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The impact of the monetary policy on economic inequality in Canada

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Abstract

In this paper, income, earnings, and consumption inequality in Canada are measured using two distinct types of inequality measures. Subsequently, I examine the effect of contractionary monetary policy on income and earnings inequality. First, I collect data on Canadian families' income and earnings from the Survey of Consumer Finance and the Survey of Labor and Income Dynamics from 1982 to 2011. I collect data on Canadians' consumption from the Survey of Family Expenditure and the Survey of Household Spending from 1982 to 2009. I conduct a measurement to develop a historical measure of income, earnings, and consumption inequality, and the results indicate that consumption and income inequality have increased slightly in Canada. However, the findings indicate that between 1982 and 2011, earnings inequality has increased significantly. I convert the inequality data from annual to quarterly frequency using Denton's (1971) methodology. Lastly, I examine the effect of a monetary policy contraction on income and earnings inequality. I estimate the effect of the monetary policy shock using the Proxy-SVAR method and verify the result using an alternative approach with the Cholesky decomposition. I find that contractionary monetary policy reduces income and earnings inequality in the short run. I examine several transmission channels and conclude that contractionary monetary policy reduces inequality via the income composition and portfolio channels but increases inequality via the saving redistribution channel.

Keywords: economic inequality, contractionary monetary policy, proxy variable, earnings, income, shock

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I. Introduction

Economic inequality exists as a result of disparities in the living standards of individuals, families, households, regions, and nations. While there are numerous definitions of living standards, the most common one is that it refers to the amount of income, wealth, and expenditure available to individuals, families, and households in society. The most frequently used method for examining economic inequality is to compare the wages, income, wealth, and consumption of families within specific regions (in this case, Canada) over time (in this research, from 1982-2011). For several decades, Canada has seen an increase in economic inequality. For instance, the 2013 Conference Board of Canada reports that income inequality has been increasing in Canada since 1980, with wealthy individuals getting richer and poor individuals getting poorer. A study by Brzozowski et al. (2009) reports that income, consumption, and wealth inequality have increased in Canada between 1980 to 2009.

Increased economic inequality is viewed as a serious problem because several studies have demonstrated that increased economic inequality results in slower economic growth, lower educational attainment, and increased criminal activity among individuals, particularly the poor (Dabbla-Norris et al.,2015; Cingano, 2014). Despite increased welfare programs and policies, economic inequality has increased in Canada and other countries over the last few decades. Many studies have revealed various causes that can explain the rise in inequality. For instance, a study by S. Breau (2015) summarizes these causes into three broad factors that can explain the rise in economic inequality: (i) local labour market and economic conditions, which refer to the conditions of the demand and supply of workers and includes skill-biased technological change and increasing need for skilled workers; (ii) the socio-demographic characteristics, including age, gender, education, and geographic situation; (iii) institutional factors, which explain how fiscal and monetary policy transmissions affect inequality.

The focus of this paper is to investigate the impact of monetary policy on inequality. Following the recession of 2009, researchers began examining the relationship between monetary policy and inequality. The primary goal of monetary policy, according to central banks, is to maintain the monetary value by ensuring low, stable, and predictable inflation. This boosts household confidence in purchasing and investing, encouraging longer-term investment in the economy, and resulting in long-term job growth and increased productivity. In addition, monetary policy can influence inequality; for example, a decrease in the interest rate promotes job growth, which benefits individuals to obtain jobs, and therefore inequality decreases. At the same time, decreases in the interest rate favour an increase in asset values, which will increase inequality since wealthy individuals are likely to own assets. Recent empirical evidence indicates that monetary policy influences inequality, and the findings show conflicting results (Coibion et al.,2012; Davtyan, 2017;

Kronick and Villarreal;2020). Furthermore, there are several channels through which monetary policy influences economic inequality in various ways.

A survey written by Colciago et al. (2019) points out that monetary policy is transmitted to households or families by exerting three effects. The first one is the income effect. Monetary policy directly impacts interest rates received by savers and paid on loans by borrowers. The second is the wealth effect, where monetary policy impacts the values of assets such as bonds, equity, and real estate. The third is the substitution effect, where a shift in interest rates influences the intertemporal consumption-saving option of households from real interest rate changes. Colciago et al. (2019) continue to mention that the interaction of these effects creates transmission channels that affect inequality. These channels depend on how households are distributed and associated with the type of income source, and the overall effect of monetary policy via these channels could either decrease or increase inequality. Coibion et al. (2012) and Amaral (2017) outline several channels through which monetary policy affects inequality, and existing empirical studies attempt to assess their relevance and find conflicting results. I briefly review these channels in detail below.

First, the income composition channel describes how households get their income from different sources, each of which may react differently to monetary policy changes. The lower class is more dependent on government transfers, while the middle class is more reliant on wages and salaries, and the upper class is more reliant on investment and business. According to Mumtaz and Theophilopoulou (2016), contractionary monetary policy increases income inequality through this channel. The financial segmentation channel implies that because people with higher income and wealth are more connected to financial markets, increases in the money supply will generate extra income for them, at least in the short term. As a result, individuals active in the market would benefit from expansionary monetary policy. Income inequality can rise as a result of this channel. The portfolio composition channel occurs when the size and composition of assets vary across households. Higher-income households will benefit most from an expansionary monetary policy that raises asset prices if they retain a larger share of their wealth in assets. Saiki and Frost (2014) show that expansionary monetary policy leads to increased income inequality through the portfolio channel. The earnings heterogeneity channel describes how monetary policy shifts have different impacts on individual labour earnings. For example, Heathcote et al. (2010) show that labour earnings at the bottom of the distribution are most susceptible to changes in the business cycle, resulting in greater fluctuations in working hours and employment than at the top of the distribution. As a result, it predicts that a monetary expansion that reduces unemployment also reduces income inequality. Inui et al. (2017) show that contractionary monetary policy via earning heterogeneity increases income inequality. Finally, the savings redistribution channel is when an increase in unexpected inflation lowers nominal assets

and liabilities' real value, making borrowers better off at the lenders' expense. The real value of nominal debts decreases. The effect on inequality depends on the way those assets and their different maturities are distributed across households. This channel implies that contractionary monetary policy is likely to increase inequality (Nakajima, 2015).

The purpose of this paper is to examine the effect of Canada's contractionary monetary policy on income and earnings inequality. The findings of this study are compared to previous empirical research that utilized data from Canada, the United States, and other countries. To begin, the analysis employs two distinct methods for determining income, earnings, and consumption inequality in Canada. I look at how inequality has changed between the period of 1982 and 2011. The inequality measures are constructed using data from the FAMEX: Survey of Family Expenditure, the SHS: Survey of Household Spending, the SCF: Survey of Consumer Finance, and the SLID: Survey of Labour and Income Dynamics. Second, this paper examines the impact of contractionary monetary policy shocks on Canada's income and earnings inequality from 1982 to 2011. Due to the absence of surveys from specific years, I cannot estimate the impact of monetary policy on consumption inequality.

I use a structural vector auto-regression model with the external instrument to examine monetary policy's impact on income and earnings inequality. The Champagne and Sekkel (2018) new monetary policy measure is used as the external instrument. This method was developed by Stock and Watson (2012) and Mertens and Ravn (2013). It assumes that there is a variable external to the VAR that serves as a proxy for the structural shock of interest. Specifically, the proxy variable is associated with the structural shock of interest and is not correlated with other structural shocks. In my robustness check, I use the Cholesky decomposition method to assess the effect of contractionary monetary policy on income and earnings inequality. With both identification approaches, my results show that contractionary monetary policy significantly reduces earnings inequality. Lastly, I analyze some transmission channels through which monetary policy affects income inequality. My findings indicate that income composition and portfolio channels may have a greater influence than saving redistribution channels. The findings of this paper suggest that monetary policymakers should be concerned about economic inequality, as policy does have an effect on inequality.

The remainder of the thesis is organized as follows. Section II describes the literature that has been done in Canada and the rest of the world. Section III presents data sources and discusses the methodology. Section IV presents and discusses the results, and section V concludes.

II. Literature Review

Empirical evidence suggests that the effect of monetary policy on inequality is priori ambiguous due to distinction between the effects of systematic and discretionary changes in monetary policy. While some studies show that contractionary monetary policy increases inequalities in countries (Mumtaz and Theophilopoulou, 2016; Coibion et al., 2012; Furceri et al., 2018), other research shows that monetary policy's tightening reduces inequality (Villareal 2014; Bivens 2015; Kronick and Villarreal 2020). The reason for rising inequality when monetary policy is tightened depends on whether there is an unexpected increase in the unemployment rate. According to Furceri et al. (2018), it also depends on the labor share of income and the degree of policy redistribution. Other studies show that expansionary monetary policy reduces inequalities (Meh et al., 2010, O'Farrell et al., 2016; Guerello, 2018; Samarina and Nguyen, 2018), while still some studies show the opposite effect (Cloyne et al. 2016; Inui et al. 2017).

Looking at the empirical work that used Canadian data to examine the impact of monetary policy, the first paper to mention Canada was a study by O'Farrell et al. (2016). Their research focuses not only on Canada but also on seven other OECD countries. The authors assess the impact of monetary policy on income inequality through financial channels. For Canada, their results indicate that a lower percentage of the interest rate works through financial assets and debt services to reduce inequalities. Furceri et al. (2018) include Canada in their study of 32-panel countries using SWID data from 1990 to 2013. They use the local projection method and find that a restrictive monetary policy increases income inequality significantly. In addition, the authors show that monetary policy's impact is asymmetric, with the contractionary effect being larger than the expansionary effect.

Kronick and Villarreal (2020) evaluate the relationship between monetary policy, inequality, and inflation in Canada. They begin by examining how income inequality has changed over time from 1992 to 2015 and how the marginal propensity of each income group varies. Kronick and Villarreal (2020) calculate income inequality and the marginal consumption propensity for each income category using data from labour force surveys. Their result shows that the upper class has a lower marginal propensity to consume than the lower class. Furthermore, since the Bank of Canada began targeting inflation in 1991 and kept inflation stabilized following the Great Financial crisis, income inequality has increased. They estimate the effect of a monetary policy shock using the local projection method and the narrative measure of Champagne and Sekkel (2018) as a true monetary policy shock. Their findings imply that an expansionary monetary policy shock increased income inequality, while a contractionary monetary policy shock had the opposite effect. The impact of an expansionary monetary policy shock was greater than the impact of a contractionary monetary policy shock.

The United States and other countries also have extensive empirical research on the impact of monetary policies on inequality. Early studies have investigated the causal link between inflation and economic inequality. They conclude that inflation has a significant impact on inequality (Romer and Romer, 1999; Bulir, 2001). Recent studies have focused on analyzing the distributional effect of monetary policy on inequality. Perhaps the most well-known paper is the Coibion et al. (2012) study, which uses U.S. quarterly consumer spending data and builds a measure of inequality between 1980 and 2008. In the study, the narrative identification method of Romer and Romer (2004) is used to identify shocks and the local projection method is used to estimate impulse responses. Their findings show that there is a persistent increase in inequality following a contractionary monetary policy shock. Coibion et al. (2012) examine the composition of income and the earning heterogeneity channels and conclude that, following a contractionary monetary policy shock on different percentiles of labour earning and total income distributions, earnings at the upper end of the distribution increase while earnings at the bottom of the distribution decrease. To avoid outliers, their analysis excluded the top and bottom 1%.

However, Davtyan (2017) uses inequality measures representing the entire income distribution, even the top 1% and draws different conclusions. Davtyan (2017) identifies monetary policy shocks using the contemporaneous exclusion restrictions and vector error correction model (VECM) framework. The paper shows that a contractionary monetary policy shock leads to a decline in inequality, which is different from Coibion et al.'s (2012). Davtyan (2017) attributes the difference to including the top 1% income. Other studies confirm the results of Coibion et al. (2012), such as the Aye et al. (2019), which uses quarterly U.S. data and estimates an impulse response using the local projection method.

Mumtaz and Theophilopoulou (2017) build income and consumption inequality measures using quarterly data from the United Kingdom. They estimate structural VAR and FAVAR (factor augmented vector autoregressive) models and find that a monetary policy contraction increases their measures of inequality. Low-consumption and low-income households are harmed more by the contractionary policy than those at the top of the distribution. Their analysis also shows that monetary policy impacts inequality via the income composition channel and the earning heterogeneity channel.

Moreover, other studies investigate how an expansionary monetary policy shock impacts inequality. Inui et al. (2017) use microeconomic data on households in Japan to study how monetary policy shocks are transmitted to inequality. Inui et al. (2017) construct income and consumption inequality measures using quarterly data from 1981 to 1998, and the local projection method to estimate impulse responses. Their results reveal that after the expansionary monetary policy shock, there is an increase in income inequality through the earning heterogeneity channel. Their findings suggest that the portfolio channel and the channel of redistribution of savings cannot explain the distributional effect of monetary policy on inequality.

Samarina and Nguyen (2018) find a contradictory result when examining the effects of expansionary monetary policy on income inequality in 10-euro countries from 1999-2014. Samarina and Nguyen (2018) observe that expansionary monetary policy leads to a decrease in inequality and analyze the distributional effect via macroeconomic and financial channels. Their findings indicate that the impact of monetary policy on income inequality is mainly distributed through income heterogeneity channels. Other research in euro countries reveals that expansionary monetary policy reduces inequality (Guerello, 2018; O'Farrell et al., 2016).

My methodological approach is most related to the empirical work by Albert, Peñalver and Perez-Bernabeu (2020), which examines the effect of monetary policy on wealth and income inequality in the United States using data from 1982 to 2012, and then evaluates the different transmission channels discussed in the introduction, as well as through additional housing and tax channels. Albert, Peñalver and Perez-Bernabeu (2020) use a proxy structural Bayesian vector autoregression to identify their monetary policy shock. Their findings indicate no statistically significant response to income inequality after an expansionary monetary policy shock. However, they find that expansionary monetary policy tends to increase wealth inequality. When assessing transmission channels, their results suggest that expansionary monetary policy could reduce income inequality through earning heterogeneity, savings redistribution channels, and tax and housing channels.

So far, I have only mentioned the impact of conventional monetary policy on inequality. After the 2008 financial crisis, several researchers examined how unconventional monetary policy impacted inequality. For instance, it is also possible that unconventional monetary policy may have the same redistributive effect as conventional monetary policy. Saiki and Frost (2014) are the first researchers to examine the effect of unconventional monetary policy (UMP) on income inequality. Their study employs Japanese quarterly data from 2008 to 2014 to estimate a VAR. Their results show that expansionary UMP increases income inequality through portfolio channels; when asset prices rise, the rich benefit from it since they own most of the assets. Mumtaz and Theophilopoulou (2016), for the second part of their research for the U.K., examine the effect of quantitative easing on inequality and find that UMP leads to an increase in inequality through the income composition channel. For the United States, Montecino and Epstein (2015) find the same result that quantitative easing increases income inequality through earnings heterogeneity and income composition channels. Guerello (2018) uses a panel VAR to estimate the UMP's impact on inequality in the eurozone and shows that UMP leads to an increase in inequality. Bivens (2015) finds the opposite result for quantitative easing on U.S. data, and suggests that quantitative easing reduces inequality through earnings heterogeneity by increasing employment and real wages. Casiraghi et al. (2018) use Italian data to assess the use of quantitative easing and conclude that quantitative easing reduces inequality, particularly

among the lower classes. Inui et al. (2017) conclude that quantitative easing does not significantly affect inequality in Japan.

In conclusion, all these studies demonstrate that the effect of monetary policy on inequality remains unclear, as it has the potential to either decrease or increase economic inequality. Therefore, I use the Proxy -SVAR approach in my analysis to examine the impact of monetary policy on income and earnings inequality in Canada, as this approach has not been applied to Canadian data. Numerous studies utilizing this approach indicate that it reduces estimation bias due to measurement errors and, in general, has favourable empirical properties (Noh, 2018; Lunsford, 2015).

III. Data sources and Methodology

3.1. Data sources

3.1.1. Income data

The income data come from the following public-use microdata file sources: Survey of Consumer Finances (SCF) 1982-1997 and the Survey of Labour and Income Dynamics (SLID) 1998-2011. SCF aims to provide annual cross-sectional income and work experiences of individuals, families, and households in Canada. This survey's target populations are individuals and families who live in 10 provinces of Canada of age 15 years and older. It excludes individuals who live in the territories and reserves and full-time members of the Canadian forces. Since 1985 SCF was carried out as the supplement of the Labour Force Survey (LFS). The sample of 30,000 to 35,000 households is taken through two consecutive selection stages. This selection method is called two-stage sampling. Since a multi-stage, stratified, clustered sample design was used, standard error estimates are based on the normal sample design. The sampling weight obtained from this survey should be treated as only approximate. The reliability of the survey's estimates depends in part on the quality of independent population estimates used to determine the weights. In January of 1995, the LFS introduced a new sample design and a modified weighting system (Statistics Canada, 2020)

SLID was introduced in 1993 and shares several similar features with SCF. SLID also offers annual cross-section estimates that use LFS as a sampling frame. It has the same target population. Moreover, the sampling weights are adjusted for non-response to ensure population counts and not adjusted for income response bias. In comparison to SCF, SLID is designed for panel analysis. Panels have been interviewed for up to 6 years, with new panels being added every three years. The first panel was in 1993, and the last

panel was in 2004. Each year, a panel is interviewed in January to obtain labour statistics and obtain income information in May. In the income questionnaire, individuals can consent to Statistics Canada to connect to their tax files from Canada Revenue to obtain their income records; more than 80 % of individuals offer permission to do so.

Another distinction between the SLID and the SCF is the formation of the family. In the SCF, the family stems from the head of the family, which gives priority to the husband. It includes the primary beneficiary of income in SLID. Sample surveys must, of course, discuss sampling error and non-sampling uncertainty. The SCF response rate is usually about 80 percent, although the SLID response rate is greater than 80 percent.

I construct income panel data from 1982 to 2011 using SCF data from 1982 to 1997 and SLID data from 1998 to 2011. I use the family level as the accounting unit. I use data for SCF from 1993 to 1997 instead of SLID because SCF data gives more details about the family's income source, even though both surveys' income distribution is similar.

I include the following variables in my constructed income data. First, family size is used to apply root scale for adjustment of family size, since any papers that use family level or household level as an accounting unit always adjust total income to account for the family or household composition difference (for example, in Coibion et al.2012; Sarlo et al., 2015; Sarlo, 2016). Wages and salaries are gross cash wages and salaries earned during the reference year from all the works before deductions for pension plans, hospital benefits, taxes, Canada Savings Bonds, etc. This variable also includes tips for employees such as waiters and porters, farm workers' wages, cleaning women, newspaper boys and babysitters, as well as net commissions (gross commissions less expenses) of a salesperson who worked for only one business at a time and did not pay for his/her own office and employees; the wages and salaries variable is always positive (Statistics Canada, 2020).

Total income from self-employment gives the sum of amounts reported by all individuals in the family based on various types of self-employment activities. Self-employment income is defined as income received as a result of being a partner in or sole owner of an unincorporated business or professional practice. Only the individual's share of net income is included in the case of partnerships. This variable may be positive, indicating a business profit, or negative, indicating a loss (Statistics Canada, 2020).

Total earnings include the wages and salaries from employment and the earnings from self-employment. Total income from investment includes the sum of amounts reported by all individuals in the family on account of investment income. This source of income includes interest received on bonds, deposits, and savings certificates from Canadian or foreign sources, dividends received from Canadian and foreign

corporate stocks, cash dividends received from insurance policies, net rental income from real estate and farms, interest received on loans and mortgages, regular income from an estate or trust fund and other investment income. It may be positive or negative.

Total government transfer payment provides the sum of amounts received by all individuals on account of Child Tax Benefit, Old Age Security, Guaranteed Income Supplement, and Spouses Allowance, Canada/Quebec Pension Plan benefits, Employment Insurance, Social Assistance and Provincial Income Supplements and Other Income from Government Sources.

Total income before taxes is the sum of receipts from Total Earnings, Total Investment Income, Total Government Transfer Payments, Retirement Pensions, Superannuation and Annuities, and Other Money Income before tax deductions. It may be positive, negative or zero.

Total income after tax includes total income after tax deductions.

For my sample constraint, I took the sample design as given, but I removed from my sample the respondents whose income component and wages are less than zero. The original dataset was 999,344, and after dropping the non-positive income values (35,495), the sample size is 949,849.

3.1.2. Consumption data

Consumption data were taken from the Survey of Family Expenditure (FAMEX) and the Survey of Household Spending (SHS). FAMEX is the cross-sectional data collected occasionally between 1969 to 1996 on the individuals and household components. In 1997, SHS replaced the FAMEX, and since then, this survey has been carried out annually, and it is a cross-sectional survey. The target population of both surveys is the residents of Canada living in the ten provinces, and for some years, it includes the population living in the territories. The FAMEX was a multi-stage stratified clustered sample selected from the Labour Force Survey sampling frame. The survey is carried out through interviews in February and March, referring to the previous year. The response rate of this survey varies between 60-70%. The weighting factors represent the difference in sampling and response rates between geographic areas and spending units. SHS has the same purpose as FAMEX to collect information on the amount of food, clothes, shelter, transportation, and health care to understand Canadian household spending behaviours. The assembled data come from a survey of FAMEX: 1982,1984,1986, 1990, 1992, 1996 and SHS from 1997 to 2009. 2009 was the last time that Statistics Canada provided public micro-data for use in research. Due to data limitations and changes in the Canadian survey, it is not easy to decide which variables to include for consumption. I use the total current consumption; it includes expenditures on food, shelter, household operation, household furnishings and equipment, clothing, transportation, health care, personal care, recreation, reading materials

and other printed matter, education, tobacco products and alcoholic beverages, and miscellaneous expenses (Statistics Canada, 2020).

In addition, I use the total expenditure variable, which includes all components in current consumption plus personal taxes, security, gifts, and contributions. My original sample size was 243,406, but after removing values less than $1,000, my sample size is 243,324.

3.1.3. Macroeconomic and Proxy Variables

The identified narrative monetary policy shocks are taken from Champagne and Sekkel (2018), which I use as a proxy variable. To calculate this monetary policy measure, they follow Romer and Romer (2004)'s approach by estimating the expected series of changes in the policy rate, forecasts from the Bank of Canada's staff economic projections from 1974 to 2015, and real-time data. The equation they use to calculate this measure of monetary policy is:

$$\Delta i_m = \alpha + \beta_1 i_{t-d14} + \sum_{h=1}^{3} \rho_h u_{t-h} + \sum_{j=-1}^{2} \gamma_t \hat{y}^f_{m,j} + \sum_{j=-1}^{2} \delta_j \pi^f_{m,j} + \sum_{j=-1}^{2} \theta_j \left(\hat{y}^f_{m,j} - \hat{y}^f_{m-1,j}\right) + \sum_{j=1}^{2} \emptyset_j \left(\pi^f_{m,j} - \pi^f_{m-1,j}\right) + \beta_2 FFR_{t-d14} + \beta_3 ER_{t-d14} + \beta_4 \Delta FFR_{m-m-1} + \beta_5 \Delta ER_{m-m-1} + \varepsilon_m$$

where Δi_m represents their monetary policy instrument, measured at a meeting-by-meeting frequency for m. The subscript j denotes the quarter of the real-time data, while $t-h$ and $t-d14$ refer to information from the previous months and two weeks relative to the meeting date, respectively. $\hat{y}^f_{m,j}$ represents forecast of real GDP growth, $\pi^f_{m,j}$ is forecast of inflation and u_{t-h} is the rate of unemployment for the previous three months. They control for the federal fund rate of the U.S. (FFR), the exchange rate between Canada and U.S. (E.R.) and ε_m is the monetary policy shock. Additionally, they include forecast revisions made in relation to the previous round of forecasts. The series of the calculated monetary policy shock is monthly. I build the series of quarterly shocks by taking the sum of the shock occurring after three months.

The macroeconomic variables that I use in the benchmark model and the robustness check come from Statistics Canada and the Federal Reserve Economy database (FRED). Quarterly Gross Domestic Product (GDP) at current prices comes from FRED, and it is seasonally adjusted. The consumer price index of all items (CPI) in CANSIM v41690973. The bank rate is from Champagne and Sekkel (2018). The data for the unemployment rate and the industrial production index comes from FRED. More details are given in the appendix about variable transformations.

Other variables that I use to evaluate the transmission channels come from Statistics Canada and the Bank of Canada, and the sample covers 1982Q1 to 2011Q4. To evaluate the saving redistribution channel, I include the 10 years bonds yield from the Bank of Canada from CANSIM V122543. For the portfolio channel, I use the Toronto stock exchange composite index from CANSIM V122618; see the appendix for more details about transformations and scale.

3.2. Methodology

3.2.1. Model Specification

The model used for this paper follows the Structural Vector Autoregression (SVAR) proposed by Sims (1980), which can be written in the following way.

(1) $$Ay_t = \sum_{j=1}^{p} \alpha_j y_{t-j} + \mu_t$$

Y_t is $nx1$ vectors of economic variables and inequality measures. A is a nxn nonsingular matrix of the coefficients, $\alpha_j,\ j = 1, \dots, p$ are nxn coefficients matrices, μ_t is $nx1$ vector of structural shocks.

With $E[\mu_t] = 0$, $E\ [\mu_t\ \mu_t'] = I$, $E\ [\mu_t\ \mu_s'] = 0$ for s different from t

Multiplying each side by A^{-1} gives the reduced form of the vector autoregression (VAR)

(2) $$y_t = \sum_{j=1}^{p} \delta_j y_{t-j} + \varepsilon_t$$

Where $\varepsilon_t = A^{-1}\mu_t$ and $\delta_j = A^{-1}\alpha_j$ and using $A^{-1} = B$, the vector of structural shock is written as:

(3) $$\varepsilon_t = B\mu_t$$

The covariance matrix of the reduced form shock ε_t is:

(4) $$E[\varepsilon_t \varepsilon_t'] = [BB'] = \sum$$

3.2.2. Identification

The goal is to find the covariance matrix of ε_t containing $\frac{n(n+1)}{2}$ independent elements to find the column of B that corresponds to the structural shock of interest. Different approaches can be used to identify these elements. One popular approach is recursive ordering. This approach imposes the relationship between μ_t and ε_t by restricting the matrix B to be lower triangular. It is achieved by applying the Cholesky

decomposition; I will use this approach as a robustness check. The second popular approach is the long-run restriction developed by Blanchard and Quah (1989). It consists of imposing restrictions on the long-run effects of shocks implied by the theory. The third popular approach developed by Uhlig (1997) consists of imposing sign restrictions on the response variables. There are other approaches to identifying the shock (for example, higher frequency identification, factor augmented VAR).

In this study, I use a different approach to identify the monetary policy shock. The approach was developed by Stock and Watson (2012) and Mertens and Ravn (2013). This method assumes that there is a variable external to the VAR that serves as a proxy for the structural shock of interest. Specifically, the proxy variable is associated with the structural shock of interest and is not correlated with other structural shocks. This proxy variable method will calculate the element of B without imposing any restriction on the matrices. Various researchers who used this method state that this approach gives a better estimate than other identification approaches (Carriero et al. 2015; Gertler and Karadi, 2015)

Let $Z_t$be $kx1$ vector of proxy variables (instrument variables), which will be correlated to the structural shock of interest, in this case, the monetary policy shock. This instrument variable must be uncorrelated to other shocks. Therefore, consider the partition of the shock μ_t

(5) $$\mu_t=\begin{bmatrix}\mu_t^m\\ \mu_t^a\end{bmatrix}$$

Where μ_t^m is kx1 vector containing the monetary policy shock, which is the shock of interest, and $(n-k)\,x1$ vector μ_t^a provides all other shocks. For Z_t to be a valid proxy variable, it has to satisfy the following conditions.

(6) $E[Z_t\mu_t^{m\prime}]=\phi$ where ϕ is an unknown nonsingular kxk matrix

(7) $E[Z_t\ \mu_t^{a\prime}]=0$

A third condition states that the instrument variable needs to be uncorrelated with lagged dependent variables. Mertens and Ravn (2013) states that the third condition can be relaxed, and Z_t can still be a valid instrument. If the proxy is correlated with the lagged dependent variables, the proxy variable can be the error from the projected estimated proxy variable on lagged variables. In this study, the proxy is orthogonal to the lagged dependent variables.

The assumptions mentioned above can be translated to the restrictions on an element of B . Now, consider the partition of B .

(8) $B=[b^m\ b^a\ ]$

Where b^m is vector nxk and b^a is vector $nx(n-k)$.

These elements can be further partitioned by the structural shocks:

(9) $$B = [b^m\, b^a] = \begin{bmatrix} b_1^m & b_1^a \\ b_2^m & b_2^a \end{bmatrix}$$

Stock and Watson (2012) and Mertens and Ravn (2013) combine equations (3), (6) and (7) to have a valid instrument and get

(10) $$\phi b^{m\prime} = E[Z_t \varepsilon_t{}']$$

The equation (10) has the dimensions of kxn and provides only $(n-k)xk$ new identification restrictions; it also has the unknown ϕ with a dimension of kxk. The authors suggested to partition $E[Z_t\varepsilon_t'] = \left[E[Z_t\varepsilon_{1t}'] \; E[Z_t\varepsilon_{2t}']\right]$ So the restriction can be written as

(11) $$b_2^m = (E[Z_t\varepsilon_{1t}']^{-1}E[Z_t\, \varepsilon_{2t}'])b_1^m$$

The equation above was obtained from assumptions (6) which are:

(12) $$E[Z_t\; \mu_t{}'] \;=\; [\phi\; 0]$$

where 0 is vector $kx(n-k)$ of zeros. Then multiplying B in the equation (12) gives

(13) $$E[Z_t\mu_t{}']\, B' =\; [\phi\; 0]\, B'$$

which verifies the result found by Mertens and Ravn (2013) to be correct.

$$\phi b_1^{m\prime} = E[Z_t \varepsilon_t{}']$$

The authors conclude that these restrictions are a set of covariance restrictions because $(E[Z_t\varepsilon_{1t}']^{-1}E[Z_t\, \varepsilon_{2t}'])$ is known. The impulse responses to a monetary policy shock can thus be estimated. Mertens and Ravn (2013) suggest the following steps for estimation:

(i) Estimate the reduced form VAR using ordinary least-squares and keep the estimates of the VAR residuals ε_t.

(ii) Regress the estimates of the VAR residuals on the instrument Z_t to estimate $(E[Z_t\varepsilon_{1t}']^{-1}E[Z_t\, \varepsilon_{2t}'])$

(iii) Use $(E[Z_t\varepsilon_{1t}']^{-1}E[Z_t\, \varepsilon_{2t}'])$ in equation (11). Since I am only interested in the monetary shock, therefore k=1, there is no need for further assumptions, and the impulse response can be easily estimated.

IV. Results

4.1. Measure of inequality

I use two methods to measure inequality, the first being the Gini coefficient and the second being the difference between the 90th and 10th percentiles of the cross-sectional distribution of logarithmic levels. The Gini coefficient is the statistical measure that can take values ranging from 0 to 1 (or 0 percent to 100 percent). A zero coefficient indicates perfect equality in the distribution of income or wealth among a population, while a coefficient of 1 indicates a perfect inequality of income distribution among a population. The second method is the difference between the 90th and 10th percentiles to see how monetary policy affects individuals in the lower and upper classes. The construction of distribution percentiles gives a way to see family ranks. There are other measures of inequalities that I do not use in this paper like decile ratio, percentile ratio, the standard deviation of the natural logarithm.

Statistics Canada only conducts annual surveys to obtain information on Canadians' income and I compile panel data from 1982 to 2011 from these surveys. From this panel, I calculate the measure of total earnings inequality since earnings constitute a significant part of total income. To allow a good comparison of levels between families (or households), researchers have proposed a method for adjusting family income to account for the family size which entails the use of equivalence scales. An equivalence scale is a ratio of the amount of income required by families (or households) of two or more people to maintain a single person's standard of living. The most common approach is the root square equivalence scale, which is determined by dividing income by the square root of family size. Canadians' studies on income inequality and consumption inequality (Sarlo et al., 2015; Sarlo, 2016; Brian et al., 2010) have used this method. Therefore, I use this approach to construct the adjusted total income before taxes and adjusted income after taxes. The variables described above will be used to examine the impact of monetary policy on income inequality and earnings inequality.

In addition, I calculate the average measure of investment income, which is one of the primary sources of income, and the average measure of self-employed income, which is another source of income for Canadian families. I also calculate the average measure of the total government transfer payment, since it has been shown that lower-class families derive most of their income from the government's transfer payment (National Household Survey, 2011). I also build the average measure of wages and salaries, which is the primary source of income for most Canadians. I calculate these measures to assess the transmission of monetary policy through the income composition channel.

Figure 1: Inequality in total income before Tax, total income after tax and earnings in Canada

Before 1996, Statistics Canada publishes annual consumption and spending data for Canadian families every two years, often every four years. I, therefore, compile the panel data for the following years: 1982, 1984, 1986, 1990, 1992, 1996 to 2009, respectively. From this group, I create a time series of inequality measures, which I know does not give me enough points to study the impact of monetary policy on consumption inequality. If I included these data points, the estimated impulse response would be statistically insignificant and inconsistent. So, I limit the study of consumption inequality and spending only by looking at how it is correlated with income inequality and how it differs over time because of the missing data before 1996.

Figure 1 displays the two inequality measures of total adjusted income before tax, total adjusted income after tax, and earnings inequality using the annual sample. Wages and salaries, and earnings from self-employment are included in total earnings shown in figure 1. The Gini coefficients of earnings are not calculated with zero values which implies I only consider employed individuals. Panel A, figure 1, contains the Gini coefficients, demonstrating that earnings inequality has risen significantly, particularly during the recession. The Gini index is 0.38 in 1990 and quickly rises to 0.41 in 1993. Following the recession, it remains flat until just before the year 2000. Earnings inequality rises from 2000 to 2007, then falls from 2007 to 2008 before rising again during the 2008-2009 financial crisis. Using the Gini coefficient, earnings inequality increases by 22% over the last 30 years. Figure 1's Panel B presents the 90th -10th percentile difference, which follows the same trend as the Gini coefficient; using this measure, earnings inequality grows by 39%. Observing income inequality, the overall measure of pre-tax and post-tax income inequality exhibits the same pattern. Pre-tax income inequality, on the other hand, is greater than post-tax income inequality. In Panel A, figure 1, income inequality rises slightly from 1983 to 1984 and then falls gradually from 1984 to 1990. It rises from 1990 to 1993 because of the Canadian recession at the time. Income inequality remains flat in the early 2000s until 2008, when it falls slightly because of the 2008 recession. Income inequality grows by 3.7 percent for total pre-tax income and 5.9 percent for total post-tax income over the entire period. The 90th-10th differential percentile line in Panel B is flatter than the Gini coefficient line path. Because I do not control for any variables or limit the sample size in my measurement, I obtain a Gini coefficient of total income before and after-tax that is slightly different from those calculated by Statistics Canada (2020). It is also because Statistic Canada's Gini coefficient contains average income data between SLID and SCF from 1993 to 1998, whereas the Gini coefficient in this study only includes SCF income data from 1993 to 1998. My findings are close to those of Sarlo et al. (2015), who employ the same data sources as me and find that adjusted after-tax income inequality between families increased between 5 and 10 percent from 1980 to 2010.

The measure of total consumption and total expenditure inequality is illustrated in Figure 2. The figure demonstrates that the degree of change in overall current consumption inequality is slightly greater than the degree of change in total expenditure inequality. Although the degree of change in total expenditure is greater than that in total current consumption, both exhibit the same pattern.

Panel A, figure 2, shows that consumption inequality increases slightly from 1982 to 1986, then declines to 1990 before rising during a recession and continuing to rise until 1998. After 1998, consumption inequality remains stable until 2007, just before the financial crises, at which point consumption declines. Figure 2's panel B demonstrates that following the 1992 recession, consumption disparity remains stable in total current consumption but declines slightly in total expenditure. Before 1996, the result is uncertain because Statistics Canada conducts a consumption survey every two or four years; some years between 1982 and 1996 are omitted. This result confirms Norris and Pendakur's (2015) findings, who use only SHS data and discover that consumption inequality did not change significantly between 1997 and 2009. This finding is also consistent with Coibion et al.'s (2012) finding that consumption inequality has remained stable in the United States. When the Gini coefficients for consumption and income inequality are compared in Figures 1 and 2, consumption inequality is less variable than income inequality. According to Norris and Pendakur (2015), consumption inequality is lower than income inequality since households continue to attempt to smooth consumption over time, while income inequality is higher due to its significant variance.

The correlation measures between income inequality and consumption inequality are presented in Table 1. The result indicates that income and consumption inequality have a strong positive correlation. Numerous studies (Cutler and Katz, 1991; Norris and Pendakur, 2015; and Sarlo, 2016 for Canada) established a positive relationship between income and consumption inequality, as well as the fact that income and consumption inequality trend in the same direction. If Canada's contractionary monetary policy reduces income inequality, I believe it will also reduce consumption inequality. Coibion et al. (2012) demonstrate that income and consumption inequality are positively correlated for the U.S. When examining the impact of a contractionary monetary policy shock on income and consumption inequality, their findings prove that a contractionary monetary policy shock increases both income and consumption inequality. Before examining the impact of contractionary monetary policy on income and earnings inequality, I convert my annual income and earnings sample data to quarterly data because it allows for more data points.

Figure 2: Inequality in total consumption and total expenditure in Canada from 1982-2009

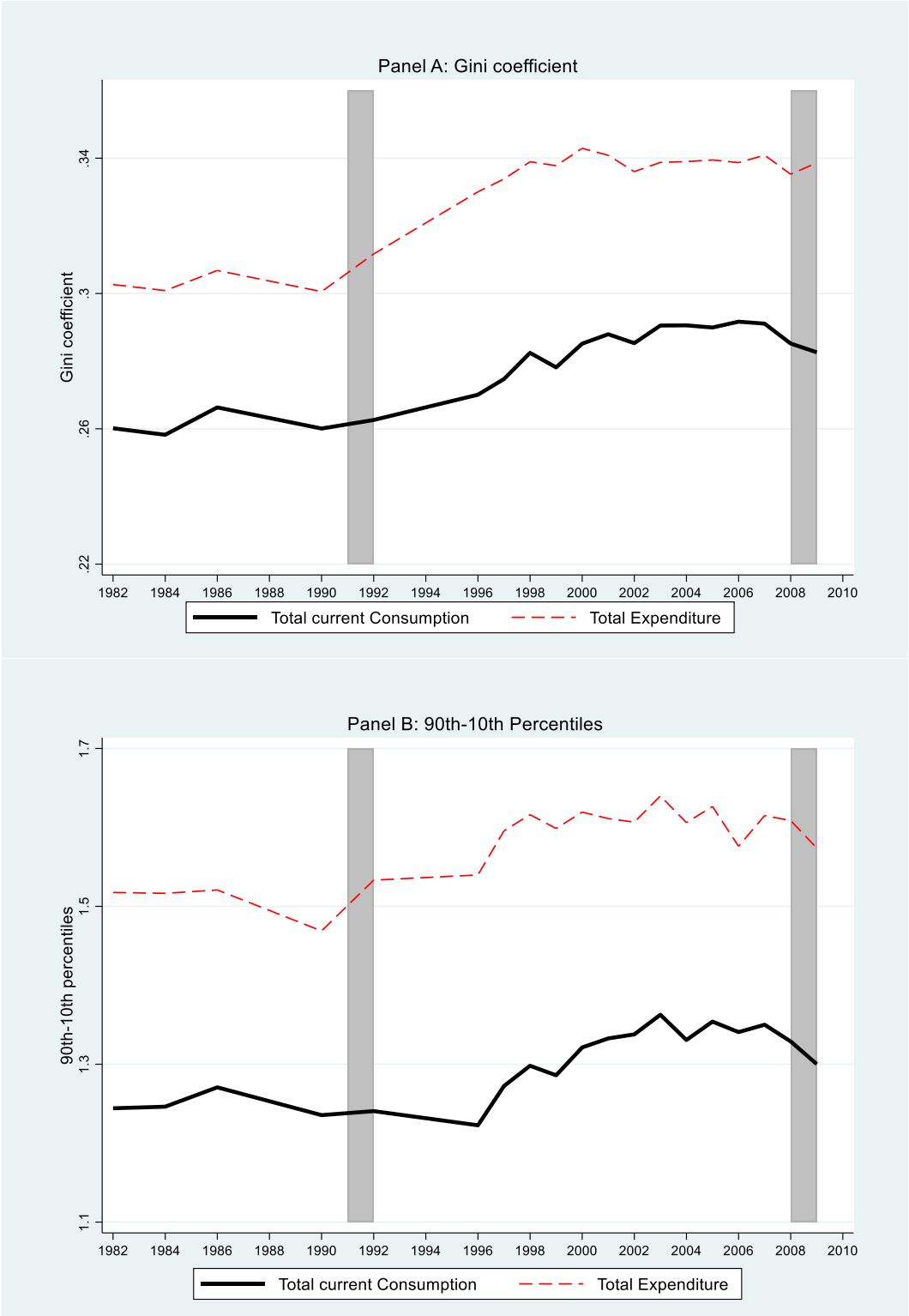
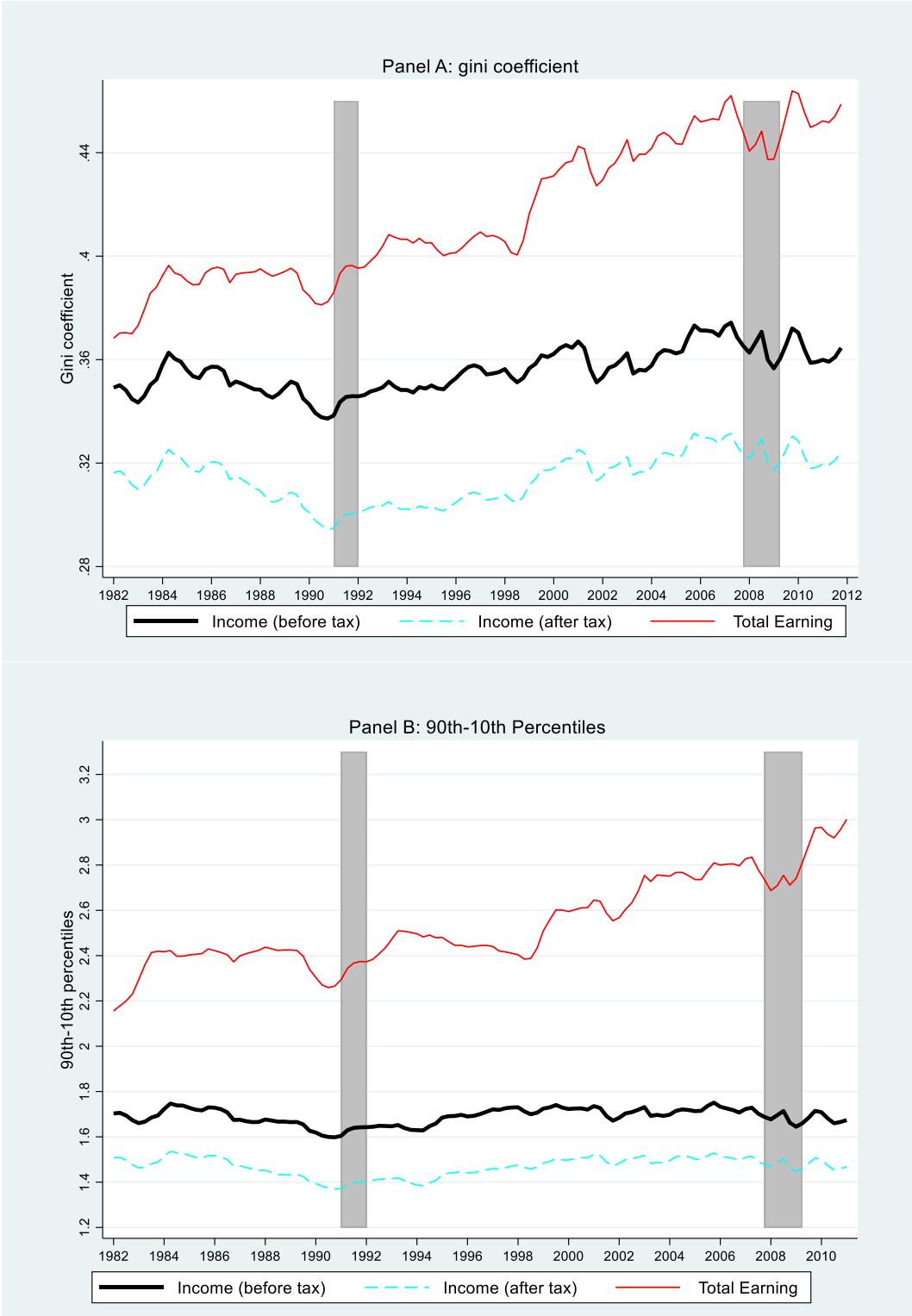


Table 1: Correlations of inequality in income, earnings, total current consumption, and total expenditure

	Gini Index	90th-10th
corr (pre-tax income, earnings)	0.850	0.320
corr (post-tax income, earnings)	0.700	0.460
corr (pre-tax income, consumption)	0.750	0.410
corr (post-tax income, consumption)	0.610	0.560
corr (post-tax, expenditure)	0.430	0.500
corr (pre-tax income, expenditure)	0.690	0.570
corr (earnings, expenditure)	0.850	0.700
corr (earnings, consumption)	0.920	0.840
corr (pre-tax income, post-tax income)	0.900	0.900
corr (consumption, expenditure)	0.930	0.850

Figure 3:Inequality in total income before and tax and total earning using quarterly interpolated data.



Davtyan (2017) argues that using a small sample raises concerns about estimation; more data points must be observed to use contemporaneous Identification. As a result, the author interpolates the data from annual to quarterly frequency using the Boot et al. (1967) method. I use Denton's (1971) method in my research, a mathematical procedure for converting annual data to quarterly frequency while preserving quarter-to-quarter changes. This method requires the use of an economic indicator to convert low-frequency data to high-frequency data. I use the nominal gross domestic product (GDP) as an indicator because it is a widely used metric for comparing countries' performance. GDP is a reference indicator in the business cycle, and the business cycle refers to the natural ups and downs of economic growth over time; GDP usually indicates the state of economic conditions. As seen in Figures 1 and 2, the inequality measures change during the recession period; GDP comoves with inequality measures. Interpolated data on income and earnings inequality are presented in Figure 3. I transform the result in the E-views 12 application using nominal GDP as an indicator. The findings indicate that the differences between figures 1 and 3 are minimal; figure 3 shows that earnings and income increased during the 1992 recession. Additionally, it demonstrates how income inequality decreased during the financial crisis of 2008. Then again, as shown in Figure 1, the line trend remains flat.

4.2. Analysis of the macroeconomic variables

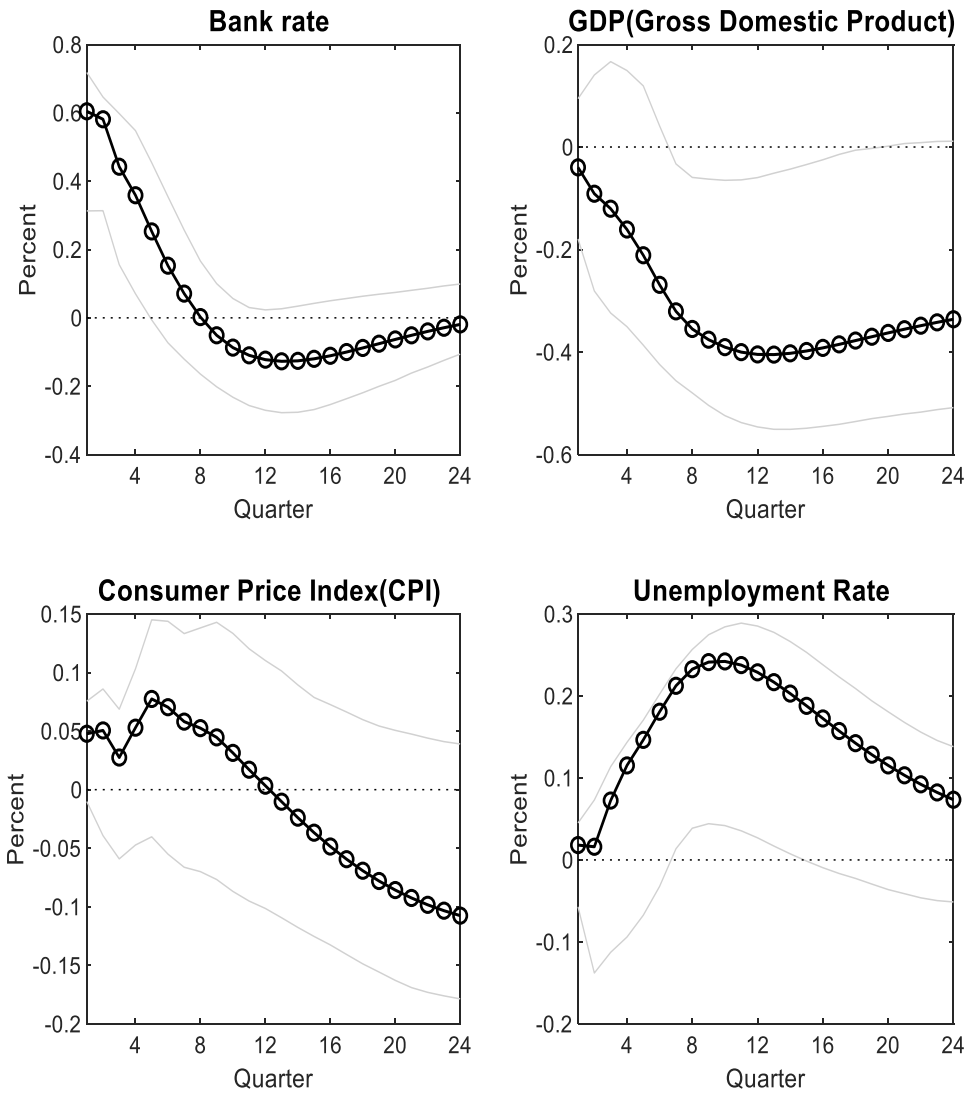
I begin by examining the effects of a contractionary monetary policy shock on macroeconomic variables and determining whether Champagne and Sekkel's (2018) narrative monetary measure is a strong proxy variable. The model comprises four variables: the bank rate, the gross domestic product at the current price, the unemployment rate, and the consumer price index. I first convert the GDP and consumer price index to logarithmic form and multiply by 100 to convert to percentage points. I use Lunsford's (2015) methodology to assess the strength of the identified Champagne and Sekkel (2018) monetary policy measures as the proxy. The test is based on Lunsford's (2015) weak IV literature, which consists in regressing the instrument variables projected on the endogenous variables, followed by calculating the F-statistic of the regression of the instrument variable on the residuals of the VAR. Lunsford (2015) defines weak proxy set as any proxy variable that produces an asymptotic bias larger than 10%. If the F-statistic exceeds critical values, it indicates that the proxy variable is not a weak instrument for identifying monetary policy shocks. I regress the instrument orthogonal to the model against four macroeconomic variables (bank rate, nominal GDP and CPI, and unemployment rate), yielding the residual vector from which the F-statistic is computed. I calculate the F-statistic to be 15.297, and when I compare it to Lunsford's (2015) critical values at the 10% level of statistical significance (see appendix table 2 for the critical values), one can observe that the

calculated F-statistic is greater than the critical values. Furthermore, Staiger and Stock (1997) recommend that the calculated F-statistic be greater than 10 to avoid using weak instruments. As a result, I reject the null hypothesis and conclude that the identified narrative monetary policy shock is not a poor proxy variable for identifying monetary policy.

Figure 4 presents the impulse response function of GDP, CPI, the unemployment rate, and the bank rate to a contractionary monetary policy shock. The sample period covers 1982Q1 to 2011Q4. The black line with black circles represents point estimates of the impulse response functions. The grey lines represent the 95% confidence interval, which was calculated using the bootstrap method. My forecast horizon is set to 24 periods. Figure 4 demonstrates that a one-percentage-point contractionary monetary policy shock causes the bank's rate to rise in the first quarter. Following that, the bank rate begins to decline, eventually reaching zero in the eighth quarter. The bank rate response is significant between the first and fifth quarters. A one percentage point contractionary monetary policy shock reduces gross domestic product in the first quarter. It continues to decline until the 12th quarter, at which point it stabilizes for the remaining periods. Between periods six and sixteen, the response of GDP is significant. The contractionary monetary policy significantly increases the consumer price index for the first two quarters, decreases from the third quarter to the fourth quarter, and increases between the fourth and sixth quarters. After that, the consumer price index declines till the end of the horizon. Moreover, the result indicates that a one-percentage-point contractionary monetary policy shock increases unemployment until the 12th quarter, at which point it declines. The response is significant from quarter 7 to quarter 10.

The response of the bank rate, GDP, and the unemployment rate corresponds to the theory that contractionary monetary policy raises short-term interest rates, lowers GDP, and raises the unemployment rate. The findings are consistent with Champagne and Sekkel's (2018) paper, in which they use their monetary policy measure as the true shock in econometric models using the local projection method and the Cholesky decomposition. They discover that contractionary monetary policy reduces GDP, raises the unemployment rate and raises the bank rate after its impact. On the other hand, my method reveals a price puzzle in the consumer price index response to a contractionary shock. Champagne and Sekkel (2018) also show the price puzzle when using the bank rate as the policy instrument. Another empirical work that employs the narrative identified monetary policy of Romer and Romer’s approach as a proxy demonstrates that it also creates a price puzzle (Kliem and Kriwosky, 2013).

Figure 4: The effect of the contractionary monetary policy on macroeconomic variables



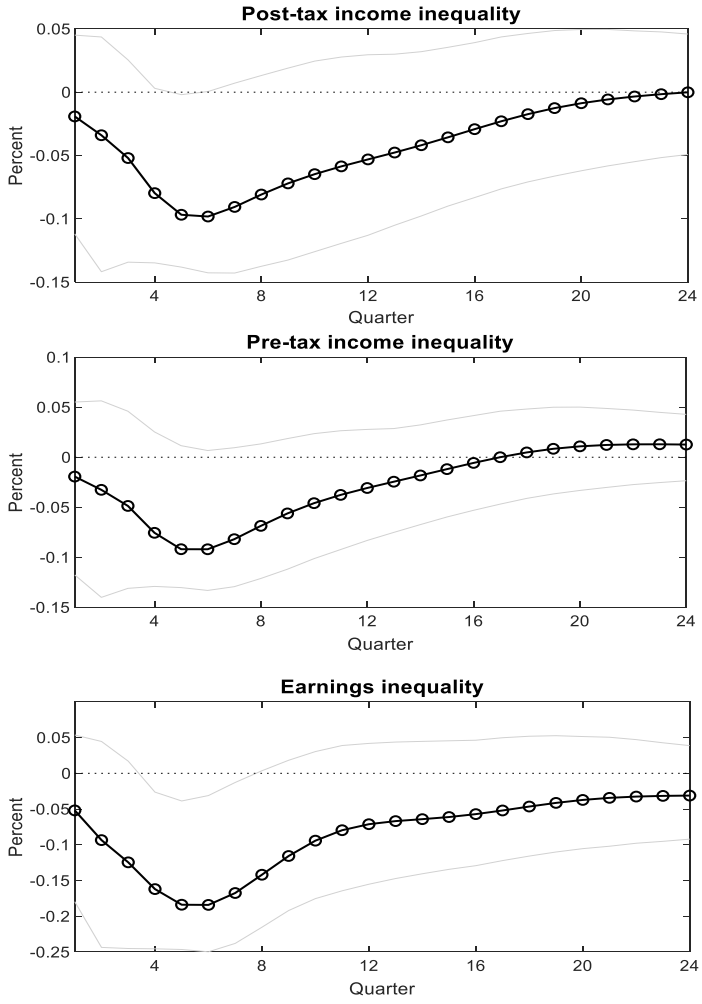
Note: impulse response to one percentage point contractionary monetary policy from the VAR (solid line with circles) with the 95 percent confidence level in the gray line. VAR includes Bank rate, log (GDP), log (CPI) and unemployment rate. The lag set at 3—sample period: 1982Q1-2011Q4. The proxy variable is the newly identified monetary policy measure of Champagne and Sekkel (2018).

Ramey (2016) explains that this is because the proxy approach relaxes the recursive assumption, where output and price variables are not allowed to respond to a monetary policy shock within the period. Thus, using the Romer and Romer shock as the proxy can affect the output and price movements.

4.3. The effect of the monetary policy on earnings and income inequality.

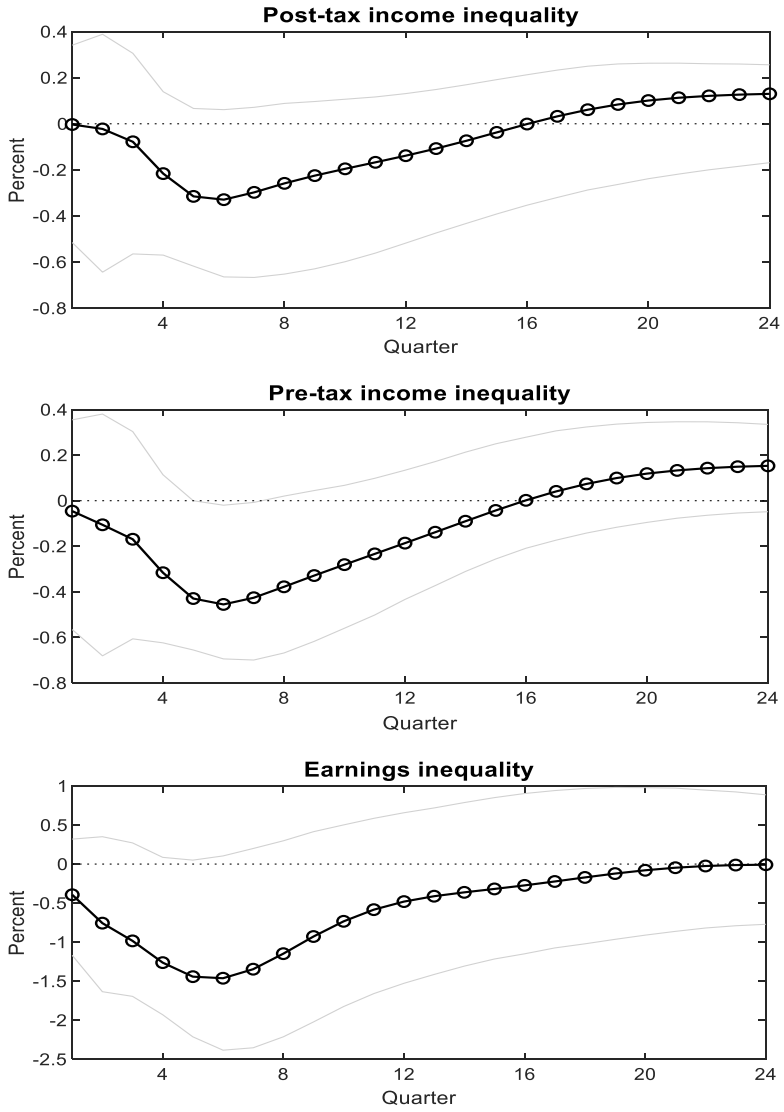
My benchmark model has four variables: Y_t= [bank rate, GDP, unemployment rate, and inequality measure]. I convert GDP to logarithm form and multiply by 100 to get percentage points, then include a measure of inequality, one at a time, and multiply it by 100 to convert to percentage points as well. I set the lag length to three, and the sample period ranges from 1982 Q1 to 2011Q4. I set the forecast horizon to 24 quarters. I use the proxy-SVAR to estimate the effect of contractionary monetary policy, by following Lunsford's (2015) approach. Figure 5 shows the impulse response of the Gini coefficient of adjusted post-tax income inequality (in the first row), the Gini coefficient of adjusted pre-tax income inequality (in the second row), and the earnings Gini coefficient (in the third row). I compute the F-statistic for each model; it is 14.09 in the first row, 13.901 in the second, and 14.957 in the third, and the results still indicate that the narrative measure is not a weak proxy variable. Figure 6 presents the impulse response of the same variables using the 90th- 10th percentile difference measure. I do not show the figure of the macro-variables again because it is similar to the one shown in figure 4. In assessing earnings inequality, Figure 5 shows that a one percentage point surprise increase in the bank rate reduces earnings inequality on impact to -0.05 percentage point, with a peak in the fifth quarter. Earnings inequality gradually increases from the 6th quarter to the 12th quarter, after that it remains flat until the end of the horizon. Earning inequality in Figure 6 shows a greater effect, but it still shows a similar result to figure 5. When looking at income inequality, Figure 5 shows that a one-percentage-point increase in the shock causes a significant decrease in adjusted after-tax income inequality of -0.0192 percent, which continues to fall until it reaches a peak in the fifth quarter at -0.09 percent; in the long run, the effect remains stable. Observing the pre-tax and after-tax income inequality results shows a similar effect, so I will continue to examine post-tax income inequality. Figure 6 shows that contractionary monetary policy reduces income inequality for the first four quarters, then increases before remaining flat in the long run. My findings can be compared to Kronick and Villareal's (2020) previous research on the effects of expansionary and contractionary monetary policy on income inequality. They construct income inequality measures at the level of employed individuals using monthly labour force survey data from 1992 to 2015, and they estimate the impulse response using local projections. Their findings support my finding that contractionary monetary policy reduces income inequality in Canada.

Figure 5: The effect of the contractionary monetary policy on income inequality and earning inequality (using Gini coefficient)



Note: impulse response to a one percentage point contractionary monetary policy (solid line with circles) and the 95 percent confidence levels (gray lines) of Gini coefficient for post-tax income (first row), pre-tax income (second rows) and Earnings (third row). The benchmark model includes Bank rate, log (GDP), unemployment rate and a measure of inequality. The lag set at 3—sample period:1982Q1-2011Q4. The proxy variable is the newly identified monetary policy measure of Champagne and Sekkel (2018). The confidence level was calculated using bootstrap methods with replication set at 10000.

Figure 6: The effect of the contractionary monetary policy on income inequality and earning inequality (using 90th-10th percentile differential)



Note: impulse response to a one percentage point contractionary monetary policy (solid line with circles) and the 95 percent confidence levels(gray lines) of 90th-10th percentile differential for post-tax income(first row), pre-tax income(second rows) and Earnings(third row). The benchmark model includes Bank rate, log (GDP), unemployment rate and a measure of inequality. The lag set at 3—sample period:1982Q1-2011Q4. The proxy variable is the newly identified monetary policy measure of Champagne and Sekkel (2018). The confidence level was calculated using bootstrap methods with replication set at 10000.

My findings can also be compared to previous empirical work based on data from the United States. My results contradict the empirical results of Coibion et al. (2012) and Mertens (2018). Mertens (2018) employs the same methodology as this study but uses annual data of income inequality, and he finds that contractionary monetary policy increases income inequality in the United States. However, my findings are in line with the findings of Davtyan (2017), who uses the income Gini index from the OECD database, which was annual and interpolated to quarterly frequency, and finds that contractionary monetary policy reduces income inequality in the United States. The author claims that her findings differed from those of Coibion et al. (2012) because survey data typically excluded the top 1%, and the top 1% in the U.S. always make a difference. My results are also in line with Villareal (2014), who finds that contractionary monetary policy leads to a decrease in income inequality in Mexico. Villareal (2014) argues that his results are different from Coibion et al. (2012) because of the different way Mexico targets its inflation. I also think that my results are different from Coibion et al. (2012) because Canada's economic structure is different from the U.S.

4.4. Analysis of some transmission channels

First, I examine the composition of income channels. Canadian families' total income comes from various sources, so I gauge the average measure of wage and salary earned through employment, self-employment earnings, investment income, and government transfer payments. I divide these different shares of total income above by quintile. The findings are summarized in Table 2, and it shows that the lower class relies heavily on government transfers, whereas the upper class also relies heavily on wages. The results of table 2 are in line with the analytical paper of Statistics Canada (2011)[1], which shows that wages account for a sizable portion of the middle and upper classes' total income. The upper class is more likely to own a business and invest, and the lower class is more reliant on government transfer payments.

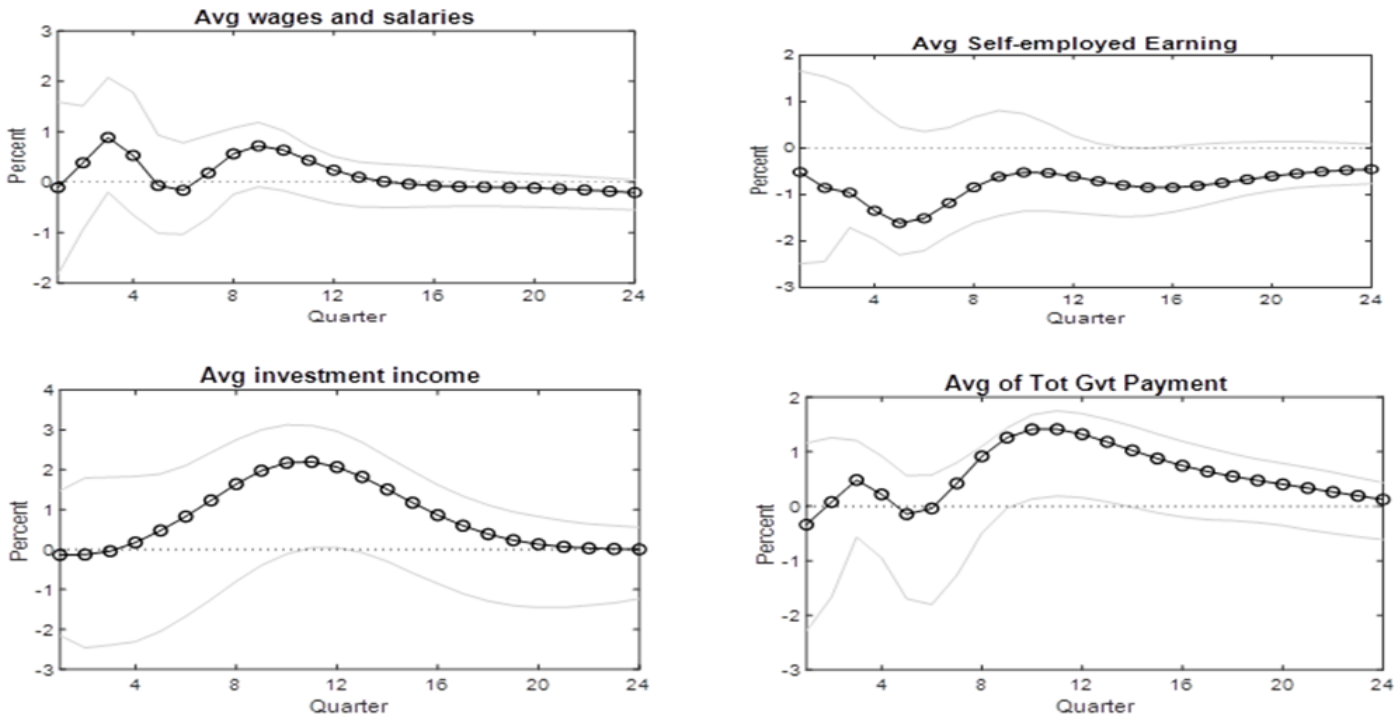
Afterwards, I incorporate these average measures of income sources into the model and calculate the monetary policy shock's effect on them. The average wage and salary, average self-employment, average investment income, and average total government payment responses to a 1% contractionary monetary policy are indicated in Figure 7.

[1] **The analytical document report for the 10% of Canadians with the lowest family after-tax incomes, government transfers contributed 67.5% of their income**.

Table 2: Decomposition of income by quintile

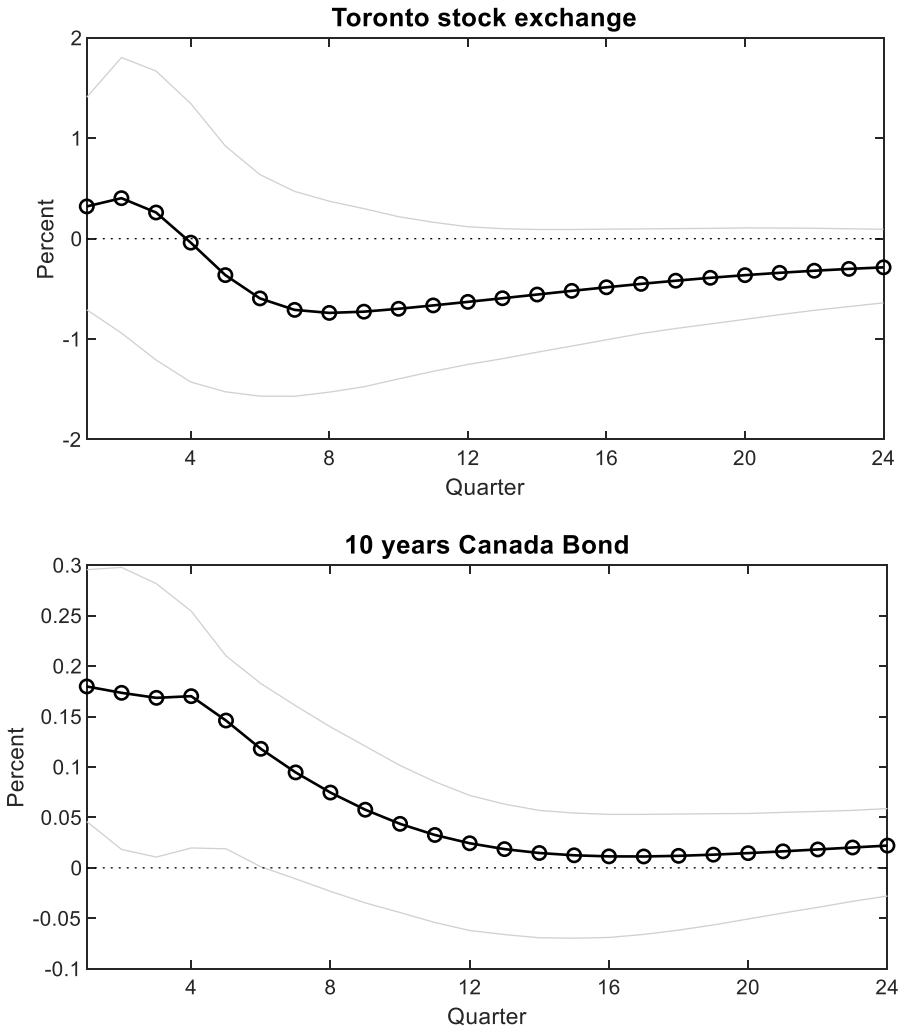
Share of income source				
Quintiles by total income before tax	wages	investment	self-employment	government transfer payment
Panel a: 1980s				
Bottom:1	0.248	0.061	0.043	0.649
2	0.429	0.084	0.062	0.424
3	0.679	0.070	0.064	0.187
4	0.795	0.055	0.056	0.095
Top: 5	0.810	0.070	0.073	0.046
Panel b: 1990s				
Bottom:1	0.220	0.038	0.036	0.707
2	0.379	0.061	0.053	0.507
3	0.619	0.060	0.061	0.260
4	0.764	0.049	0.054	0.133
Top: 5	0.821	0.052	0.069	0.059
Panel c: 2000-2011				
Bottom:1	0.271	0.032	0.041	0.656
2	0.430	0.046	0.046	0.479
3	0.621	0.048	0.049	0.282
4	0.757	0.043	0.047	0.153
Top: 5	0.832	0.048	0.062	0.058

Figure 7: The effect of the contractionary monetary policy on income source variables



Note: impulse response to a one percentage point contractionary monetary policy (solid line with circles) and the 95 percent confidence levels (gray lines) of average income source variables. The benchmark model includes Bank rate, log (GDP), unemployment rate and a measure of the average income share. The lag set at 3—sample period:1982Q1-2011Q4. The proxy variable is the newly identified monetary policy measure of Champagne and Sekkel (2018). The confidence level was calculated using bootstrap methods with replication set at 10000.

Figure 8: The effect of the contractionary monetary policy on the financial variables



Note: impulse response to a one percentage point contractionary monetary policy (solid line with circles) and the 95 percent confidence levels (gray lines) of financial variables. The benchmark model includes Bank rate, log (GDP), unemployment rate and Toronto stock exchange (first row). In the second row, the same three macro variables and ten years Canada bonds. The lag set at 3— sample period:1982Q1-2011Q4. The proxy variable is the newly identified monetary policy measure of Champagne and Sekkel (2018). The confidence level was calculated using bootstrap methods with replication set at 10000.

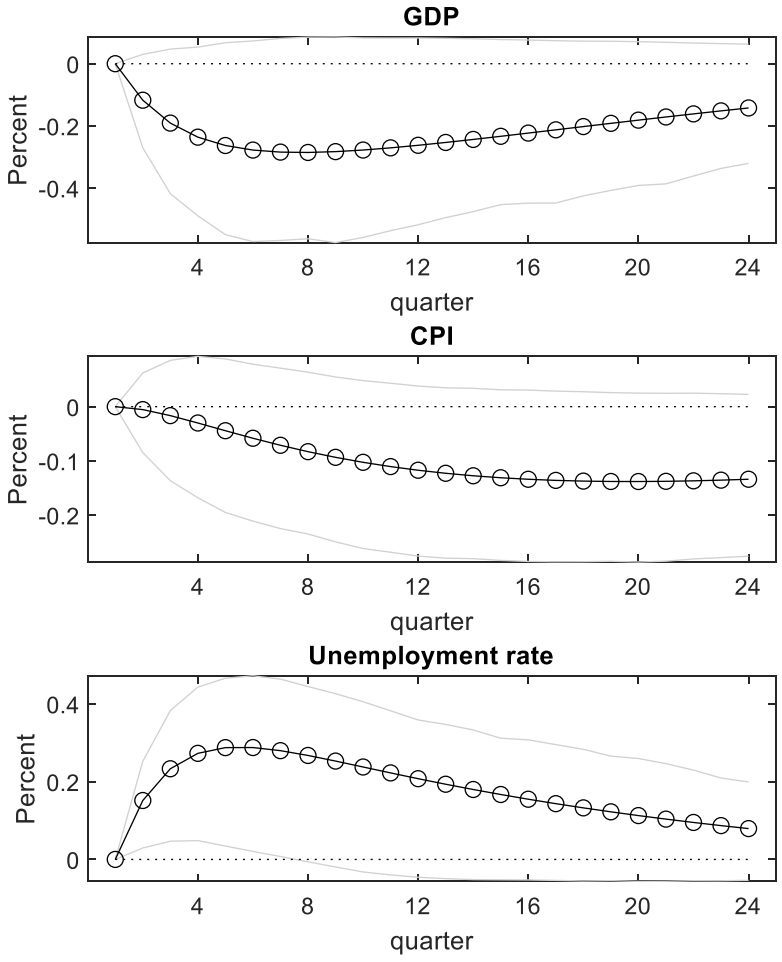
The figure 7 illustrates how the contractionary monetary policy shock increases both wages and total government transfer payment, but the responses are insignificant. Increasing in wages and total government expenditures lead to decrease in income inequality, as most Canadian families rely on wages, whereas the bottom class relies on total government payments. As illustrated in the figure 7, a contractionary monetary policy shock leads to an increase in investment income, the response is significant from period 4 to period 10, suggesting the increase in investment income benefits the upper-income family more. Nakajima (2015) demonstrates that the top income earns more dividends from investments, thus increasing inequality. The findings point out that a contractionary monetary policy reduces self-employment earnings, which harms the upper-income earners and reduces income inequality. As a result, I believe that contractionary monetary policy reduces income and earnings inequality via the income composition channel.

I next use the real price of the Toronto Stock Exchange as an indicator to examine the portfolio channel and the 10-year Canadian bond yield as an indicator for the savings redistribution channel. Bear in mind that these are qualitative findings; it is critical to further comprehend how these transmission channels contribute to income inequality. As illustrated in Figure 8, the result shows that a contractionary monetary policy shock has a negative effect on stock prices at the mean, albeit the response is insignificant. Most studies have discovered that lower asset and equity prices result in decreased income inequality. According to O' Farrell et al. (2016), upper-income families are more likely to own assets and benefit more from asset price increases. Figure 8 also shows that contractionary monetary policy raises the 10-year Canadian bond in the first quarter, the result is insignificant for the first few quarters. According to Doepke and Schneider (2006), increases in long-term interest rates will harm borrowers while benefiting savers. As a result, monetary policy tightening increases inequality via this channel.

4.5. Robustness check

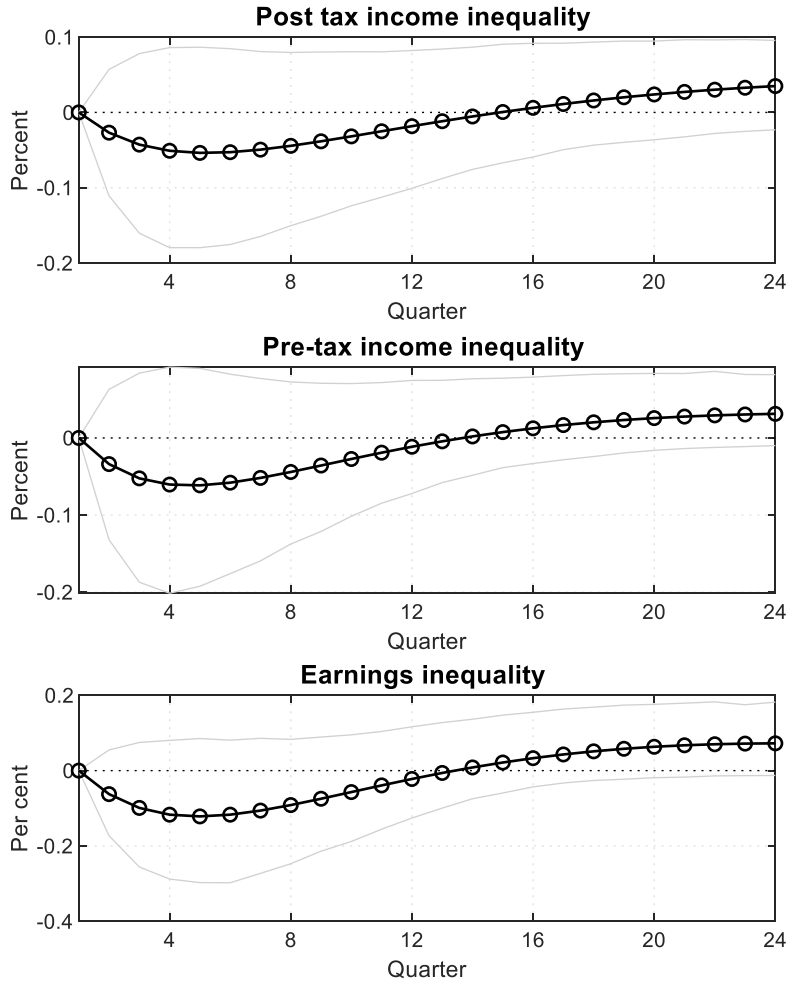
In this section, I assess the robustness of the results. First, I replace GDP with the industrial production index and replace the unemployment rate with the consumer price index in the benchmark model. The results are shown in appendix figures 1 and 2, which show that contractionary monetary policy reduces income inequality and earnings inequality in the first year and a half. Furthermore, I use the same variables as in the benchmark model, but I change the lag number to 2. The results are shown in appendix figures 3 and 4, and I still reach the same conclusion.

Figure 9: The effect of the contractionary monetary policy on macroeconomic variables using Cholesky decomposition.



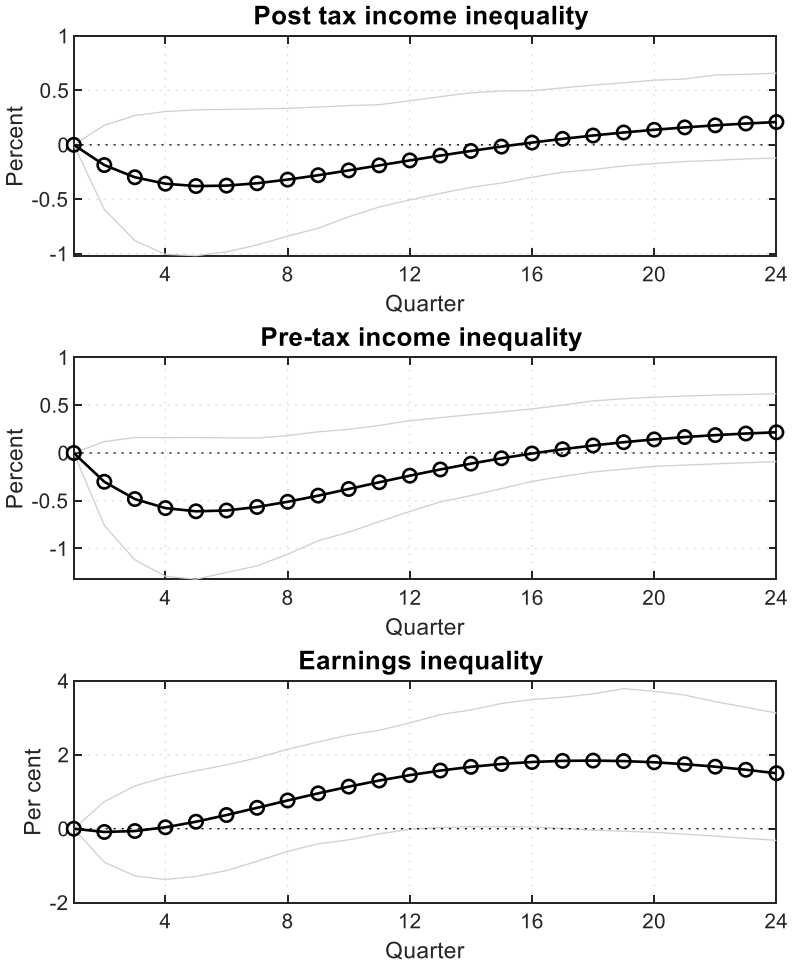
Note: Impulse responses to a one percentage point contractionary monetary policy shock. VAR with log (GDP), log (CPI), unemployment rate, and identified monetary policy measure of Champagne and Sekkel (2018). set lag at 1. Sample period: 1982Q1–2011Q4. Gray lines indicate 95 percent confidence levels.

Figure 10: The effect of the contractionary monetary policy on income inequality and earning inequality using Cholesky decomposition.



Note: impulse response to a one percentage point contractionary monetary policy (solid line with circles) and the 95 percent confidence levels (gray lines) of Gini coefficient for post-tax income (first row), pre-tax income (second rows) and Earnings (third row). The benchmark model includes log (GDP), unemployment rate and a measure of inequality and new identified monetary policy measure of Champagne and Sekkel (2018) ordered last. The lag set at 1—sample period:1982Q1-2011Q4.

Figure 11: The effect of the contractionary monetary policy on income inequality and earning inequality using Cholesky decomposition.



Note: impulse response to a one percentage point contractionary monetary policy (solid line with circles) and the 95 percent confidence levels (gray lines) of 90th-10th percentile differential for post-tax income (first row), pre-tax income (second rows) and Earnings (third row). The benchmark model includes log (GDP), unemployment rate and a measure of inequality and new identified monetary policy measure of Champagne and Sekkel (2018) ordered last. The lag set at 1—sample period:1982Q1-2011Q4.

Champagne and Sekkel (2018) argue that their newly identified monetary policy measure should be used as a structural shock within the VAR rather than as a proxy variable. As a result, I investigate the impact of contractionary monetary policy on income and earnings inequality using the Cholesky decomposition method. Remember from equation 4 that I need a set of restrictions that contains $n(n+1)/2$ to find $\sum$. So, I use the Cholesky decomposition, where I set the lower triangle of the B coefficient to zero, and I order the Champagne and Sekkel monetary policy measure last in the VAR, implying that the shock is affected by the other variables in the VAR at the same time. I begin by examining the macro variables. Figure 9 shows that a contractionary monetary policy shock lowers GDP while also lowering the Consumer Price Index. The figure also depicts how a contractionary monetary policy raises the unemployment rate. Figure 9 confirms Champagne and Sekkel's (2018) empirical findings, but my findings are more significant in the first few quarters and are also more persistent over time than their findings.

Following that, I estimate the effect of contractionary monetary policy on income and earnings inequality using the VAR of four variables: GDP, unemployment rate, inequality measure, and shock. Figure 9 depicts the impulse response of the Gini coefficient of income inequality and the earning earnings inequality. The outcome is similar to that obtained in section 4.2, which shows that a contractionary monetary policy shock decreases income inequality until the sixth quarter, then increases before it flattens. Figure 10 shows that when the Gini index is replaced with the 90-10th percentile difference, the result for income inequality is similar, but earning inequality increases. The result in this figure is insignificant in comparison to the result in figure 6.

Therefore, I conclude that my results are robust to the changes and show that contractionary monetary policy decreases income and earnings in Canada. My findings align with Kronick and Villarreal's (2020) findings, which also show that contractionary monetary policy reduces income inequality in Canada.

V. Conclusion

The purpose of this research is to examine the effect of contractionary monetary policy on income and earnings inequality in Canada. I begin by collecting data on family income from the Survey of Consumer Finance (SCF) and the Survey of Labor and Income Dynamics (SLID), and then adjust total income before and after taxes to account for family composition. I use two types of inequality measures to create time series to measure pre-and post-tax income inequality and earnings inequality (Gini coefficient and the 90th-

10th percentiles differentials). Using the two types of inequality measures, I construct time series of total current consumption and total expenditure using data from the Survey of Family Expenditures (FAMEX) and the Survey of Household Spending (SHS). Between 1982 and 2011, income inequality increases by 3.7 percent in total pre-tax income, 5.9 percent in total post-tax income, and 22% in earnings, as measured by the Gini coefficient. The measure of consumption inequality in Canada shows that consumption inequality increases slightly between 1982 and 2009. Also, the findings indicate that income inequality and consumption inequality follow similar trends and are positively correlated. My contribution is to examine earnings and income inequality in Canada using data from SCF and SLID. It enables me to sum up the various sources of income available to Canadians.

Previously, all studies that used Canadian data estimated the effect of monetary policy on inequality using local projection and microsimulation techniques. Rather than that, I chose to use Stock and Watson's (2008) and Mertens and Ravn's (2013) Proxy-SVAR approach in this study. This strategy entails using an external instrument that must satisfy two criteria to be used to determine monetary policy. Then, to assess my robustness, I employ the Cholesky decomposition. I identify the monetary policy shock using the Champagne and Sekkel (2018) narrative of the monetary policy measure as a proxy variable. To obtain a more precise estimate, I use the Denton methodology to interpolate the income data from annual to quarterly frequency. In addition to macroeconomic variables, I include income and earnings inequality measures in the structural vector autoregressive model.

My findings suggest that a contractionary monetary policy shock reduces income inequality both before and after taxes. My findings reveal that contractionary monetary policy reduces earnings as well. Because the proxy approach creates a price puzzle, I perform a robustness check using the Cholesky decomposition method, ordering the shock last. The findings support the idea that tightening monetary policy reduces income and earnings inequality. After examining several monetary policy transmission channels, I discover that while contractionary monetary policy reduces income inequality via the income composition and portfolio channels, redistribution saving channels contribute to an income inequality increase. However, the results regarding the transmission channels are often insignificant, suggesting more work is necessary to discern the main transmissions

This study demonstrates that there is room for additional research in analyzing the impact of monetary policy in Canada on macroeconomic variables by using a proxy approach. They must first develop a more robust proxy approach than that described in this paper. Again, this study could be expanded to incorporate more recent data to additionally examine the effect of forward guidance on income and earnings inequality in Canada.

VI. References

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VII. Appendix

Appendix A: DATA and critical Values

This section describes the various data series along with relevant sources used in the paper. The following indices indicate how series in Appendix Table 1 are transformed.

0. No transformation

1. I convert the data into logarithm form then multiply by 100

2. I transform monthly data into quarterly data by taking the average of 3-month values at a time. This calculation happens in the program E-views.

3. Transformation of the daily values into quarterly data, I use EViews 12 for transformation

Appendix table 1: Macro variables

Macro Variables	source	CANSIM table or code	period retrieved	Trans.
Gross Domestic Product	FRED database	CANGDPNQDSMEI	1982M1-2011M12	1
Bank rate	Bank of Canada	Champagne and Sekkel (2018)	1982Q1-2011Q4	0
Consumer Price Index	Statistic Canada	v41690973	1982m1-2011M12	1, 2
unemployment rate	Fred data base	LRUNTTTTCAM156S	1982m1-2011M12	2
Industrial Index	Fred data base	CANPROINDMISMEI	1982m1-2011M12	2
1-year treasury bill	Bank of Canada	v39067	1982/01/05-2011/12/31	3
10-year Canada bond yield	Bank of Canada	V122543	1982m6-2011m12	2
Toronto stock exchange composite index, high	Bank of Canada	V122618	1982m1-2011M12	2
Monetary policy measures	Bank of Canada	Champagne and Sekkel (2018)	1982Q1-2011Q4	0

Appendix Table 2: critical values for F-statistic calculated by Lunsford (2015)

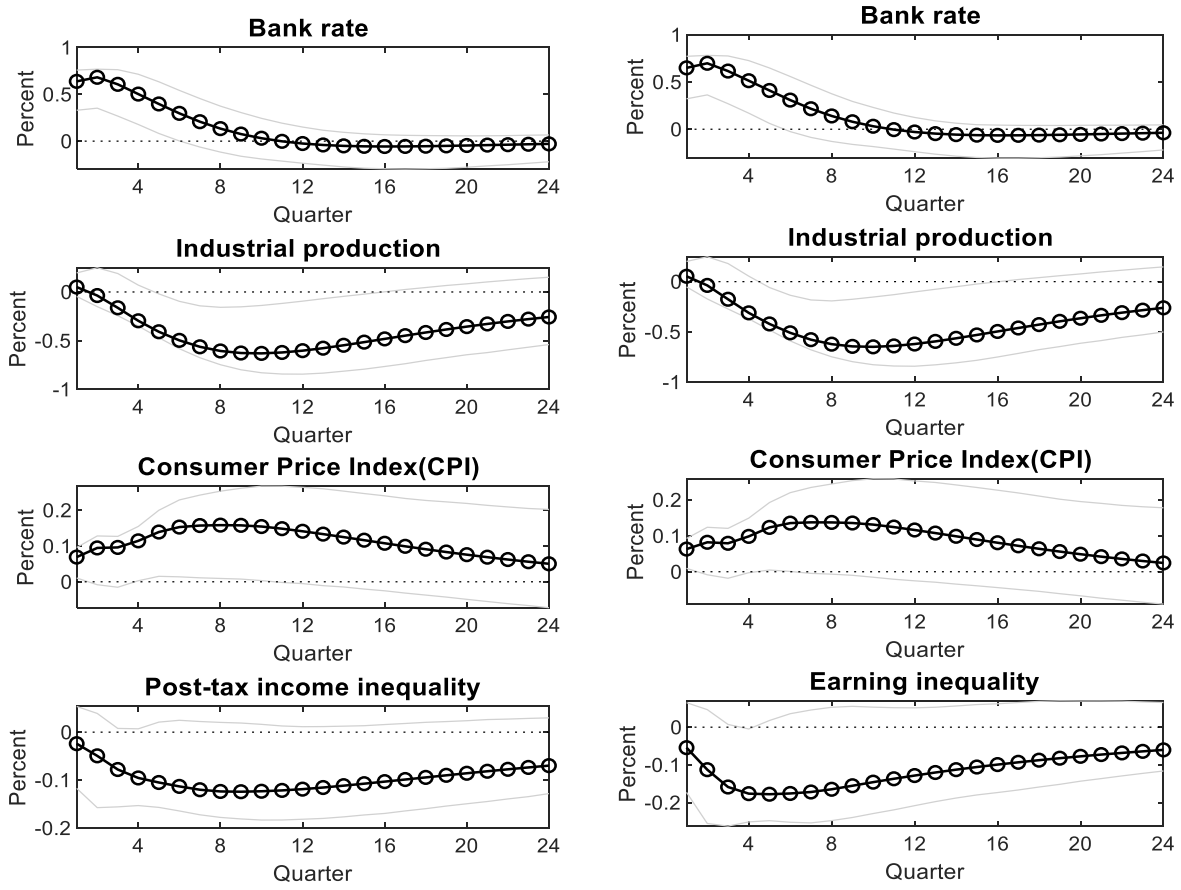
	α=0.10				α=0.05				α=0.01			
	b=0.80	b=0.90	b=0.95	b=0.99	b=0.80	b=0.90	b=0.95	b=0.99	b=0.80	b=0.90	b=0.95	b=0.99
n												
2	5.31	7.61	11.20	36.04	6.51	9.06	12.96	39.18	9.12	12.13	16.61	45.42
3	4.85	7.38	11.82	43.24	5.77	8.53	13.28	46.03	7.73	10.92	16.26	51.50
4	4.58	7.24	12.03	46.42	5.35	8.22	13.30	48.92	6.96	10.23	15.85	53.78
5	4.40	7.12	12.09	48.19	5.07	7.98	13.23	50.47	6.46	9.74	15.50	54.87
6	4.27	7.03	12.11	49.31	4.87	7.81	13.14	51.41	6.10	9.39	15.20	55.45
7	4.17	6.94	12.08	49.98	4.71	7.65	13.04	51.93	5.83	9.10	14.93	55.69
8	4.09	6.86	12.05	50.47	4.59	7.53	12.94	52.30	5.61	8.86	14.70	55.83
9	4.01	6.79	12.00	50.77	4.48	7.41	12.84	52.51	5.43	8.66	14.49	55.83
10	3.95	6.73	11.96	51.03	4.39	7.32	12.76	52.67	5.28	8.49	14.31	55.83
11	3.90	6.68	11.92	51.21	4.31	7.24	12.68	52.78	5.15	8.34	14.15	55.80
12	3.86	6.64	11.90	51.41	4.25	7.17	12.61	52.92	5.04	8.22	14.02	55.80
13	3.82	6.59	11.86	51.50	4.19	7.10	12.54	52.95	4.95	8.10	13.89	55.73
14	3.78	6.55	11.82	51.59	4.14	7.04	12.48	52.99	4.86	8.00	13.78	55.66
15	3.75	6.52	11.79	51.70	4.09	6.99	12.43	53.05	4.78	7.91	13.68	55.63
16	3.72	6.48	11.76	51.73	4.05	6.93	12.38	53.04	4.71	7.83	13.58	55.53
17	3.69	6.46	11.73	51.80	4.01	6.89	12.33	53.07	4.65	7.75	13.50	55.50
18	3.67	6.43	11.71	51.85	3.98	6.85	12.29	53.08	4.60	7.68	13.42	55.44
19	3.65	6.40	11.68	51.89	3.95	6.81	12.25	53.09	4.54	7.62	13.34	55.38
20	3.62	6.38	11.66	51.91	3.92	6.78	12.21	53.08	4.50	7.56	13.27	55.31

Note: The F statistic is from the projection of the de-meaned proxy variable on the VAR errors. n is the VAR dimension, 1-b is the level of asymptotic bias, α is the level of statistical significance.

source: Lunsford (2015)

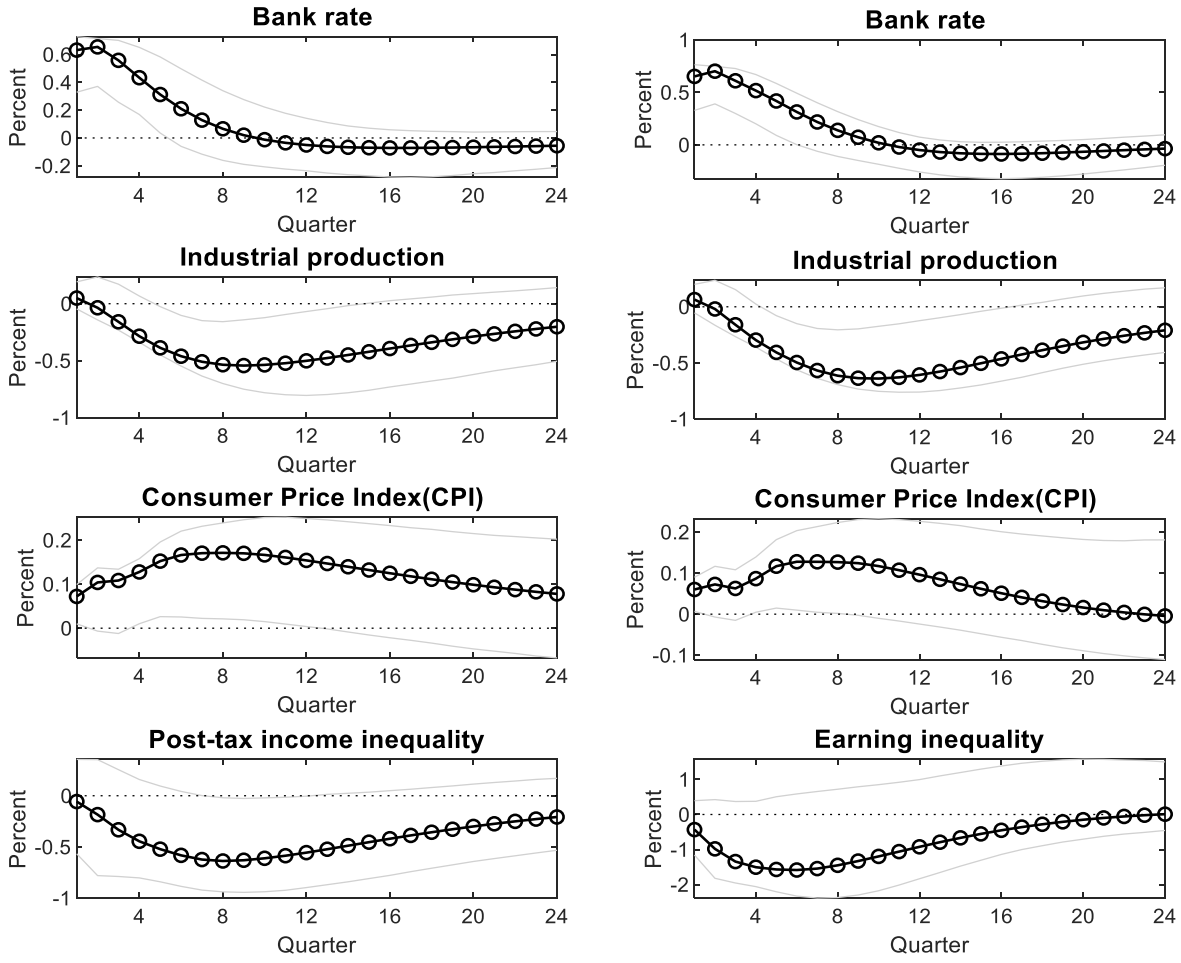
Appendix B: Supplementary Figures

Appendix Figure 1: The effect of the contractionary monetary policy on macroeconomic variables and inequality measure in Gini Coefficient



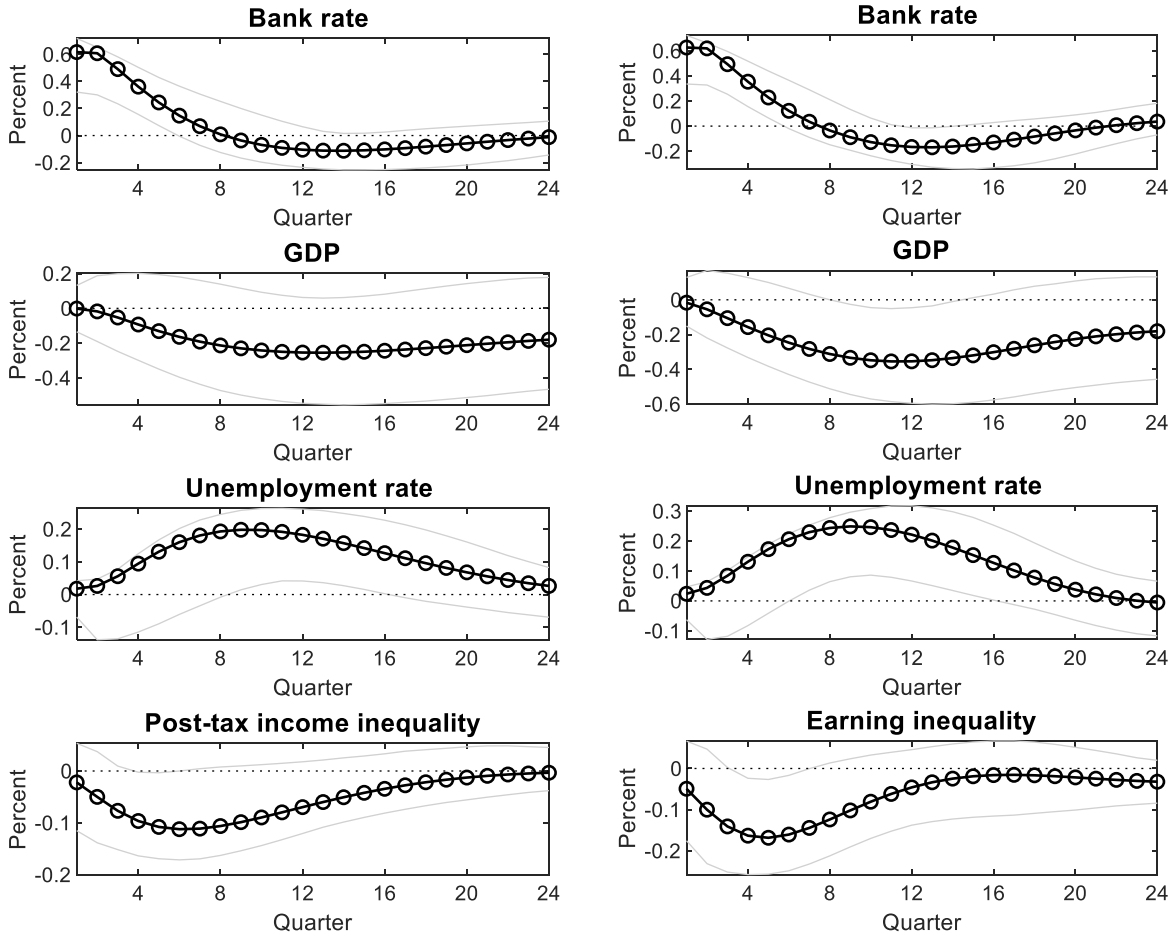
Note: Impulse response to a one percentage point contractionary monetary policy from the baseline VAR (solid line with circles) with confidence 95 percent confidence bands in the gray line. Column A: include Bank rate, log (Industrial index), log (consumer price index), Gini of post-tax income. Column B: same macro variables as column B and Gini of earnings. The lag is set at 3. Sample period: 1982Q1-2011Q4. The Proxy variable is the new measure of monetary policy by champagne and Sekkel (2018)

Appendix Figure 2: The effect of the contractionary monetary policy on macroeconomic variables and inequality measure of 90th-10th percentile



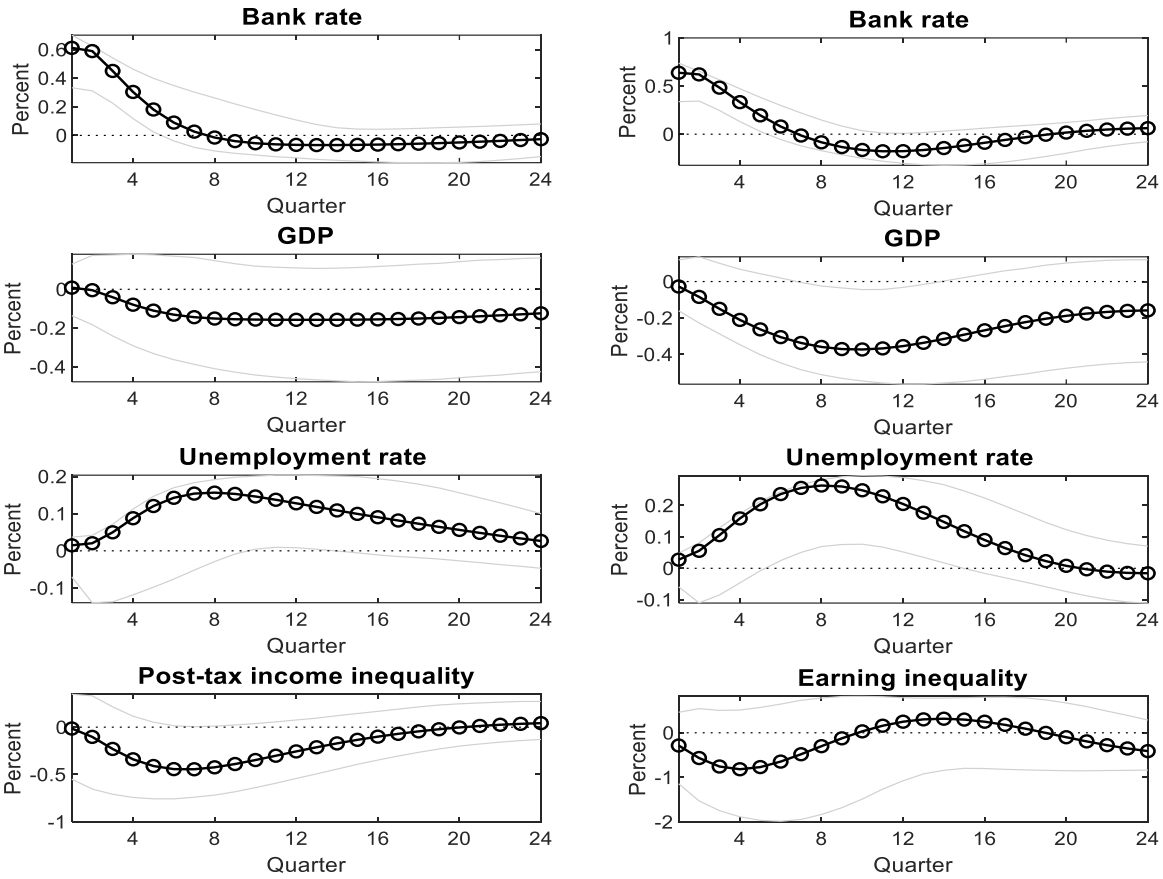
Note: Impulse response to a one percentage point contractionary monetary policy from the baseline VAR (solid line with circles) with confidence 95 percent confidence bands in the gray line. Column A: include Bank rate, log (Industrial index), log (consumer price index), 90th-10th percentile difference of post-tax income. Column B: same macro variables as column B and 90th-10th percentile difference of earnings. The lag is set at 3. Sample period: 1982Q1-2011Q4. The Proxy variable is the new measure of monetary policy by Champagne and Sekkel (2018)

Appendix Figure 3: The effect of the contractionary monetary policy on macroeconomic variables and inequality measure in Gini Coefficient



Note: Impulse response to a one percentage point contractionary monetary policy from the baseline VAR (solid line with circles) with confidence 95 percent confidence bands in the gray line. Column A: include Bank rate, log (GDP), unemployment rate, Gini of post-tax income. Column B: same macro variables as column B and Gini of earnings. The lag is set at 2. Sample period: 1982Q1-2011Q4. The Proxy variable is the new measure of monetary policy by champagne and Sekkel (2018)

Figure 4: The effect of the contractionary monetary policy on macroeconomic variables and inequality measure in 90th-10th differential percentiles



Note: Impulse response to a one percentage point contractionary monetary policy from the baseline VAR (solid line with circles) with confidence 95 percent confidence bands in the gray line. Column A: Bank rate, log (GDP), unemployment rate, 90^{th}-10^{th} percentile difference of post-tax income. Column B: same macro variables as column B and 90^{th}-10^{th} percentile difference of earnings. The lag is set at 2. Sample period: 1982Q1-2011Q4. The Proxy variable is the new measure of monetary policy by Champagne and Sekkel (2018)