has remained relatively flat and has even drifted down in the lower deciles.[10] Stagnant middle-class income over the last several decades is a common obser-

[8]For more stylized facts on income distribution in Canada see Burkinshaw et al. (2022).
[9]This point is also stressed by Fortin et al. (2012).
[10]Appendix B provide more discussion on this.

vation among countries of the Organisation for Economic Cooperation and Development (OECD (2018)). Moreover, Zhang and Chung (2016) document that income mobility across income groups has also worsened, suggesting that inequality has become more persistent over time. Meanwhile, while some fluctuations are observed during economic downturns, high-income households pulled their income higher and away from the rest over the sample period.

The variation in relative income over time in Canada, combined with considerable variation in the monetary policy instrument over the same period, raises important questions about how the income distribution changes over the business cycle and what role monetary policy plays. In answering these questions, it is important to consider the fact that sources of household income differ across deciles in Figure 3. While wage, salary and commission make up the majority of household income in all deciles, investment income and professional business income make up a much larger share of income for the highest decile. In contrast, non-professional income and other income shares gradually increase as we move to lower deciles. The share of non-professional business income is smaller in the first decile due to a fraction of non-professional business making a net loss. It is possible that sensitivity to shocks differs across these sources of income. For instance, investment income and non-professional business income could be more susceptible to macroeconomic conditions and come with higher volatility. In Section 5 for the implications of monetary policy shocks for household income, we confirm this intuition.

3 Business cycle and income-growth distribution

Before analyzing the impact of monetary policy shocks on the income-growth distribution among tax filers, we first assess how the distribution changes over the business cycle. This is so we can make statements regarding whether monetary policy amplifies or dampens the business cycle dynamics of the income-growth distribution. The section presents the analysis of how the income-growth distribution correlates to GDP growth.

3.1 Correlation between moments of income-growth distribution and GDP growth

This part analyzes how the distribution of income growth correlates with GDP growth in Canada, closely following Busch et al. (2022).[11] Busch et al. (2022) use a mix of survey data and a sample of administrative data for the United States, Germany and Sweden to analyze the correlation between the distribution of labour-earnings growth and GDP growth for each country. In contrast, our analysis uses data with a larger sample and also more broad and comprehensive definition of income (i.e., market income), which includes income from investment and others like private retirement income. Despite these differences, our findings confirm those of Busch et al. (2022) that the skewness of income-growth distribution is counter-cyclical while its variance is not. Below, we first present the results based on market income and then break down by income source.

3.1.1 Market income

We first estimate the following time-series equation based on market income:

$$m\left(\Delta Income_{i,t}\right) = \alpha + \gamma t + \beta^m \Delta GDP_t + u_t, \text{ where} \tag{1}$$

$$\Delta Income_{i,t} = \frac{\text{Market income}_{i,t+1} - \text{Market income}_{i,t}}{|\text{Market income}_{i,t}|} \times 100.$$

$\Delta Income_i$ indicates the percent change in the market income of household i from year t. We take the absolute value for the denominator of this ratio since there are negative values

[11]The literature on the income-growth distribution over the business cycle had focused on the counter-cyclical variance of individual income shocks since a seminal paper by Storesletten et al. (2004). Guvenen et al. (2014) brought in new insight into this literature by highlighting the role of counter-cyclical skewness over the business cycle playing a larger role than that of variance.

due to net loss in business income. $m(.)$ is the function that maps the cross-sectional annual income-growth distribution of all households in the sample to its moment for a given t. We look at the *mean*, *variance* and *skewness* of the household income-growth distribution. For the skewness, we follow the literature and use Kelley skewness: Kelley Skewness $\equiv \frac{\text{(P90 - P50) - (P50 - P10)}}{\text{P90 - P10}}$, where P indicates the percentile. The use of Kelley skewness allows us to breakdown the skewness movements by the two tails of the distribution. Hence, we also provide the estimation results for the moments P90-P10, P90-P50 and P50-P10. Finally, β^m measures the correlation of our interest.

We use the annual income tax data for households from 1982 to 2019, as well as the log-differenced annual Canadian real GDP for the same period to estimate Equation (1).[12] Table 1 displays the estimation results for the mean, variance and Kelley skewness.[13] Intuitively, the mean of the income-growth distribution is positively correlated with GDP growth. One percent GDP growth is significantly correlated with the average income growth of 1.009%. The variance shows a weakly-positive correlation. This non-negative coefficient estimate confirms the finding by Busch et al. (2022) that the variance of income growth is not counter-cyclical.

Regarding skewness, the right four columns of Table 1 presents the results for Kelley skewness and its components. We find a significant and positive correlation between Kelley skewness and GDP growth. Hence, the skewness is pro-cyclical, i.e., the skewness of income growth becomes more positive (or right-skewed) when GDP growth is higher and vice versa. More intuitively, during economic expansions, the right tail of the household income-growth distribution moves out to the right away from its median and/or the left tail moves in to the right closer to the median. Hence, both the income-rich and/or income-poor households increase their income more than their median-income peers.

As mentioned above, one benefit of using Kelly skewness is that we can break down

[12] Canadian real GDP data series can de obtained from Statistics Canada through this link.

[13] Given the sensitivity of some moments, especially the variance, to the outliers of the distribution, the estimation results shown in this section are based on the winsorized income-growth distribution at 1% and 99%. Appendix C presents those based on the raw distribution, which confirm the findings in this section.

the relative movements of the two tails in understanding the dynamics of the skewness. We observe that GDP growth significantly and positively correlates with P90-P50 of the income-growth distribution, while it negatively correlates with P50-P10. This means that, when GDP increases, both P90 and P10 of the income-growth distribution move more to the right than the median does, making the distribution more right-skewed. Hence, the movement in both tails contributes to the pro-cyclicality of the skewness. We also note that the weakly significant result for P90-P10—a measure of variability as with the variance—confirms our finding that the variance is not counter-cyclical.

3.1.2 By income source

To further understand the cyclicality of income growth, Equation (1) can be estimated by the source of income instead, i.e., the breakdown of market income. We estimate the following time-series equation:

$$m\left(\Delta Income_{i,j,t}\right) = \alpha + \gamma t + \beta^m \Delta GDP_t + u_t, \text{ where} \tag{2}$$

$$\Delta Income_{i,j,t} = \frac{\text{Income}_{i,j,t+1} - \text{Income}_{i,j,t}}{|\text{Market income}_{i,t}|} \times 100.$$

Now, $\Delta Income_{i,j,t}$ includes the index j for the source of income where j indicates one of the following sources: wage, salary and commission (WSC_y); non-professional business income (Bus_y); professional business income ($Prof_y$); investment income (Inv_y); and other income ($Other_y$).[14] The growth is measured relative to the the base of market income (in absolute value) as shown in Equation 2. In comparison to the typical percentage change in income with respect to its own value as the base, $\Delta Income_{i,j,t}$ uses the market income as the base to capture the relative importance of the change in the value of each income source, j, that

[14] We use the subscript y to indicate that the definitions are based on the source of income itself. When analyzing the impact of monetary policy shocks in later sections, we use the definition based on household characteristics by the major source of income within household income.

is comparable across all sources.[15] For example, when the WSC_y and Inv_y both change by \$100 in one year, $\Delta Income_{i,j,t}$ is exactly the same regardless of the level of WSC_y or Inv_y in the base year.

Table 2 presents the estimation results of Equation 2 for the mean and variance. Regarding the mean, all income sources, except $Other_y$, show pro-cyclicality with GDP growth with WSC_y showing the highest correlation and the most significance. Bus_y and Inv_y also show a high and significant degree of pro-cyclicality, and $Prof_y$ with the lowest but still weakly significant pro-cyclicality. Regarding the variance, we observe that the finding in Section 3.1.1 that the variance of market-income growth is weakly pro-cyclical with GDP growth is driven by WSC_y and Bus_y with the latter being the more important and significant contributor.[16] The variance for all other income sources show non-significant cyclicality with GDP growth.

Finally, to further understand the pro-cyclicality of the skewness in market income, Equation (2) can also be estimated for skewness by the source of income. Table 3 contains the estimation results of Kelley skewness for this breakdown. All income sources except for Other show positive and significant coefficients for GDP growth. That is, the pro-cyclicality of the skewness in market income is driven by all of these sources. Among income sources with pro-cyclical skewness, Inv_y has the highest correlation with GDP growth at 0.0544, hence contributing the most to the pro-cyclical skewness of market income, followed by WSC_y at 0.0262.

[15] In addition, since market income is restricted to be above and below certain threshold values around zero, using it as the denominator of the change in income helps avoid the issue of the division by small numbers, making the ratio extremely large and thus generating outliers. Hence, no additional restriction in the value of income around zero for different sources is placed.

[16] Our finding that the variance of WSC_y is not counter-cyclical appears different from other papers. For example, Bowlus et al. (2022) use similar Canadian data and find that the variance of labour earnings growth increases during recessions, i.e., counter-cyclical variance. We can note three differences in the details of the analyses that may lead to these contradictory findings. First, their study is based on individual labour earnings while ours is on household's. Second, theirs residualizes labour earnings by filtering them by observable characteristics of the individuals while ours is unfiltered. Finally, their conclusion regarding counter-cyclicality is drawn based on the increase in variance in recessions while ours is based on the correlation analysis with GDP growth throughout business cycles.

3.2 Correlation conditional on the level of income

The analysis in the previous section was based on income growth that is unconditional on the level of income. This section provides the analysis of the income and GDP growth correlation *conditional* on the level of income by estimating the following regression model by exploring the panel data structure of household income tax records over time:

$$\begin{aligned}\frac{y_{i,t}-y_{i,t-1}}{|y_{i,t-1}|} =& \sum_{q=1}^{10}\left(\beta_q \cdot \Delta GDP_t \cdot Decile_{i,t-1,q} + \eta_q \cdot Decile_{i,t-1,q}\right) \\ &+ \sum_{\ell=1}^{2}\delta_\ell \cdot \frac{y_{i,t-\ell}-y_{i,t-1-\ell}}{|y_{i,t-1-\ell}|} + \\ &+ \alpha_i + \gamma_t + \varepsilon_{i,t}, \end{aligned} \tag{3}$$

where i indexes each household, t the year, and q each income decile group. $y_{i,t}$ is the market income for household i at time t.[17] $Decile_{i,t-1,q}$ is a dummy variable that equals 1 when household i belongs to the decile group q at time $t-1$ and 0 otherwise. α_i captures the individual household fixed effects and γ_t the time effects. The standard errors are clustered at the household level. Given the inclusion of the time fixed effects, our interest for the estimation result is the relative difference in the correlation of income-GDP growth across income decile groups, i.e., β_q. We set the 5th income decile as the reference group.

Table 4 presents the estimation results and Figure 4 displays the estimates of β_q's with the 99% confidence band, where $q = 5$ is the reference group. The figure shows that both the lowest and the highest income decile groups exhibit higher positive correlation between their income growth and that of GDP then their 5th income decile peers. The 2nd decile to the 6th show similar degrees of correlation with that of the 5th. The 7th to the 9th income decile groups have lower income-GDP growth correlation than the 5th.

Table 1 in Section 3.1 informs us that both the upper and the lower tails of the income-growth distribution positively co-move with GDP growth more than the median does, thereby

[17] Given that y_i can be negaive, we take the absolute value when it is the denominator of a ratio.

generating the pro-cyclicality of skewness. Now, Table 4 further gives insight into this dynamics that these movements by the two tails of the income-growth distribution are driven by the income growth of the lowest and the highest income-level decile groups.[18]

Given the observed pro-cyclicality of the skewness in the income-growth distribution, our main question is how monetary policy interacts with and impacts it. In the rest of the paper, we identify the monetary policy shocks in Canada and analyze their impacts on the distribution of income growth using the tax records to give insight into this question.

4 Monetary policy shocks

Our empirical approach in analyzing the impact of monetary policy on household income growth relies on monetary policy shocks identified in the literature. Specifically, we extend the monetary policy shock time series constructed by Champagne and Sekkel (2018) to cover our household income data period until 2019.[19] Champagne and Sekkel (2018) estimate these shocks by using narrative evidence, following Romer and Romer (2000), with real-time data and forecasts from the Bank of Canada projections. Specifically, they estimate the following regression equation:

$$\begin{aligned}\Delta i_m \;=\;& \alpha + \beta_1 i_{t-d14} + \sum_{h=1}^{3} \rho_h u_{t-h} + \sum_{j=-1}^{2} \sigma_j \hat{y}^f_{m,j} + \sum_{j=-1}^{2} \delta_j \pi^f_{m,j} \\ & + \sum_{j=-1}^{2} \theta_j \left(\hat{y}^f_{m,j} - \hat{y}^f_{m-1,j}\right) + \sum_{j=-1}^{2} \phi_j \left(\pi^f_{m,j} - \pi^f_{m-1,j}\right) \\ & + \beta_2 FFR_{t-d14} + \beta_3 ER_{t-d14} + \beta_4 \Delta FFR_{m-m_{-1}} + \epsilon_m, \qquad (4)\end{aligned}$$

where the dependent variable (Δi_m), the change in the intended policy rate, is measured at a meeting-by-meeting frequency, as indicated by the subscript m . The subscript j denotes

[18] In addition, the finding that the magnitude of the contemporaneous correlation with GDP monotonically declines from the lowest income to the high income excluding the top confirms the earlier work on the US income distribution over the business cycle by Castañeda et al. (1998).

[19] Their original estimation period was over 1974-2015.

the quarter of the real-time data or forecast relative to the meeting date, while subscripts $t-h$ and $t-d14$ refer to information from the previous months and two weeks relative to the meeting date, respectively (and not to information from a previous meeting). Specifically, Champagne and Sekkel (2018) regress the change in the policy target rate (Δi_m) between two meetings on the one- and two-quarter-ahead forecasts of real output growth ($\hat{y}^f_{m,j}$) and inflation ($\pi^f_{m,j}$), as well as the nowcast and the real-time one-quarter lag. They also include the revisions to the forecasts relative to the previous round of forecasts (e.g., $\hat{y}^f_{m,j} - \hat{y}^f_{m-1,j}$), since both the level and change in the forecasts can be important determinants of the Bank of Canada's behavior. To control for economic developments between meetings, they include the intended policy rate two weeks before the meeting and the (real-time) rates of unemployment for the previous three months.

Champagne and Sekkel (2018) make two important departures from Romer and Romer (2000): first, in the third line of Equation (4) they further control for the levels and changes of the U.S. FFR (FFR_{t-d14}) and the logarithm of the USD/CAD nominal exchange rate (ER_{t-d14}) two weeks before the meeting. Canada is a small-open economy with close ties to the U.S., and these variables are included to capture any tendency for the Bank of Canada to react to interest rate movements in the U.S. as well as the changes in the value of the Canadian dollar relative to its U.S. counterpart. Second, they break the estimation of Equation (4) into two sub-samples: the first sub- sample includes all those meetings preceding the inflation targets (i.e., 1974–1991) and the second sub-sample regroups all meetings afterward (1992 onwards).[20] Champagne and Sekkel (2018) show that there was a structural break in the Bank of Canada's reaction function, with the U.S./Canadian dollar exchange rate and U.S. interest rates being the main drivers of changes of the policy rate in the two decades prior to inflation targeting, and GDP and inflation forecasts the main drivers afterwards. The estimated residuals from Equation (4) for each sub-sample are spliced together for the meeting-by-meeting series of monetary policy shocks. We annualized them for our purpose

[20]The Bank of Canada adopted an inflation targeting framework in 1991, and has made only minor changes since then. Bank of Canada (2021)

by summing over the shocks within each year. Figure 5 displays these shocks over the period of 1982-2019.

In order to check the validity of these annualized and extended monetary policy shock series, we test their macroeconomic implications by estimating the following Canadian-province-level panel local projections model:

$$
\begin{aligned}
\ln Y_{j,t+h} - \ln Y_{j,t-1} &= \phi_h \cdot MP_t \\
&+ \sum_{\ell=1}^{2} \varphi_{h,\ell} \cdot (\ln GDP_{j,t-\ell} - \ln GDP_{j,t-1-\ell}) \\
&+ \sum_{\ell=1}^{2} \psi_{h,\ell} \cdot (\ln CPI_{j,t-\ell} - \ln CPI_{j,t-1-\ell}) \\
&+ \sum_{\ell=1}^{2} \omega_{h,\ell} \cdot (\ln BCPI_{t-\ell} - \ln BCPI_{t-1-\ell}) \\
&+ \lambda_j + \varepsilon_{j,t+h}, \qquad (5)
\end{aligned}
$$

where j is one of the ten Canadian provinces and h the forecast horizon. Y is real GDP or CPI. Figure 6 shows the impulse-response function for GDP growth and CPI inflation with respect to a 1-pp monetary policy tightening shock. The outer band indicates the 90% confidence and the inner band the 68% confidence. Real GDP starts to decline after Year 1 and displays a persistent decline up to Year 4. CPI inflation increases in Year 1 before persistently declining over the 5 year period. These observations are broadly consistent with the findings of Champagne and Sekkel (2018) with their monthly shock series over the period of 1974-2015.

In the following section, we use these annualized monetary policy shocks to identify their impacts on household income.

5 Impacts of monetary policy shocks on household income

This section uses the monetary policy shocks identified in the previous section and analyzes the impacts of those shocks on household income, using the panel local projections method developed by Jordà (2005). We first estimate the impact on the average income of households and then sequentially introduce interaction terms between the monetary policy shock and two types household characteristics to understand the heterogeneous impacts of monetary policy. Specifically, the two types of household characteristics are the decile of the household's average income over the previous two years and the major source of income over the previous two years. As discussed in earlier sections, there are five sources of income: wage, salary and commission (WSC), non-professional business (Bus), professional business (Prof), investment (Inv) and other (Other).[21] For example, if a household earns the most income for the past two years from WSC, the household is labeled as WSC.

Specifically, we estimate the following four regression equations:

$$\begin{aligned}\frac{y_{i,t+h} - y_{i,t-1}}{|y_{i,t-1}|} &= \beta_h \cdot MP_t \\ &+ \sum_{\ell=1}^{2} \gamma_{h,\ell} \cdot \frac{y_{i,t-\ell} - y_{i,t-\ell-1}}{|y_{i,t-\ell-1}|} + \sum_{\ell=1}^{2} \sigma_{h,\ell} \cdot MP_{t-\ell} + \theta_h \cdot X + \alpha_i + \varepsilon_{i,t+h}, \quad (6)\end{aligned}$$

$$\begin{aligned}\frac{y_{i,t+h} - y_{i,t-1}}{|y_{i,t-1}|} &= \beta_h \cdot MP_t \\ &+ \sum_{q=1}^{10} \beta_{hq} \cdot MP_t \cdot Decile_{i,t-1,q} + \eta_{hq} Decile_{i,t-1,q} \\ &+ \sum_{\ell=1}^{2} \gamma_{h,\ell} \cdot \frac{y_{i,t-\ell} - y_{i,t-\ell-1}}{|y_{i,t-\ell-1}|} + \sum_{\ell=1}^{2} \sigma_{h,\ell} \cdot MP_{t-\ell} + \theta_h \cdot X + \alpha_i + \varepsilon_{i,t+h}, \quad (7)\end{aligned}$$

[21] Note that these definitions are different from those in Section 3.1.2. The definition used in the current section determines a household characteristics and not the source of income itself.

$$\begin{aligned}
\frac{y_{i,t+h}-y_{i,t-1}}{|y_{i,t-1}|} &= \beta_h \cdot MP_t \\
&+ \sum_{s=1}^{5} \beta_{hs} \cdot MP_t \cdot Source_{i,t-1,s} + \eta_{hs} Source_{i,t-1,s} \\
&+ \sum_{\ell=1}^{2} \gamma_{h,\ell} \cdot \frac{y_{i,t-\ell}-y_{i,t-\ell-1}}{|y_{i,t-\ell-1}|} + \sum_{\ell=1}^{2} \sigma_{h,\ell} \cdot MP_{t-\ell} + \theta_h \cdot X + \alpha_i + \varepsilon_{i,t+h}, \quad (8)
\end{aligned}$$

and

$$\begin{aligned}
\frac{y_{i,t+h}-y_{i,t-1}}{|y_{i,t-1}|} &= \beta_h \cdot MP_t \\
&+ \beta_{h1} \cdot MP_t \cdot Decile_{i,t-1,1} + \eta_{h1} Decile_{i,t-1,1} \\
&+ \beta_{h10} \cdot MP_t \cdot Decile_{i,t-1,10} + \eta_{h10} Decile_{i,t-1,10} \\
&+ \sum_{s=1}^{5} \beta_{hs} \cdot MP_t \cdot Source_{i,t-1,s} + \eta_{hs} Source_{i,t-1,s} \\
&+ \sum_{s=1}^{5} \beta_{h1s} \cdot MP_t \cdot Decile_{i,t-1,1} \cdot Source_{i,t-1,s} + \eta_{hqs} Decile_{i,t-1,1} \cdot Source_{i,t-1,s} \\
&+ \sum_{s=1}^{5} \beta_{h10s} \cdot MP_t \cdot Decile_{i,t-1,10} \cdot Source_{i,t-1,s} + \eta_{hqs} Decile_{i,t-1,10} \cdot Source_{i,t-1,s} \\
&+ \sum_{\ell=1}^{2} \gamma_{h,\ell} \cdot \frac{y_{i,t-\ell}-y_{i,t-\ell-1}}{|y_{i,t-\ell-1}|} + \sum_{\ell=1}^{2} \sigma_{h,\ell} \cdot MP_{t-\ell} + \theta_h \cdot X + \alpha_i + \varepsilon_{i,t+h}, \quad (9)
\end{aligned}$$

where i indexes the household, t the year, h the forecast horizon of the local projections, q the income decile, and s the major source of income. y_i is the market income of household i in year t.[22] The dependent variable in all specifications is the growth rate of income from $t-1$ to $t+h$, expressed in percentage. MP_t is the monetary policy shock identified in the previous section. Equation 6 is the baseline specification where β_h is the parameter of our interest, capturing the average percentage change in income over the horizon h from a 1-pp monetary policy tightening shock. We include, as control variables, the first two lags of the dependent variable and that of the monetary policy shocks. In addition, the variable X

[22] Given that y_i can be negaive, we take the absolute value when it is the denominator of a ratio.

contains three macro control variables: the first two lags of real GDP growth, those of CPI inflation, and those of the changes in a commodity price index.[23] Finally, α_i captures the household fixed effects. All other specifications include the same set of control variables.

Equation 7 introduces the income decile dummies and their interactions with monetary policy shocks to the baseline specification. Similarly, Equation 8 adds the major-income-source dummies and their interactions with monetary policy shocks. Finally, Equation 9 introduces triple interaction terms across monetary policy shocks, income quantiles (the bottom and the top decile) and major income sources. We estimate all specifications with the panel fixed effects estimator and cluster the standard errors at the household level.[24] Our sample for these estimations consists of 40 million to 63 million household-year observations for $h = 5$ to $h = 0$, respectively. Estimation results for Equation 6 to 9 are presented in Table 5 to 8, respectively.

Figure 7 displays the impulse-response function of a 1-pp tightening monetary policy shock on the household income growth in percentage, using the estimates from Equation 6. The confidence band shown in this figure, as well as for the rest of the figures below, is for 99%, and hence most of the estimation results are highly statistically significant. Monetary policy tightening decreases household income on average over the 5-year period with the Year-1 effect at a -0.8-pp decline in the growth rate of their market income and the peak impact in Year 4 at -1.8 pp.[25]

Figure 8 and 9 show the responses across income deciles in Year 1 and 4, respectively. Both figures indicate that the high-income households (those in the 10th decile) lower their income-growth rate by -0.9 pp more than their middle-income peers (those in the 5th decile) in Year 1 and by -1.1 pp in Year 4. In addition, the low-income households (those in the 1st

[23]For the commodity price index, we use the Bank of Canada commodity price index (BCPI), converted to Canadian dollars.

[24]For robustness, we estimated the models clustering the errors at the 6-digit postal code level and found no significant changes in the results.

[25]We also observe an oscillation of the income-growth response with an uptick in Year 2 before it persistently declines. From the column $h = 2$ of Table 6 and 7, we see that lower income-decile households, as well as those with non-WSC income, contribute more to this uptick in Year 2.

decile) also lower their growth rate but by less than those of their high-income peers in both Year 1 and 4, indicating that inequality between the two tails of the income distribution is shrinking. Moreover, the point estimates in the two figures across the 2nd to the 10th decile slopes downwards, implying that the higher the income, the lower the income growth. Hence, the monetary policy tightening reduces overall income inequality. Finally, the large reduction in income growth by the high income suggests that the income-level distribution is becoming more negatively skewed or more left-skewed. The next section elaborates more on this and discusses the implications of monetary policy tightening on the income-growth skewness.

Monetary policy can impact households differently due to the differences in the sources of their income. Figure 10 and 11 exhibit the responses across household's major sources of income in Year 1 and 4, respectively, based on the estimation of Equation 8. Two grouping of households by their major income source emerge: one with wage, salary and commission (WSC), professional business (Prof) and Other (Other) income, and another with non-professional business (Bus) and investment (Inv) income. Both groups for both Year 1 and 4 lower their income growth but the first group with WSC, Prof and Other income do so much less than the second with Bus and Inv income. Households with Inv as their major income source, especially, stands out as their income growth persistently declines more than 6 pp both in Year 1 and 4. The difference between the two types of solo proprietorship is also interesting to highlight. Households who receive the most income from their professional businesses (e.g., doctors, lawyers and accountants) exhibit a similar impact on their income growth to those with wage, salary and commission as their major income source. In contrast, households with the major income from non-professional businesses (e.g., plumbers and small restaurant owners) are closer to those with investment income as their major income source, likely reflecting the difference in the volatility of business by type and its sensitivity to the macroeconomic environment like monetary policy.

The source and the level of income can receive interacting effects from monetary policy shocks. Figure 12 and 13 show the responses across household's major sources of income for the 1st and 10th income decile in Year 1 and 4, respectively, based on the estimation of Equation 9. First, we note that, among the households with wage, salary and commission as their major income source, those in the highest income decile lower their income growth more than their peers in the lowest decile, persistently in both Year 1 and 4. This finding adds to the ongoing discussion in the literature on the transmission channels of monetary policy to income inequality. Our finding contrasts others in that Amberg et al. (2022) find that monetary policy shocks impact the labour income of the low income more than that of the high income, while Andersen et al. (2023) show that monetary policy has the largest impact on salary income of the lower-middle part of the income distribution. Second, low-income households with investment income as their major source are hit harder (lower income growth by 12 pp) than their high-income peers (lower growth by 4.5 pp) by monetary policy tightening in Year 1. In Year 4 however, the decline in the income growth appears more persistent for the high-income households with non-professional business and investment income than the low-income peers.

6 Discussion: monetary policy, business cycle and income-growth distributions

What are the implications of monetary policy for the dynamics of the income-growth distribution over the business cycle and that of income inequality? Our analysis in this paper indicates that monetary policy counters the income-growth dynamics of the business cycle and hence stabilizes the dynamics of the income-level inequality.

This section elaborates this argument by bringing together our analysis of the income-growth distribution over the business cycle in Section 3 and that of the impacts of monetary policy on the income-growth distribution in Section 5. Our findings suggest that monetary policy counters and dampens the business-cycle force that makes the skewness of the income-growth distribution pro-cyclical with GDP growth. On one hand, Section 3 showed that the skewness of the income-growth distribution is pro-cyclical such that the two tails of the distribution more positively co-move with GDP growth than the middle of the distribution does. On another hand, Section 5 delivered the monetary-policy implied distribution of income growth from the estimation of Equation 7. We then need to derive the contribution of of monetary policy to the skewness of the income-growth distribution and then compare that with the finding on the skewness of the income-growth distribution over the business cycle. In the following, we do this by looking at the one-year horizon.

Common wisdom dictates that a monetary policy tightening happens when the economy overheats (i.e., during a boom period). During booms, the income-growth distribution becomes more positively skewed and, when monetary policy tightens responding to the overheating economy in the boom, it counters and dampens the pro-cyclicality of the skewness by bringing the distribution more towards negatively skewned.[26] We can visually compare the dynamics of income-growth distributions in the boom and after the monetary policy shock by looking at Figure 4 and 8. Figure 14 superimposes these two figures on top of each other. In doing so, the numbers from Figure 8 are adjusted to be relative to the 5th income decile group, as well as being annualized to be comparable with the income-GDP growth correlation figure where the numbers are based on annual growth rates.

We observe a clear pattern that monetary policy tightening counters the higher income growth of the low and high income households (relative to their 5th income decile peers) in the boom and reduce their relative advantage over their peers, especially, for the high income household. The low and high income households are the contributors to the observed pro-cyclical skewness of the income-growth distribution, and by countering their business-cycle movements, monetary policy reduces this pro-cyclicality. By doing so, monetary policy in turn stabilizes the income-level distribution or income inequality over the business cycle. In contrast to the low and high income households, those in the upper middle class between

[26]The correlation coefficient between annual GDP growth and annual changes in the Bank Rate of the Bank of Canada over the data period, 1982-2019, is significantly positive at 0.5471.

the 7th and the 9th income decile households have relatively low income growth during the boom and in addition fare relatively worse from monetary policy tightening.

7 Conclusion

This paper aims to contribute to the literature on monetary policy and inequality by using Statistic Canada's Longitudinal Administrative Databank of taxfilers to address three dimensions: i) document how different moments of income-growth distribution are correlated with the business cycle; ii) estimate the impacts of monetary policy shocks on the level of household income by income decile group and by major source of income, and iii) assess how monetary policy amplifies or dampens the dynamics of income-growth distribution over the business cycle. The empirical results are based on tax filers only, and therefore address dynamics on the intensive margin.

Our findings confirm Busch et al. (2022) in that the skewness of the income-distribution is pro-cyclical, while the variance is not. Movements in both tails of the distribution contribute to the pro-cyclical skewness. With regards to the effects of monetary policy, we find that there are larger and more persistent declines in income growth for high-income households through their wage, salary and commission income as well as partly their non-professional business and investment income.

Those households with non-professional business or investment income as the major source of income experience larger income-growth declines in the face of monetary policy tightening. This latter result is consistent with other studies, which find the variation in income sources across the distribution is a key driver behind the distributional consequences of monetary policy actions. Finally, our results show that monetary policy counters the pro-cyclical skewness in the income-growth distribution, and thereby stabilizes the income-level distribution or income inequality over the business cycle.

Future iterations of this paper will endeavour to add more on relevant literature and how our method and results compare, conduct some robustness checks on the results, repeat the steps adding transfers and taxes, and potentially study more closely the top 1%.

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Tables and Figures

Table 1: Estimation results of Equation (1) for the mean, variance and Kelly skewness

	Mean	Variance	Kelley	P90-P10	P90-P50	P50-P10
GDP growth	1.009***	66.45*	0.0252***	0.792*	1.431***	-0.639***
	(0.219)	(38.33)	(0.0035)	(0.456)	(0.425)	(0.0557)
Year	0.0770**	-0.252	0.0026***	-0.0349	0.0706	-0.105***
	(0.0362)	(7.170)	(0.0007)	(0.101)	(0.0801)	(0.0264)
Constant	-148.4**	2,038	-5.080***	142.8	-100.9	243.7***
	(72.51)	(14,346)	(1.356)	(201.5)	(160.2)	(53.11)
Observations	37	37	37	37	37	37

Note: Newey-West standard errors in parentheses (maximum lag length: 3). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 2: Estimation results of Equation (2) for the mean and variance by income source

	Mean				
	WSC_y	Bus_y	$Prof_y$	Inv_y	$Other_y$
GDP growth	0.712***	0.458**	0.202*	0.540*	0.00423
	(0.112)	(0.178)	(0.109)	(0.283)	(0.0223)
Year	0.0615**	-0.0519**	-0.148***	0.0603**	0.00430
	(0.0246)	(0.0214)	(0.0205)	(0.0252)	(0.00371)
Constant	-118.9**	106.9**	299.5***	-120.2**	-7.961
	(49.26)	(43.16)	(40.99)	(50.45)	(7.446)
Observations	37	37	37	37	37

	Variance				
	WSC_y	Bus_y	$Prof_y$	Inv_y	$Other_y$
GDP growth	17.99*	27.23***	-4.191	80.19	3.218
	(10.05)	(9.244)	(5.223)	(67.92)	(1.981)
Year	1.805	-30.42***	-19.97***	4.773	0.344
	(2.840)	(1.796)	(1.573)	(6.229)	(0.686)
Constant	-2,543	62,130***	40,910***	-9,292	-586.2
	(5,685)	(3,613)	(3,157)	(12,431)	(1,372)
Observations	37	37	37	37	37

Note: Newey-West standard errors in parentheses (maximum lag length: 3). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: Estimation results of Equation (2) for Kelly skewness by income source

	WSC_y	Bus_y	$Prof_y$	Inv_y	$Other_y$
GDP growth	0.0262***	0.0177***	0.0104**	0.0544***	-0.0102
	(0.0018)	(0.0062)	(0.0042)	(0.0174)	(0.0077)
Year	0.0026***	-0.0001	-0.0054***	0.0088***	0.0026*
	(0.0007)	(0.0008)	(0.0013)	(0.0024)	(0.0015)
Constant	-5.130***	0.479	10.97***	-17.66***	-4.960
	(1.482)	(1.652)	(2.507)	(4.793)	(2.972)
Observations	37	37	37	37	37

Note: Newey-West standard errors in parentheses (maximum lag length: 3). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4: Estimation results of Equation (3)

	Dependent variable: $\frac{y_{i,t}-y_{i,t-1}}{y_{i,t-1}}$
$\Delta GDP_t \cdot Decile_1$	0.355***
	(0.0438)
$\Delta GDP_t \cdot Decile_2$	0.0205
	(0.0255)
$\Delta GDP_t \cdot Decile_3$	0.0362
	(0.0248)
$\Delta GDP_t \cdot Decile_4$	0.000193
	(0.0214)
$\Delta GDP_t \cdot Decile_6$	-0.0122
	(0.0180)
$\Delta GDP_t \cdot Decile_7$	-0.0538***
	(0.0167)
$\Delta GDP_t \cdot Decile_8$	-0.0697***
	(0.0170)
$\Delta GDP_t \cdot Decile_9$	-0.0594***
	(0.0191)
$\Delta GDP_t \cdot Decile_{10}$	0.140***
	(0.0375)
$\frac{y_{i,t-1}-y_{i,t-2}}{y_{i,t-2}}$	-8.01e-05***
	(2.47e-06)
$\frac{y_{i,t-2}-y_{i,t-3}}{y_{i,t-3}}$	2.51e-05***
	(1.69e-06)
Constant	12.22***
	(0.167)
Observations	71,593,685
R-squared	0.125
Household FE	Yes
Time FE	Yes
Decile group FE	Yes

Note: Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5: Estimation results of Equation (6)

Dependent variable: $\frac{y_{i,t+h}-y_{i,t-1}}{y_{i,t-1}}$

	Local projection horizon, h					
	0	1	2	3	4	5
MP_t	0.0906***	-0.813***	0.133***	-1.039***	-1.816***	-1.076***
	(0.0157)	(0.0184)	(0.0246)	(0.0250)	(0.0289)	(0.0302)
MP_{t-1}	-0.929***	-0.154***	-0.731***	-1.702***	-0.768***	-1.425***
	(0.0178)	(0.0219)	(0.0256)	(0.0296)	(0.0307)	(0.0340)
MP_{t-2}	0.507***	0.228***	-0.758***	-0.271***	-0.223***	-1.635***
	(0.0164)	(0.0186)	(0.0309)	(0.0250)	(0.0258)	(0.0342)
$\frac{y_{t-1}-y_{t-2}}{y_{t-2}}$	-9.87e-05***	-0.000124***	-0.000146***	-0.000165***	-0.000183***	-0.000201***
	(2.77e-06)	(3.99e-06)	(4.78e-06)	(5.79e-06)	(6.51e-06)	(7.32e-06)
$\frac{y_{t-2}-y_{t-3}}{y_{t-3}}$	1.07e-06	-1.28e-05***	-2.73e-05***	-3.48e-05***	-4.93e-05***	-6.40e-05***
	(1.67e-06)	(2.57e-06)	(2.78e-06)	(5.18e-06)	(2.88e-06)	(2.68e-06)
$\ln GDP_{t-1} - \ln GDP_{t-2}$	0.0209***	0.0241***	0.0233***	0.0246***	0.0257***	0.0223***
	(0.00105)	(0.00131)	(0.00140)	(0.00131)	(0.00154)	(0.00159)
$\ln GDP_{t-2} - \ln GDP_{t-3}$	0.00326***	0.00478***	-0.000302	0.00155	-0.00416**	-0.00126
	(0.000769)	(0.000987)	(0.00118)	(0.00129)	(0.00171)	(0.00165)
$\ln CPI_{t-1} - \ln CPI_{t-2}$	-0.101***	-0.618***	0.810***	0.524***	0.670***	0.198***
	(0.0129)	(0.0159)	(0.0433)	(0.0250)	(0.0230)	(0.0264)
$\ln CPI_{t-2} - \ln CPI_{t-3}$	-0.102***	1.065***	0.520***	0.746***	0.203***	0.677***
	(0.0130)	(0.0188)	(0.0276)	(0.0330)	(0.0264)	(0.0292)
$\ln BCPI_{t-1} - \ln BCPI_{t-2}$	0.0128***	0.0108***	-0.0314***	-0.00727***	-0.0736***	0.0140***
	(0.00121)	(0.00141)	(0.00220)	(0.00185)	(0.00208)	(0.00229)
$\ln BCPI_{t-2} - \ln BCPI_{t-3}$	-0.0195***	-0.0669***	-0.0338***	-0.0548***	-0.0242***	0.0332***
	(0.00103)	(0.00123)	(0.00141)	(0.00215)	(0.00207)	(0.00226)
Constant	15.62***	21.21***	25.27***	30.36***	36.96***	42.17***
	(0.246)	(0.354)	(0.541)	(0.646)	(0.616)	(0.743)
Observations	63,588,640	56,830,020	51,906,450	47,595,345	43,689,645	40,099,875
R-squared	0.105	0.117	0.120	0.133	0.183	0.203

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6: Estimation results of Equation (7)

Dependent variable: $\frac{y_{i,t+h}-y_{i,t-1}}{y_{i,t-1}}$

	Local projection horizon, h					
	0	1	2	3	4	5
MP_t	0.220***	-0.491***	-0.135***	-1.018***	-1.286***	-0.153***
	(0.0299)	(0.0340)	(0.0388)	(0.0432)	(0.0450)	(0.0476)
$MP_t \cdot Decile_1$	1.096***	-0.554***	1.923***	1.059***	0.263	1.490***
	(0.112)	(0.138)	(0.188)	(0.183)	(0.195)	(0.195)
$MP_t \cdot Decile_2$	0.525***	0.0795	0.902***	0.510***	0.284***	1.133***
	(0.0530)	(0.0762)	(0.0839)	(0.192)	(0.109)	(0.118)
$MP_t \cdot Decile_3$	0.270***	0.118*	0.280***	0.182***	0.0255	0.482***
	(0.0455)	(0.0605)	(0.0633)	(0.0688)	(0.102)	(0.0937)
$MP_t \cdot Decile_4$	0.0580	-0.0400	0.0742	0.0969	0.101	0.250***
	(0.0440)	(0.0506)	(0.0582)	(0.0594)	(0.0657)	(0.0684)
$MP_t \cdot Decile_6$	-0.129***	-0.152***	-0.156***	-0.0895	-0.107*	-0.169***
	(0.0373)	(0.0459)	(0.0514)	(0.0606)	(0.0577)	(0.0608)
$MP_t \cdot Decile_7$	-0.242***	-0.178***	-0.285***	-0.180***	-0.201***	-0.332***
	(0.0351)	(0.0456)	(0.0445)	(0.0506)	(0.0560)	(0.0580)
$MP_t \cdot Decile_8$	-0.309***	-0.348***	-0.291***	-0.198***	-0.258***	-0.399***
	(0.0346)	(0.0396)	(0.0434)	(0.0508)	(0.0535)	(0.0552)
$MP_t \cdot Decile_9$	-0.326***	-0.503***	-0.276***	-0.266***	-0.397***	-0.555***
	(0.0360)	(0.0404)	(0.0448)	(0.0631)	(0.0536)	(0.0575)
$MP_t \cdot Decile_{10}$	-0.187***	-0.887***	-0.483***	-0.550***	-1.144***	-0.761***
	(0.0553)	(0.0670)	(0.0660)	(0.0734)	(0.0966)	(0.0814)
MP_{t-1}	-0.890***	-0.361***	-0.969***	-1.594***	-0.320***	-0.548***
	(0.0173)	(0.0214)	(0.0248)	(0.0278)	(0.0278)	(0.0281)
MP_{t-2}	0.465***	0.140***	-0.803***	-0.00485	0.124***	-0.759***
	(0.0161)	(0.0182)	(0.0304)	(0.0233)	(0.0247)	(0.0309)
$\frac{y_{t-1}-y_{t-2}}{y_{t-2}}$	-7.82e-05***	-9.59e-05***	-0.000112***	-0.000126***	-0.000138***	-0.000151***
	(2.48e-06)	(3.56e-06)	(4.22e-06)	(5.13e-06)	(5.50e-06)	(6.11e-06)
$\frac{y_{t-2}-y_{t-3}}{y_{t-3}}$	2.24e-05***	1.66e-05***	7.78e-06***	7.53e-06	-1.87e-06	-1.19e-05***
	(1.74e-06)	(2.75e-06)	(2.95e-06)	(5.17e-06)	(3.02e-06)	(2.88e-06)
$\ln GDP_{t-1} - \ln GDP_{t-2}$	0.0192***	0.0198***	0.0159***	0.0149***	0.0113***	0.00408***
	(0.00102)	(0.00125)	(0.00132)	(0.00120)	(0.00142)	(0.00146)
$\ln GDP_{t-2} - \ln GDP_{t-3}$	0.00596***	0.00785***	0.00183	0.00176	-0.00584***	-0.00362**
	(0.000744)	(0.000940)	(0.00112)	(0.00122)	(0.00164)	(0.00156)
$\ln CPI_{t-1} - \ln CPI_{t-2}$	-0.00401	-0.613***	0.768***	0.269***	0.203***	-0.701***
	(0.0125)	(0.0151)	(0.0427)	(0.0227)	(0.0201)	(0.0209)
$\ln CPI_{t-2} - \ln CPI_{t-3}$	-0.176***	0.844***	-0.0232	-0.0569**	-0.797***	-0.351***
	(0.0122)	(0.0172)	(0.0251)	(0.0275)	(0.0212)	(0.0235)
$\ln BCPI_{t-1} - \ln BCPI_{t-2}$	0.00585***	-0.0110***	-0.0893***	-0.0674***	-0.0825***	0.0112***
	(0.00119)	(0.00137)	(0.00206)	(0.00169)	(0.00204)	(0.00222)
$\ln BCPI_{t-2} - \ln BCPI_{t-3}$	-0.0275***	-0.0977***	-0.0696***	-0.0459***	0.00332*	0.0687***
	(0.00102)	(0.00120)	(0.00137)	(0.00210)	(0.00192)	(0.00207)
Constant	12.36***	17.24***	21.27***	26.55***	33.23***	38.86***
	(0.200)	(0.289)	(0.464)	(0.522)	(0.412)	(0.511)
Observations	63,588,640	56,830,020	51,906,450	47,595,345	43,689,645	40,099,875
R-squared	0.125	0.145	0.150	0.155	0.227	0.251

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7: Estimation results of Equation (8)

	Dependent variable: $\frac{y_{i,t+h}-y_{i,t-1}}{y_{i,t-1}}$					
	Local projection horizon, h					
	0	1	2	3	4	5
MP_t	0.0304**	-0.492***	-0.0399	-1.051***	-1.697***	-1.250***
	(0.0143)	(0.0160)	(0.0249)	(0.0247)	(0.0259)	(0.0281)
$MP_t \cdot Bus$	0.844***	-2.618***	1.423***	-0.467***	-1.779***	2.024***
	(0.132)	(0.174)	(0.196)	(0.159)	(0.199)	(0.215)
$MP_t \cdot Prof$	1.362***	-0.0380	1.200***	0.718***	-0.114	1.783***
	(0.151)	(0.188)	(0.183)	(0.194)	(0.237)	(0.247)
$MP_t \cdot Inv$	0.428**	-6.171***	0.670**	-1.683***	-4.363***	-0.316
	(0.211)	(0.254)	(0.280)	(0.600)	(0.385)	(0.310)
$MP_t \cdot Other$	0.180***	-0.795***	1.123***	0.809***	0.888***	0.553***
	(0.0566)	(0.0703)	(0.0915)	(0.108)	(0.136)	(0.148)
MP_{t-1}	-0.897***	-0.172***	-0.759***	-1.747***	-0.826***	-1.489***
	(0.0180)	(0.0221)	(0.0259)	(0.0296)	(0.0308)	(0.0340)
MP_{t-2}	0.506***	0.191***	-0.795***	-0.319***	-0.276***	-1.688***
	(0.0164)	(0.0186)	(0.0313)	(0.0253)	(0.0260)	(0.0344)
$\frac{y_{t-1}-y_{t-2}}{y_{t-2}}$	-9.76e-05***	-0.000123***	-0.000145***	-0.000163***	-0.000182***	-0.000200***
	(2.76e-06)	(3.97e-06)	(4.76e-06)	(5.77e-06)	(6.49e-06)	(7.31e-06)
$\frac{y_{t-2}-y_{t-3}}{y_{t-3}}$	2.18e-06	-1.16e-05***	-2.59e-05***	-3.34e-05***	-4.82e-05***	-6.30e-05***
	(1.68e-06)	(2.57e-06)	(2.77e-06)	(5.19e-06)	(2.88e-06)	(2.69e-06)
$\ln GDP_{t-1} - \ln GDP_{t-2}$	0.0207***	0.0243***	0.0235***	0.0250***	0.0263***	0.0229***
	(0.00105)	(0.00131)	(0.00139)	(0.00131)	(0.00153)	(0.00159)
$\ln GDP_{t-2} - \ln GDP_{t-3}$	0.00324***	0.00503***	3.58e-05	0.00206	-0.00358**	-0.000714
	(0.000769)	(0.000986)	(0.00118)	(0.00129)	(0.00171)	(0.00165)
$\ln CPI_{t-1} - \ln CPI_{t-2}$	-0.128***	-0.615***	0.844***	0.571***	0.725***	0.264***
	(0.0131)	(0.0164)	(0.0448)	(0.0258)	(0.0230)	(0.0263)
$\ln CPI_{t-2} - \ln CPI_{t-3}$	-0.133***	1.090***	0.560***	0.809***	0.281***	0.761***
	(0.0133)	(0.0195)	(0.0278)	(0.0344)	(0.0267)	(0.0293)
$\ln BCPI_{t-1} - \ln BCPI_{t-2}$	0.0133***	0.0119***	-0.0313***	-0.00710***	-0.0738***	0.0127***
	(0.00120)	(0.00141)	(0.00221)	(0.00185)	(0.00209)	(0.00229)
$\ln BCPI_{t-2} - \ln BCPI_{t-3}$	-0.0189***	-0.0677***	-0.0348***	-0.0570***	-0.0274***	0.0293***
	(0.00103)	(0.00123)	(0.00140)	(0.00214)	(0.00207)	(0.00225)
Constant	15.58***	20.94***	24.86***	29.86***	36.43***	41.60***
	(0.248)	(0.356)	(0.545)	(0.649)	(0.615)	(0.742)
Observations	63,588,640	56,830,020	51,906,450	47,595,345	43,689,645	40,099,875
R-squared	0.105	0.117	0.121	0.133	0.184	0.203

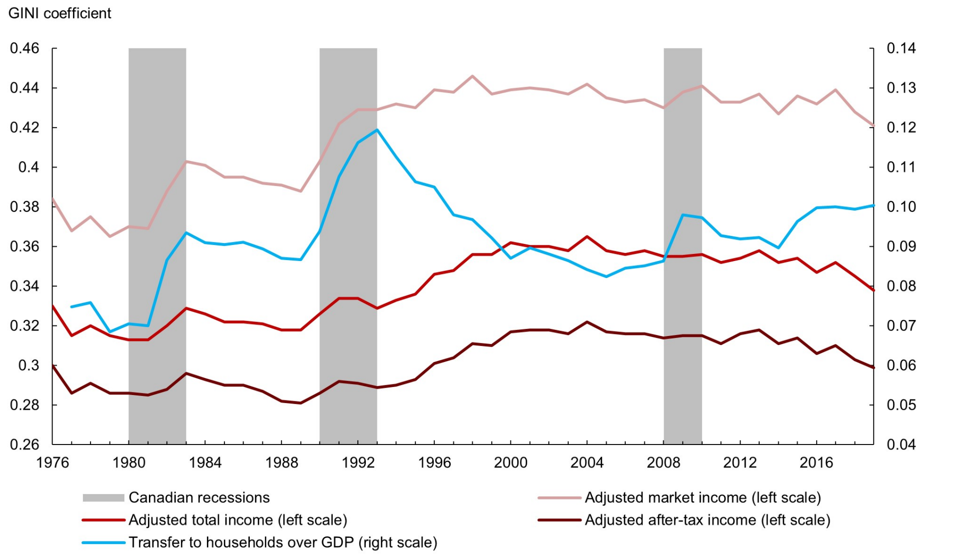
Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8: Estimation results of Equation (9)

	Dependent variable: $\frac{y_{i,t+h}-y_{i,t-1}}{y_{i,t-1}}$					
	Local projection horizon, h					
	0	1	2	3	4	5
MP_t	0.0756***	-0.403***	-0.104***	-1.005***	-1.490***	-0.943***
	(0.0131)	(0.0152)	(0.0215)	(0.0228)	(0.0221)	(0.0258)
$MP_t \cdot Decile_1$	0.980***	1.108***	1.253***	0.955***	0.710***	1.004***
	(0.0810)	(0.115)	(0.174)	(0.151)	(0.216)	(0.180)
$MP_t \cdot Decile_{10}$	0.148***	-0.541***	-0.125**	-0.285***	-0.668***	-0.142**
	(0.0409)	(0.0419)	(0.0502)	(0.0600)	(0.0810)	(0.0574)
$MP_t \cdot Bus$	0.813***	-2.303***	1.240***	-0.328**	-1.529***	2.358***
	(0.101)	(0.136)	(0.130)	(0.129)	(0.192)	(0.174)
$MP_t \cdot Prof$	1.389***	-0.311	1.773***	1.054***	0.0227	2.468***
	(0.269)	(0.366)	(0.379)	(0.375)	(0.507)	(0.505)
$MP_t \cdot Inv$	-0.355*	-6.701***	0.541*	-3.219***	-5.191***	-0.965**
	(0.187)	(0.280)	(0.297)	(0.881)	(0.523)	(0.379)
$MP_t \cdot Other$	0.0812	-0.978***	1.104***	0.818***	0.811***	0.440***
	(0.0526)	(0.0652)	(0.0895)	(0.0868)	(0.139)	(0.139)
$MP_t \cdot Decile_1 \cdot Bus$	0.193	-1.347**	1.305*	0.425	0.188	0.550
	(0.466)	(0.530)	(0.768)	(0.569)	(0.646)	(0.721)
$MP_t \cdot Decile_{10} \cdot Bus$	-0.0411	0.700	-1.052	-1.121	-0.909	-2.720*
	(0.486)	(1.542)	(1.126)	(0.958)	(1.260)	(1.624)
$MP_t \cdot Decile_1 \cdot Prof$	-0.626	-4.490**	-2.638	-2.413	-2.868	-2.943
	(1.295)	(1.744)	(1.902)	(1.934)	(2.170)	(2.673)
$MP_t \cdot Decile_{10} \cdot Prof$	-0.159	1.186***	-0.549	-0.0514	0.681	-0.682
	(0.313)	(0.413)	(0.425)	(0.431)	(0.569)	(0.574)
$MP_t \cdot Decile_1 \cdot Inv$	4.322***	-6.499***	7.378***	6.391***	1.506	5.971***
	(1.047)	(1.328)	(1.469)	(2.335)	(1.574)	(1.731)
$MP_t \cdot Decile_{10} \cdot Inv$	-0.970**	3.197***	-4.934***	0.705	0.418	-1.882***
	(0.437)	(0.493)	(0.521)	(1.028)	(0.772)	(0.621)
$MP_t \cdot Decile_1 \cdot Other$	-0.589***	-0.821***	-1.012***	-1.071**	-1.013**	-0.968*
	(0.188)	(0.272)	(0.354)	(0.423)	(0.466)	(0.570)
$MP_t \cdot Decile_{10} \cdot Other$	-0.407	0.606	-1.454***	-1.006	0.339	0.412
	(0.474)	(0.369)	(0.519)	(0.798)	(0.706)	(0.802)
MP_{t-1}	-0.817***	-0.173***	-0.769***	-1.625***	-0.598***	-1.136***
	(0.0175)	(0.0217)	(0.0253)	(0.0285)	(0.0292)	(0.0308)
MP_{t-2}	0.519***	0.201***	-0.774***	-0.181***	-0.127***	-1.380***
	(0.0162)	(0.0183)	(0.0309)	(0.0242)	(0.0253)	(0.0325)
$\frac{y_{t-1}-y_{t-2}}{y_{t-2}}$	-8.72e-05***	-0.000109***	-0.000129***	-0.000145***	-0.000161***	-0.000177***
	(2.63e-06)	(3.80e-06)	(4.53e-06)	(5.51e-06)	(6.11e-06)	(6.85e-06)
$\frac{y_{t-2}-y_{t-3}}{y_{t-3}}$	1.30e-05***	2.48e-06	-9.62e-06***	-1.41e-05***	-2.68e-05***	-3.97e-05***
	(1.69e-06)	(2.62e-06)	(2.80e-06)	(5.16e-06)	(2.85e-06)	(2.65e-06)
$\ln GDP_{t-1} - \ln GDP_{t-2}$	0.0194***	0.0218***	0.0200***	0.0210***	0.0207***	0.0162***
	(0.00104)	(0.00128)	(0.00136)	(0.00125)	(0.00148)	(0.00153)
$\ln GDP_{t-2} - \ln GDP_{t-3}$	0.00374***	0.00549***	6.43e-05	0.00142	-0.00474***	-0.00213
	(0.000756)	(0.000963)	(0.00115)	(0.00126)	(0.00168)	(0.00161)
$\ln CPI_{t-1} - \ln CPI_{t-2}$	-0.158***	-0.690***	0.748***	0.412***	0.509***	-0.0776***
	(0.0128)	(0.0157)	(0.0443)	(0.0238)	(0.0211)	(0.0230)
$\ln CPI_{t-2} - \ln CPI_{t-3}$	-0.245***	0.904***	0.267***	0.441***	-0.134***	0.353***
	(0.0125)	(0.0183)	(0.0260)	(0.0309)	(0.0234)	(0.0259)
$\ln BCPI_{t-1} - \ln BCPI_{t-2}$	0.0116***	0.00479***	-0.0509***	-0.0262***	-0.0732***	0.0153***
	(0.00120)	(0.00139)	(0.00213)	(0.00176)	(0.00207)	(0.00226)
$\ln BCPI_{t-2} - \ln BCPI_{t-3}$	-0.0195***	-0.0761***	-0.0445***	-0.0483***	-0.0125***	0.0462***
	(0.00102)	(0.00121)	(0.00138)	(0.00211)	(0.00199)	(0.00214)
Constant	14.28***	19.41***	23.28***	28.20***	34.65***	39.83***
	(0.223)	(0.323)	(0.506)	(0.593)	(0.529)	(0.645)
Observations	63,588,640	56,830,020	51,906,450	47,595,345	43,689,645	40,099,875
R-squared	0.117	0.132	0.136	0.144	0.204	0.225

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 1: Gini coefficient on various income measures over four decades



Source: Statistics Canada, Table 36-10-0477-01 and Table 11-10-0134-01

Figure 2: Average income by decile group over four decades

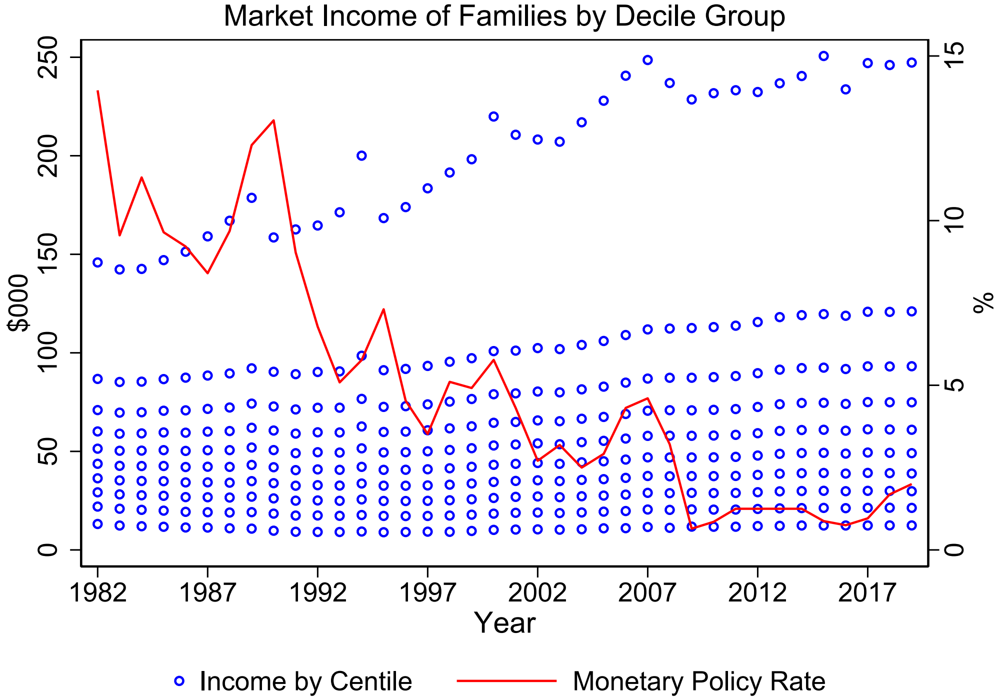


Figure 3: Major sources of household income by income decile

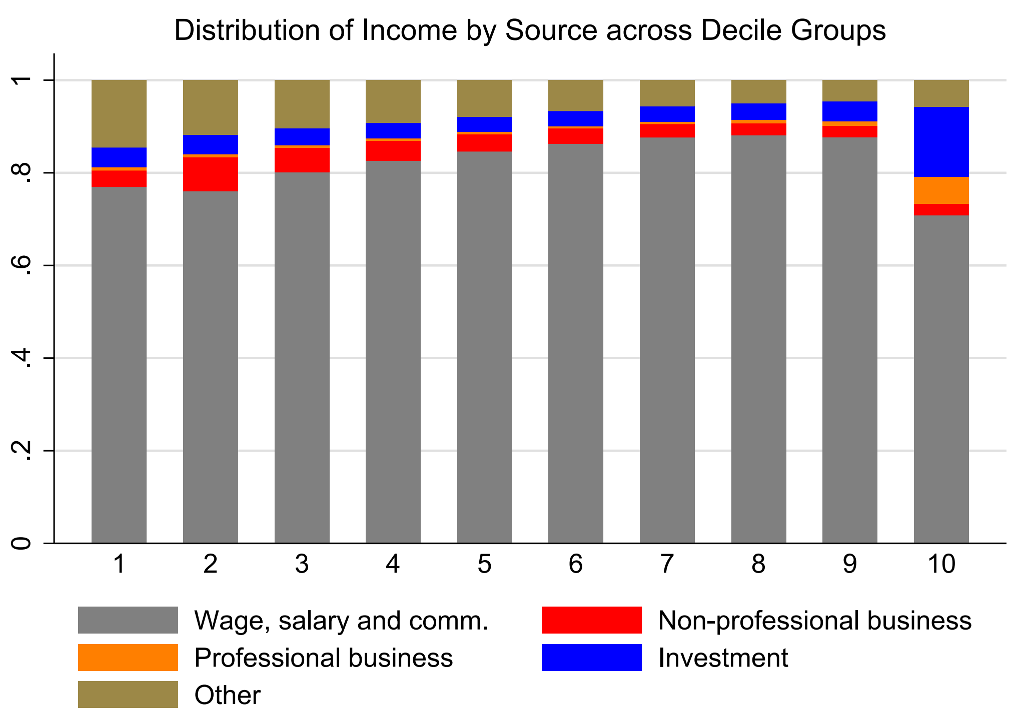


Figure 4: GDP-income growth correlation by income decile

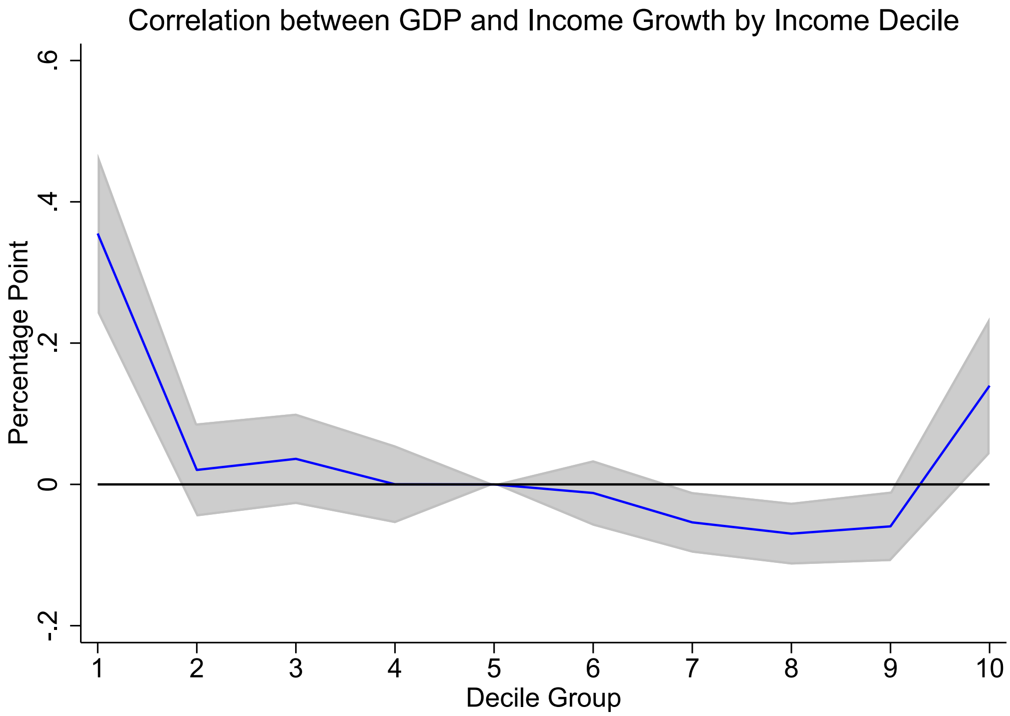


Figure 5: Annualized monetary policy shocks

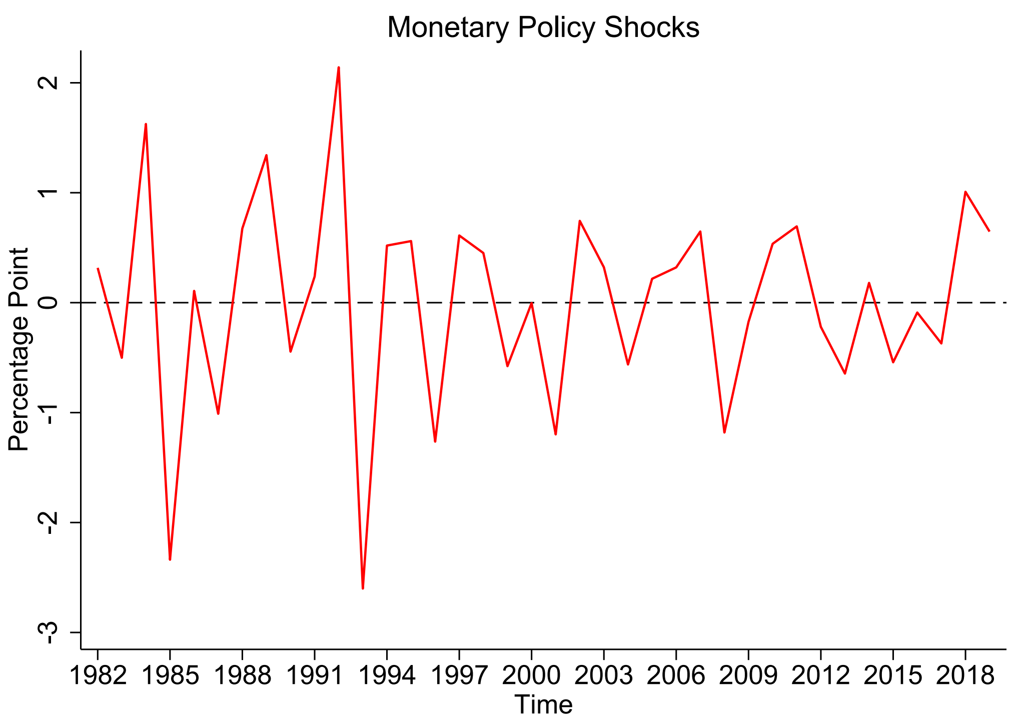


Figure 6: Impulse-response functions with annualized monetary policy shocks

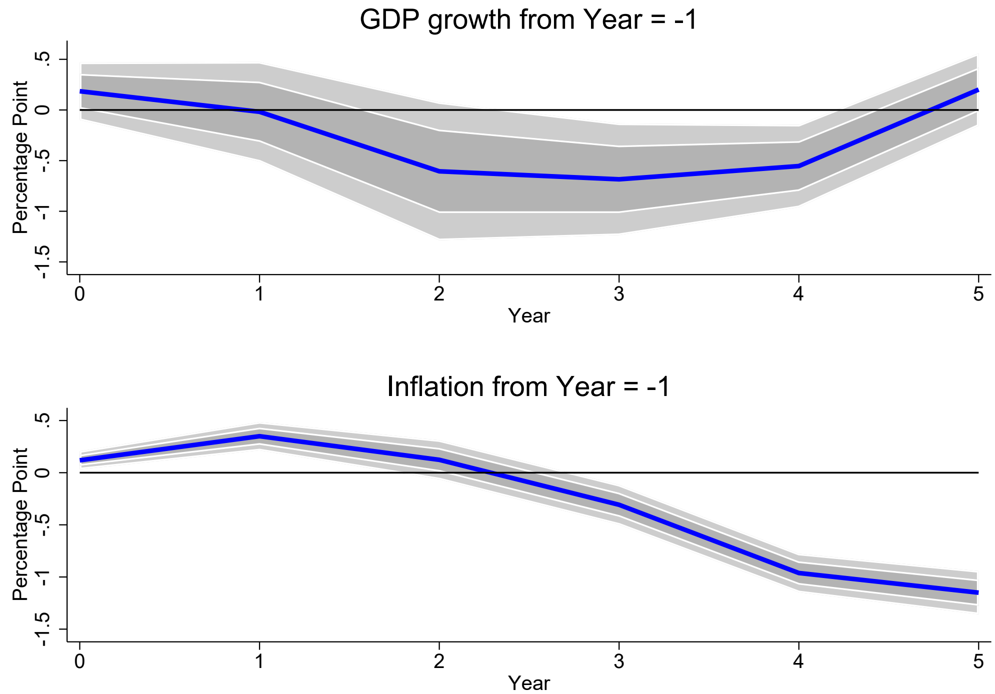


Figure 7: IRF of 1-pp MP tightening shock on household income

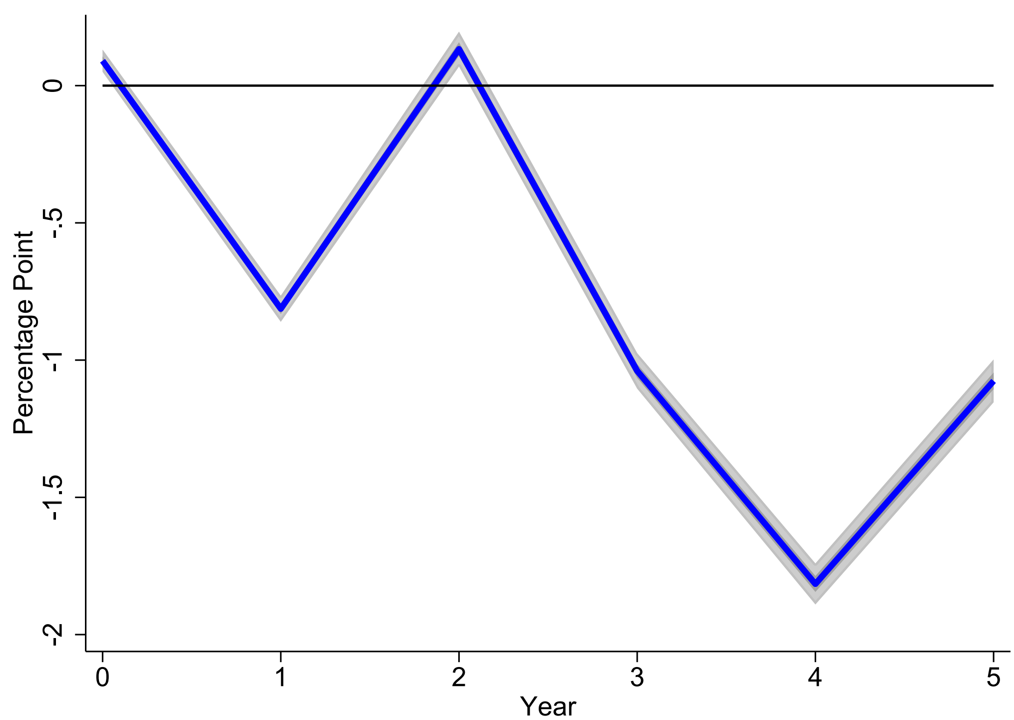


Figure 8: IRF of 1-pp MP tightening shock by income decile, Year 1

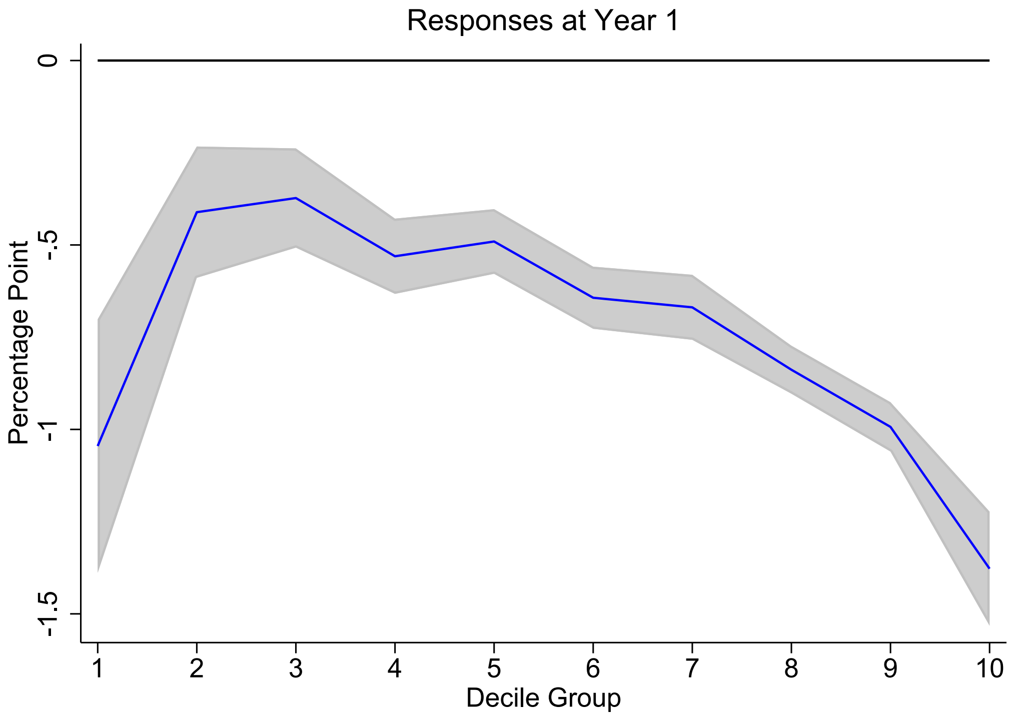


Figure 9: IRF of 1-pp MP tightening shock by income decile, Year 4

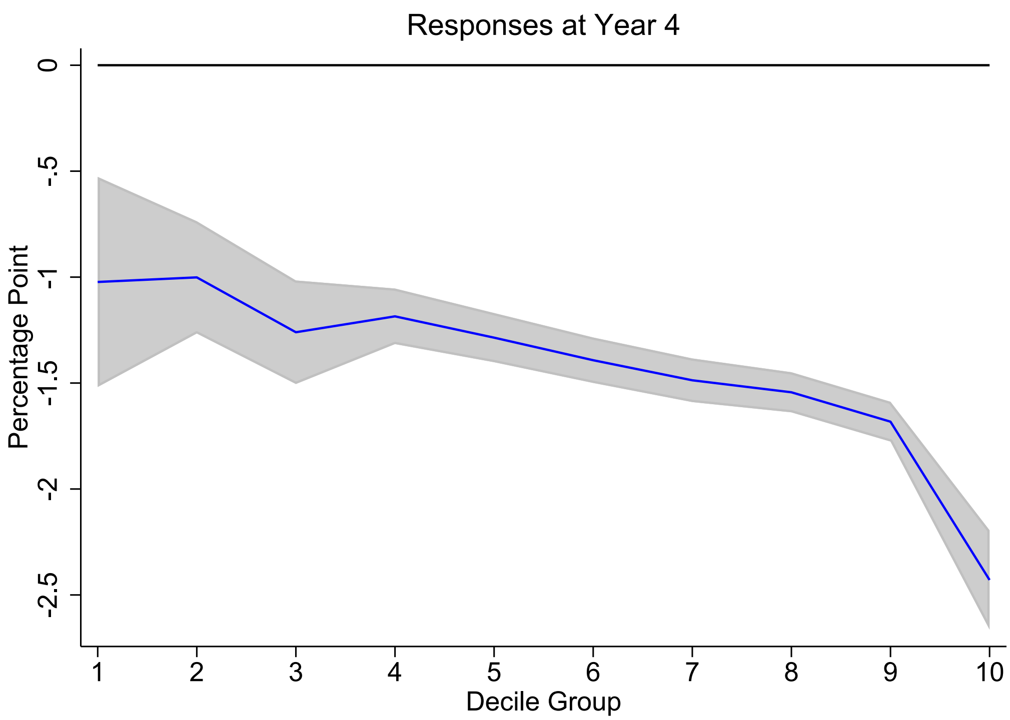


Figure 10: IRF of 1-pp MP tightening shock by major income source, Year 1

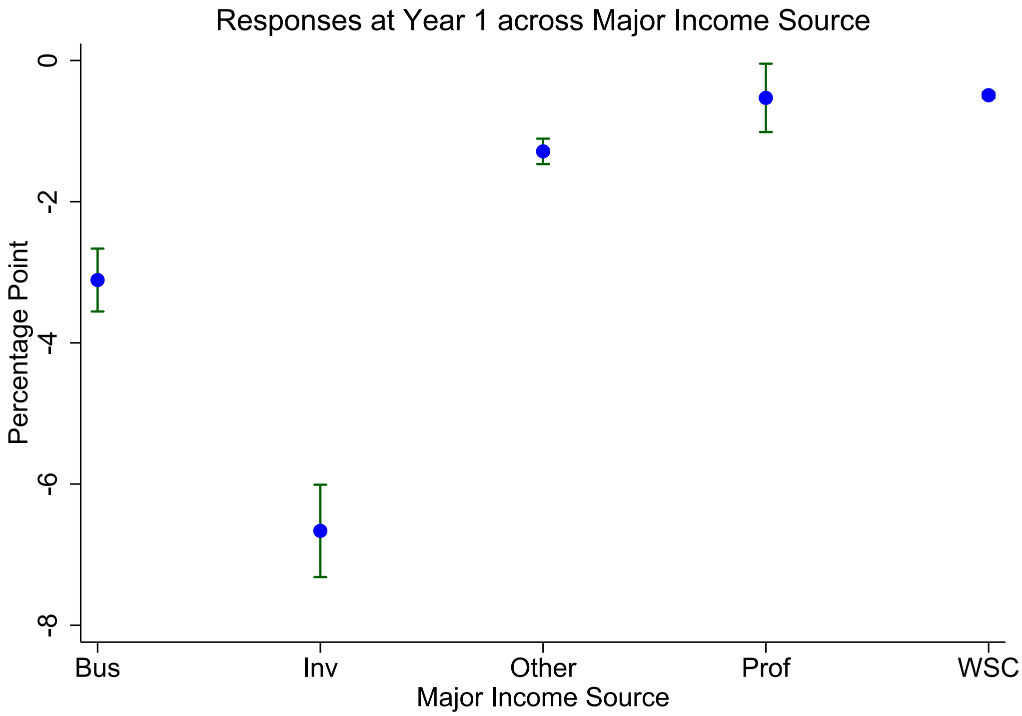


Figure 11: IRF of 1-pp MP tightening shock by major income source, Year 4

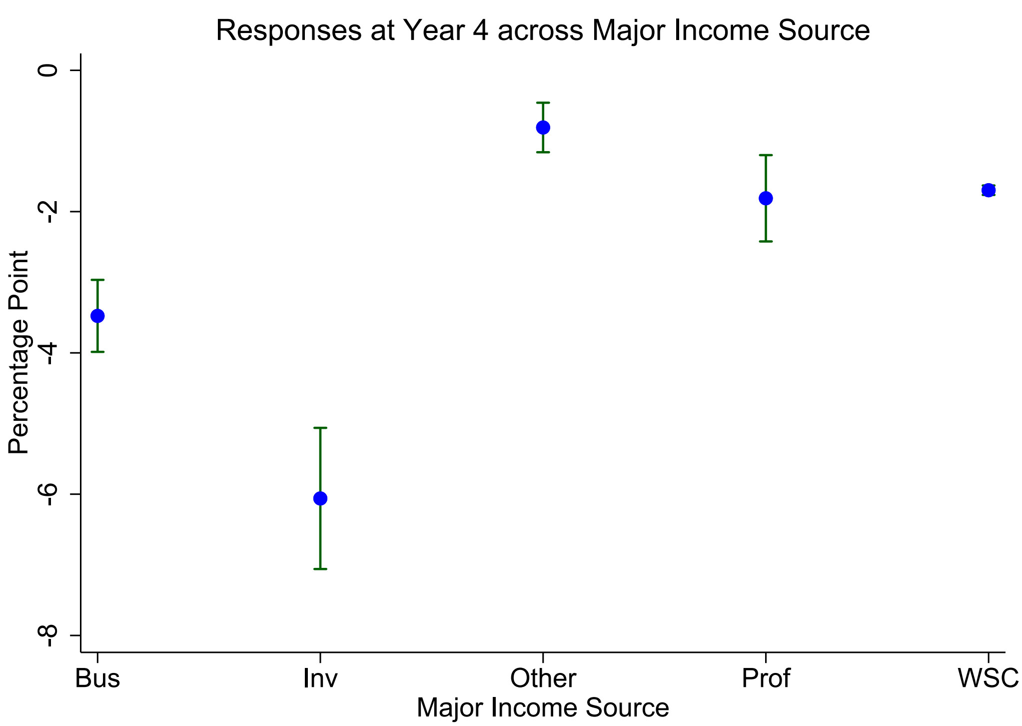


Figure 12: IRF of 1-pp MP tightening shock by major income source for the bottom and top decile, Year 1

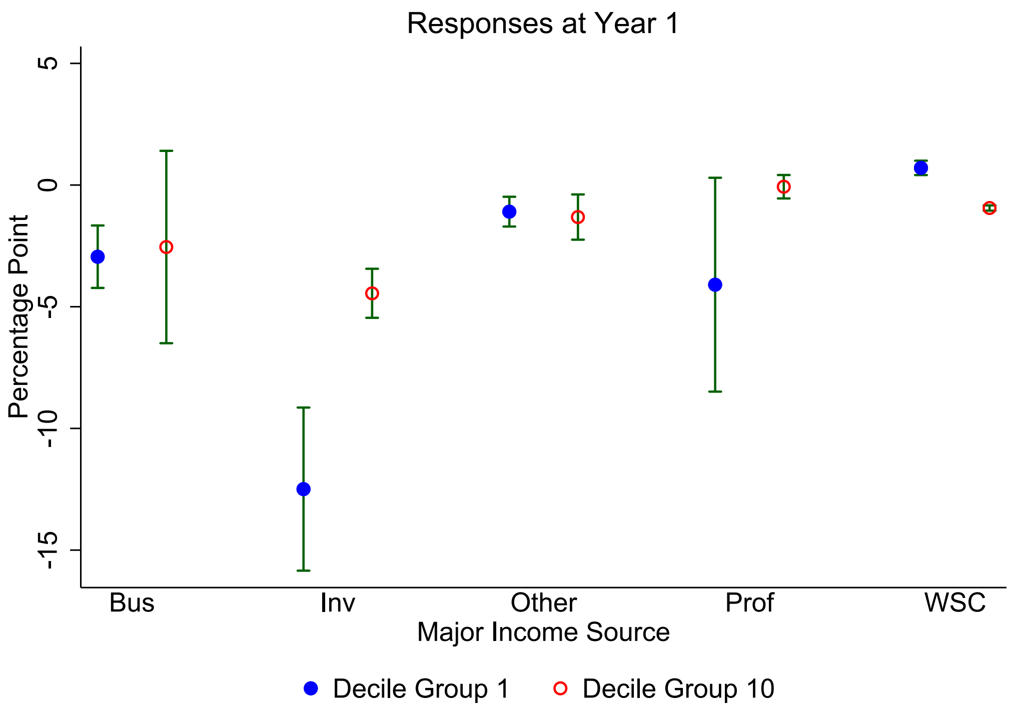


Figure 13: IRF of 1-pp MP tightening shock by major income source for the bottom and top decile, Year 4

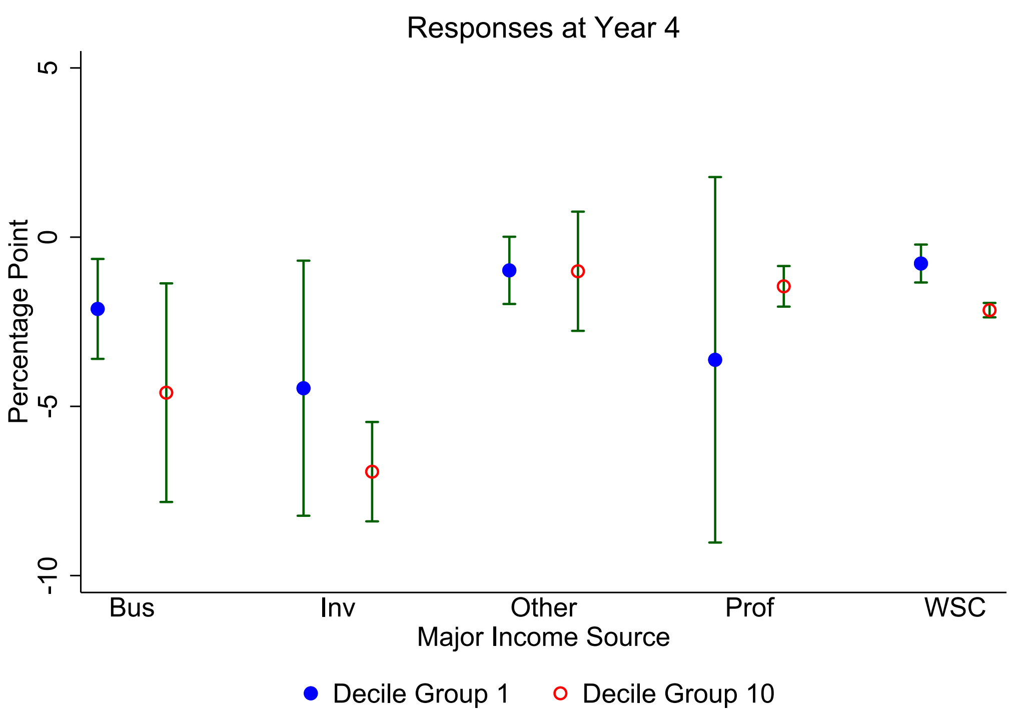
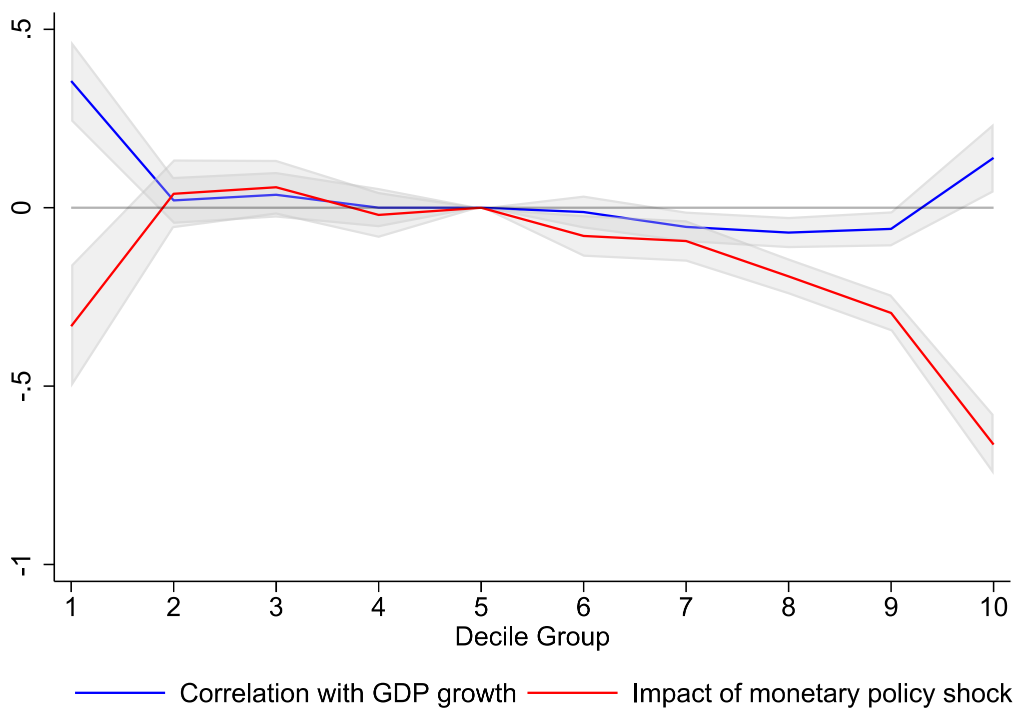


Figure 14: Comparison of the income-GDP growth correlation and the impact of monetary policy, relative to the fifth decile group



Appendix

A Tax data

Statistics Canada provides the following information regarding the Longitudinal Administrative Databank (LAD). LAD is a subset of the T1 Family File (T1FF). The T1FF is a yearly cross-sectional file of all taxfilers and their families. Census families are created from information provided annually to the Canada Revenue Agency in personal income tax returns. Both legal and common law spouses are attached by the spousal Social Insurance Number (SIN) listed on the tax form, or by matching based on name, address, age, sex, and marital status. Children are identified through a similar algorithm and supplementary files. Prior to 1993, non-filing children were identified from information on their parents' tax form. Information from the Family Allowance Program was used to assist in the identification of children. Since 1993, information from the Child Tax Benefit Program has been used for this purpose.

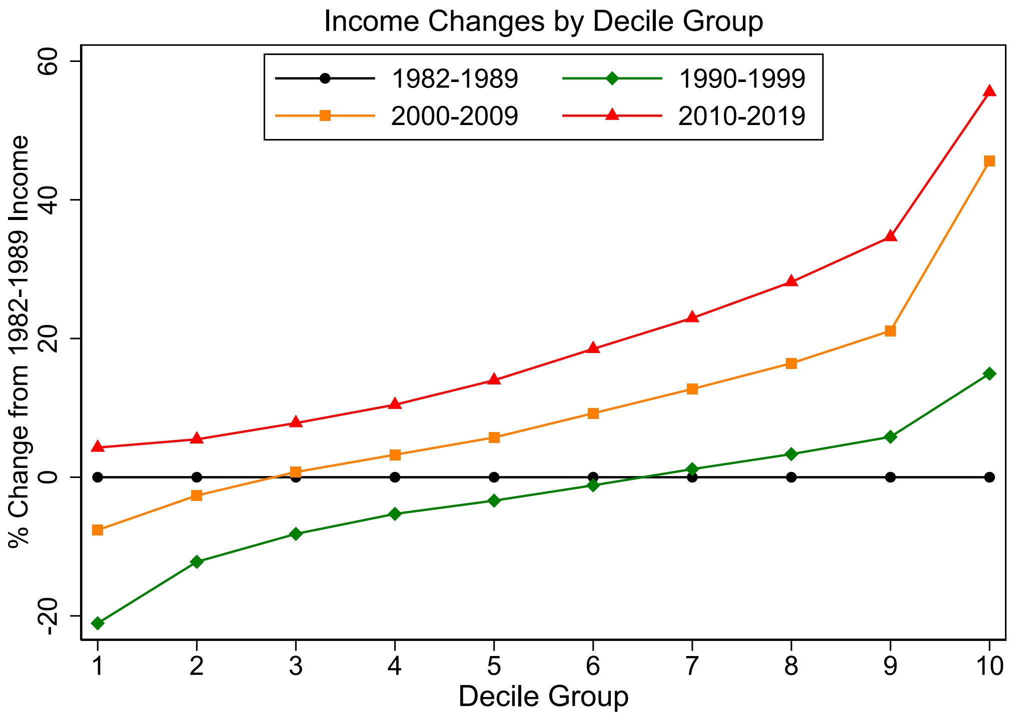
The LAD is a random, 20% sample of the T1FF. Selection for LAD is based on an individual's SIN. There is no age restriction, but people without a SIN can only be included in the family component. Once a person is selected for the LAD, the individual remains in the sample and is picked up each year from the T1FF if he or she appears on the T1 that year. Individuals selected for the LAD are linked across years by a unique LAD identification number generated from the SIN, to create a longitudinal profile of each individual. The LAD is augmented each year with a sample of new taxfilers so that it consists of approximately 20% of taxfilers for every year. The 20% sample has grown over the years: 3.2 million people in 1982, 4.05 million in 1992, 4.7 million in 2002 and 5.3 million in 2012. This growth reflects increases in the Canadian population and increases in the incidence of tax filing as a result of the introduction of the Federal sales tax credit in 1986 and the Goods and Services Tax credit in 1989.

The LAD is organized into four levels of aggregation, namely the individual, spouse/parent, family, and child levels. The databank contains information on demographics, income, and other taxation data at the different levels of aggregation from 1982-2019, with new years of data being added as the information becomes available. Changes in tax legislation and in the design of the T1 form itself have resulted in some variables not being available for all years as well as some minor definitional changes from one year to the next. The LAD also obtains information through microdata linkages to other administrative data sources including Tax Free Savings Account (TFSA) information, private corporation ownership information from Schedule 50 of the T2 tax form, and immigration information from the Landing file administrative data. In addition, a linking key resides on the Longitudinal Immigration Database (IMDB) – a database containing immigration records from 1980 to present – which allows for research to be conducted using a linked IMDB-LAD database. All microdata linkages have been approved by the relevant Statistics Canada management and privacy bodies. Further information is available at http://www.statcan.gc.ca. The LAD has been designed to serve as a research tool from which custom tabulations can be prepared. This dictionary, in turn, has been created to assist researchers in identifying the type of information that is available from the LAD. It identifies and defines the LAD variables including historical changes.

B Additional facts about income inequality

Figure A1 displays the relative changes in market income over the last four decades by household income decile, where the income of each decile is normalized to be zero for the period over 1982-1989. The 1990s was particularly a bad period for the majority of tax filers with households in the 6th decile and below on average lowered their income relative to those in the 1980s. Bowlus et al. (2022) show that labour earnings of the low-income young in particular were hit adversely in the early-1990s recession. This observation is also consistent with that of the lifetime earnings in the United States where Guvenen et al. (2022) find that

Figure A1: Reletive income changes over four decades



lifetime earnings of the median male worker declined for the cohort who started working in 1983 relative to those of the cohort who started in 1967. Stagnant middle-class income over the last several decades is a common observation among countries of the Organisation for Economic Cooperation and Development (OECD (2018)). Moreover, Zhang and Chung (2016) document that income mobility across income groups has also worsened, suggesting that inequality has become more persistent over time.

In addition, the positive slope of the curve for the 1990s in Figure A1 indicates that the inequality increased relative to the 1980s. Over the next two decades, income of all deciles increased with the highest income group steeply gaining the most. Although the Gini coefficient does not capture well the inequality driven by the tails, Figure A1 suggests that the high-income households were still pulling their income higher and away from the rest over the last two decades.

Table A1: Estimation results of Equation (1) for the mean and variance without winsorizing

	Mean	Variance
GDP growth	1.069***	932.6**
	(0.243)	(428.5)
Year	0.0931**	124.1
	(0.0424)	(87.16)
Constant	-178.6**	-240,449
	(84.93)	(174,378)
Observations	37	37

Note: Newey-West standard errors in parentheses (maximum lag length: 3). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

C Impact of income-growth outliers

This section discusses the impact of income-growth outliers in the estimation of the correlation between income-growth distribution moments and GDP growth. The estimation results presented in Table 1 in Section 3.1 used the income-growth data after winsorizing at 1% and 99%. Winsorization could impact the correlation between income-growth distribution moments and GDP growth. Table A1 presents the estimation results of Equation (1) for the mean and variance. Note that winsorization at 1% and 99% does not impact Kelley skewness since Kelley skewness only depends on the 10th, 50th and 90th percentiles of the distribution.

Comparing Table 1 and A1 reveals that the estimates regarding the mean of the income-growth distribution on GDP growth are not that different with both point estimates around 1 (1.009 and 1.069, respectively) and both highly significant. In contrast, those of the variance differ greatly with the point estimate at 66.45 and 932.6, respectively and both weakly significant. Hence, the outliers do impact the correlation of the variance of income growth with GDP growth, but not other two moments. However, regardless of the outliers, the finding that the variance of income-growth distribution is weakly pro-cyclical remains.