Distributional Impacts of Low for Long Interest Rates

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23 April 2019

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ABSTRACT: This paper asks whether tepid inflation in Canada since the financial crisis can in part be explained by the effects of monetary policy on inequality. Using different structural vector autoregression models we show that expansionary monetary policy post-crisis has led to increased inequality as more resources are shifted away from lower-income individuals, which in general have higher marginal propensities to consume. As a result, aggregate demand has not risen as much as it otherwise would have, leading to a more muted inflationary response. Our results suggest that failure to account for the heterogeneity of consumption responses across the income distribution could lead to an underestimation of the magnitude of inflation's response to a monetary policy shock.

JEL Classification Numbers: E25, E31, E52

Keywords: monetary policy, inequality, inflation puzzles

Introduction

Inflation targeting has been a relative success in many countries around the globe since its popularity rose in the early 1990s (see Parkin 2016). Leading up to the early 1990s, high inflation, high interest rates, were widespread, including in Canada. However, with the adoption of inflation targeting, Canada, and many of its peers, saw both inflation and interest rates come down, and volatility in economic activity stabilize.

However, the 2007-08 Great Recession upended both the economy, and, in some cases, the confidence of different populations in macroeconomic policy. Monetary policy, on the other hand, in the post-crisis world, has often been relied on, especially with governments unable to agree on fiscal policy. But there is a limit to the tools and capabilities of central banks. Despite rock-bottom interest rates, and different forms of unconventional monetary policy, central banks around the world have had trouble hitting their inflation targets (see Ambler and Kronick 2018).

In this paper, we look at the role of inequality in monetary policy transmission. Specifically, we ask whether monetary policy, in particular during the low for long interest rate period after the Great Recession, has had any impact on income distribution, i.e. inequality, and whether that change in income distribution has had any impact on inflation through the different consumption baskets, and different marginal propensities to consume, that characterize different income quintiles.

The link between monetary policy, inequality and inflation requires two things to be true. First, monetary policy shocks must have an exogenous impact on inequality[1]. Second, the response of demand, and therefore inflation, to a monetary policy shock must differ across the income distribution. If true, then the new composition of the income distribution as a result of a monetary policy shock matters for the aggregate impact on inflation from that shock.

We begin the analysis by showing that inequality in Canada has, indeed, changed over the whole sample period (1997 to 2015), and in particular, in the post-Great Recession period. To do this, we calculate the Gini coefficient using monthly income from the Labour Force Survey (LFS) and follow Villarreal (2016) by extracting monthly income residuals from a regression on a standard set of observables.

The results indicate increasing inequality in the lead up to the crisis, with inequality declining since. Drilling down, we find that median income growth has outpaced top decile income growth, but not lowest decile growth. The question then is whether monetary policy acted to facilitate this declining inequality or acted as more of a brake.

[1] To the extent that a significant portion of income inequality can be traced back to individual observable characteristics, these need to be accounted for before estimating the response of inequality to monetary policy shocks. Regarding shocks, in the context of an inflation targeting regime where monetary policy adheres to a predetermined rule, and where agents are assumed to be forward-looking, monetary policy shocks refer to the unanticipated or non-systematic shifts in nominal interest rates.

Before answering this question, we investigate whether consumption baskets differ across the income distribution. Following the methodology in Cravino et al. (2018), we first gather data from the Survey of Household Spending (SHS) which details money spent, by income quintile, on different goods and services. This allows us to put a weight on different goods and services for different consumption baskets across the income quintiles. Using CPI data broken down by product group, we are able to calculate the complete set of income quintile-adjusted consumption baskets. Importantly, we find a similar hump-shaped inflation volatility as in the US results in Cravino et al., which answers the question of whether demand responds differently across the income distribution.

We then use two specifications of a structural vector autoregression (SVAR) to determine whether monetary policy affects inequality and whether this contributed to tepid inflation post-crisis through its differing effects on the heterogeneous consumption baskets.

In both cases, we use the exogenous monetary policy shock series generated in Champagne and Sekkel (forthcoming). In a simple SVAR, we identify responses recursively using a Cholesky decomposition where the variables are ordered as follows: first, the commodity price index, to account for the importance of energy prices to the Canadian economy, second, the US Federal Funds Rate, to account for the importance of US monetary policy on Canadian monetary policy, third, the Champagne and Sekkel monetary policy shock series, followed by inflation, and, last, the Gini coefficient. We estimate this SVAR for the case where the Gini coefficient is accounted for and the case where it is not.

We find that expansionary monetary policy increases inflation, as expected, in both cases, i.e. with and without accounting for inequality. However, we find that when we do not account for inequality we get a more tepid inflation response, especially early on. The implication is that there is a link between inequality and inflation that if not controlled for, has the effect of biasing down the inflationary response. We also find that expansionary monetary policy does increase inequality. The implication of these two findings is that an increase in income inequality, as a result of an expansionary monetary policy shock, leads to a more tepid inflation response. The muted inflation response reflects both the heterogeneity of marginal propensities to consume across the distribution, as well as the different levels of price stickiness exhibited by consumption baskets across income levels.

The question then becomes what transmission mechanism explains both the increase in inequality and the tepid inflation response from a monetary policy shock when inequality is not accounted for. To answer this question we estimate a second SVAR where based on the specification of a structural model, in addition to US output growth and inflation, we include changes in the real effective exchange rate, the evolution of consumption and investment, and consumer price inflation. To account for household inequality we include the growth gap between compensation of employees and gross operating surplus, which are the two main streams that constitute household disposable income. As before, we use the Champagne and Sekkel monetary policy shock series. The impulse responses are identified by imposing both long-run and sign restrictions on the model coefficients. The results confirm that unanticipated reductions of the nominal interest rate increase household income inequality, and that the omission of the determinants of household income and consumption heterogeneity biases the response of inflation downwards.

Our results lead to one particularly important conclusion for monetary policy: namely that the Bank of Canada needs to account for the impact of heterogeneity on the transmission of monetary policy.

Historically, inequality was perhaps less of a concern for central bankers, as one would expect the effects of monetary policy to even out through a business cycle marked by both increases and decreases in the overnight rate. However, with a decade of low interest rates, this is likely no longer a sufficient argument.

The central bank, rightfully, is not responsible for inequality directly. However, our results make clear that not accounting for heterogeneity might lead to false conclusions concerning the likely impact of a monetary policy shock on inflation.

Our results fit into two important strands of the literature. First, as part of the literature investigating why monetary policy has often been unable to hit inflation targets since the financial crisis. Specifically, we identify one rarely investigated avenue: inequality, or heterogeneity. While some (see Cravino et al. 2018) have studied the monetary policy – inequality link in large economies like the US, as far as we can tell we are the first to study the link in the context of a small open economy[2]. Why this is important has to do with the second strand of literature our results fit into: namely the work on heterogeneous agents and complete – or incomplete – markets. Typically, when heterogeneous agent modeling is extended into small open economies, an equation for uncovered interest rate parity (UIP) is added. By definition, the UIP equation assumes markets are complete, in the Arrow-Debreu sense. However, our results show that people at different income quintiles are impacted differently by monetary policy shocks. The implication is these heterogeneous agents are not able to insure themselves completely against shocks. In other words, markets are incomplete. If true, then the UIP equation is inappropriate for inclusion into small open economy heterogeneous agent structural models. Our empirical results should aid researchers in the development of more appropriate alternatives.

From the perspective of the Economic Commission for Latin America and the Caribbean, the study of the Canadian case is of interest because the availability of sub-annual data facilitates the analysis of the impact of the conduct of monetary policy on the functional distribution of income, which is considered to be one of the major drivers of inequality over the medium-term.

This paper proceeds as follows: section 2 describes a set of Canadian stylized facts, including the tepidness of inflation post-crisis, the changing inequality over this period, and the different consumption baskets across different income quintiles; section 3 describes the two SVAR models we use to analyze the impact of monetary policy on inequality, how that affects monetary policy's ability to influence inflation, and the accompanying results; section 4 provides a set of robustness checks; section 5 concludes.

Stylized Facts

The question this paper asks is whether low for long interest rates in Canada have had any impact on income distribution, and whether changes to the distribution have contributed to tepid inflation post-crisis. For this investigation to be worthwhile, we need to establish some stylized facts. First, we need to show that Canada did indeed experience lower than expected inflation post-crisis – the so-called missing

[2] Although Canada is the world 10th largest economy in nominal terms, it is considered a small open economy because despite the size of its GDP its policies do not in general affect world prices or interest rates.

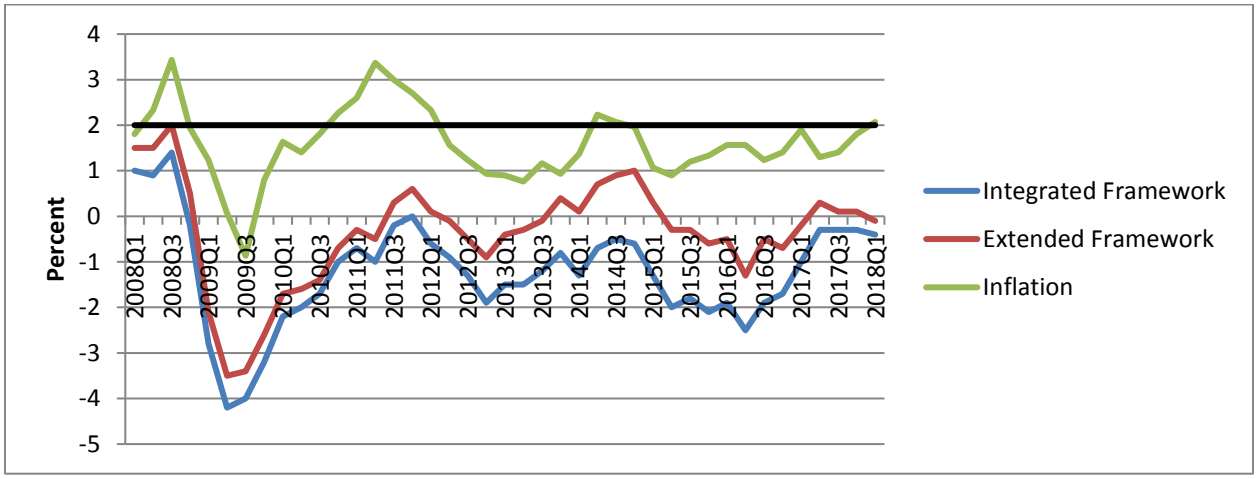
inflation puzzle.[3] Second, we need to show that there has been some change in income distribution over this period, and that different income quintiles/deciles are associated with different consumption baskets. If true, then changes to the income distribution are likely to impact inflation through differences in price rigidities across the goods making up the different consumption baskets, and through the diverse marginal propensities to consume across different income quintiles.

Tepid Inflation

Two inflation puzzles have dominated the literature post-crisis: missing disinflation over the 2009Q4 to 2011Q4 period, and missing inflation thereafter (see, for example, Williams 2010 and Friedrich 2014). Missing disinflation refers to the fact that inflation remained robust in many economies despite significant economic slack. The missing inflation puzzle, on the other hand, reflects the fact that many countries failed to hit their inflation targets - or to significantly stimulate inflation in non-inflation targeting countries - despite the closing of respective output gaps. In 2017, for example, Ambler and Kronick (2018) show that only 8 of 25 selected OECD countries hit their inflation targets, and the median gap was 45 basis points.

Canada averaged 1.63% inflation from October 2009 to April 2018, almost 40 basis points below their 2% inflation target. Canada was also not immune to either inflation puzzle. During the 2009Q4 to 2011Q4 period, inflation averaged 2.15% despite a negative output gap using either of the Bank's two output gap measures (Figure 1).[4] Similarly, despite economic slack largely disappearing since 2012, inflation has struggled to hit the 2% target, averaging only 1.45%.

Figure 1: Inflation and the Output Gap – 2000-2018



Explanations of these puzzles, both in Canada and abroad, have often focused on the Philips curve relationship between inflation and some measure of economic slack (either unemployment or the output gap). Over the period in question, estimated inflation, generated using a simple Philips curve regression

[3] See Friedrich 2014 for more on this global phenomenon.

[4] The extended framework, or, more formally, the extended multivariate filter (EMVF), was developed by Butler (1996), improved on over the years, and is the primary tool for the Bank of Canada to measure both past and present potential output. The integrated framework (IF) is a more recent development, and allows for a deeper and more robust economic analysis of potential output. See Pichette et al. (2015) for more on both measures.

with inflation as the dependent variable and the output gap and inflation expectations of professional forecasters as independent variables, does a poor job matching actual inflation (see Friedrich 2014). This suggests omitted variables are at play.

Friedrich (2014), using a panel of countries including Canada, and Kronick and Omran (2018) who focus specifically on Canada, are among those that have investigated what these possible omitted variables might be. At the global level, Friedrich finds that household inflation expectation and fiscal policy are critical for explaining the inflation puzzles, and when added to the standard Philips curve relationship, help explain the gap between estimated and actual inflation. As inflation expectations become better anchored, inflation itself becomes less reactive to movements in economic slack. The improved explanation for the puzzle from the use of household forecasts over professional forecasts is due to its additional volatility, a result that largely reflects the importance of movements in energy prices.

The importance of fiscal policy is the more surprising result. One would expect inflation expectations to already take into account fiscal policy. If governments plan on going into deficit for the foreseeable future, inflation expectations should increase. However, that does not appear to be the case in Friedrich's results. Therefore, the effect must work through the economic slack variable – in this case, unemployment. He finds the expected constant negative relationship between fiscal policy and unemployment in the pre-crisis and beginning of the crisis periods (i.e. unemployment increases (decreases) as the budget balance deteriorates (improves)). However, this relationship breaks down in the latter part of the crisis, with the correlation turning positive following the combination of austerity policies in the EU, which improved the budget balance, but did not slow down unemployment.

Kronick and Omran in their Canadian study find that financial market uncertainty, the extent to which economic growth is broad-based, and real estate prices are key drivers in explaining Canadian inflation dynamics. There is extensive work on the link between financial market uncertainty and inflation. Jovanovic (2012), for example, finds that as financial market uncertainty increases, central banks allow for more inflation, leading to an increase in inflation volatility. The link between the breadth of economic growth and inflation is, in part, related to the degree to which economic growth is evenly spread. The more evenly spread economic growth is, the higher the marginal propensities to consume, and thus, the stronger the effect on aggregate demand and inflation. Lastly, the link between real estate prices and inflation has been well-documented. Benjamin et al. (2004) and Case et al. (2005) have, for example, shown that rising real estate prices lead to higher household consumption, resulting in stronger economic growth and more robust inflation.

Other potential causes for undershooting of the inflation target in Canada include results from Kronick and Ambler (2018a, 2018b) who show that demographics, specifically an aging population, have acted as a drag on the transmission of monetary policy to the real economy. The basic idea is that aging populations, who take on less debt, are therefore less sensitive to movements in interest rates, making it more difficult for the central bank to affect spending and savings decisions. Friedrich and Gosselin (2015) find that increased competition levels in the retail sector have also worked as a drag on inflation.

Despite work in this area, more can be done to narrow in on the causes and explanations of missing inflation post-crisis, especially as the Bank of Canada begins to turn its focus towards the 2021 inflation-control agreement with the Government of Canada.

Changes to the Income Distribution

Now that we have established Canada's tepid inflation post-crisis, we turn to the evolution of inequality, through a study of the Gini coefficient. Specifically, we focus on the Gini coefficient for monthly income using Labour Force Survey data from Statistics Canada. We follow Villarreal (2016) and extract the portion of monthly income that cannot be explained by a set of standard observables. In other words, we extract and evaluate the monthly income residuals in order to calculate the Gini coefficient.

A few reasons for our use of the income-based Gini coefficient over the wealth-based Gini coefficient. First, household spending patterns are often better reflected by movements in the income-based Gini.[5] Second, when economists discuss the link between marginal propensities to consume/save and inflation, we do so with income as the denominator. Lastly, there is research to suggest that, in Canada, wealth distribution has not significantly changed much over the period under analysis. Specifically, as noted in Uppal and LaRochelle-Cote (2015), "In 2012, families in the top income quintile held 47% of the total wealth held by Canadian families, compared with 45% in 1999. Families in the bottom income quintile held 4% of the overall net worth in 2012, compared with 5% in 1999."

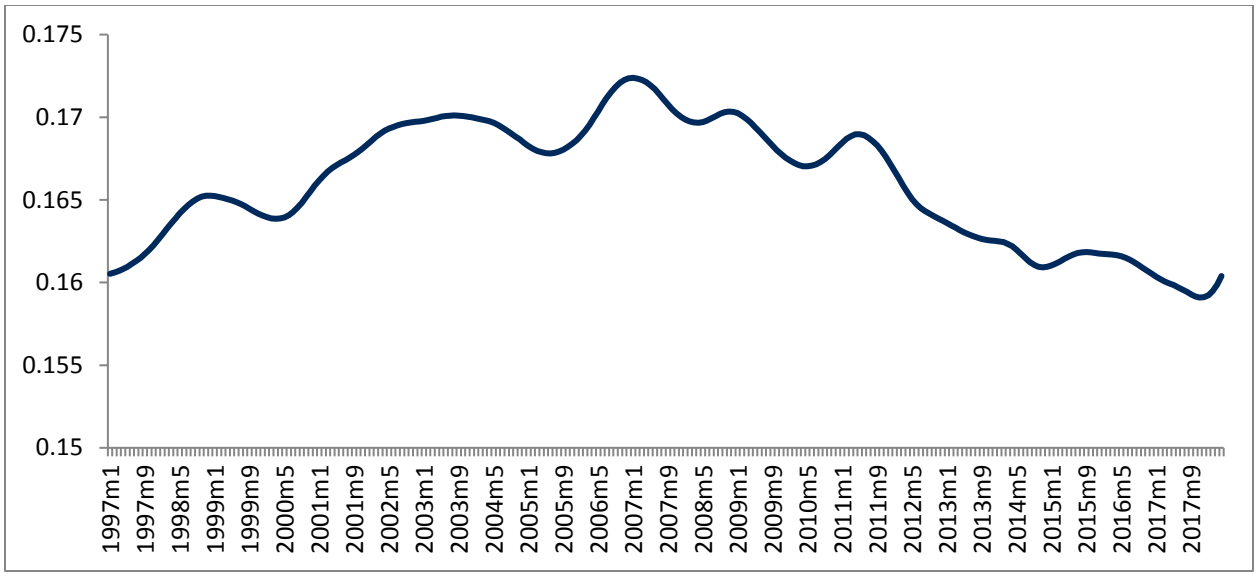
To generate these income-based Gini residuals we run a regression with monthly income as the dependent variable, and independent variables including the square polynomial on age (a proxy for experience), a variable on whether someone has finished a post-secondary degree (a proxy for ability), and other binary variables for marital status, female or male, urban area, and industry. We extract the estimated median income, and subtract this estimated variable from actual median income, giving us a set of residuals we use to estimate the Gini coefficients.

The results indicate increasing income inequality in the years leading up to the crisis, after a fall in the late 1990s (Figure 2)[6]. However, income inequality improves towards the end of the crisis, and thereafter.

Figure 2: Gini Coefficient – Monthly Income, Residuals

[5] See, for example, Dossche et al. (2018).

[6] Gini coefficient is smoothed using the LOWESS method with a bandwidth of 0.15. This means 15% of the data are used to smooth each point. Smaller bandwidths adhere to the data more closely.

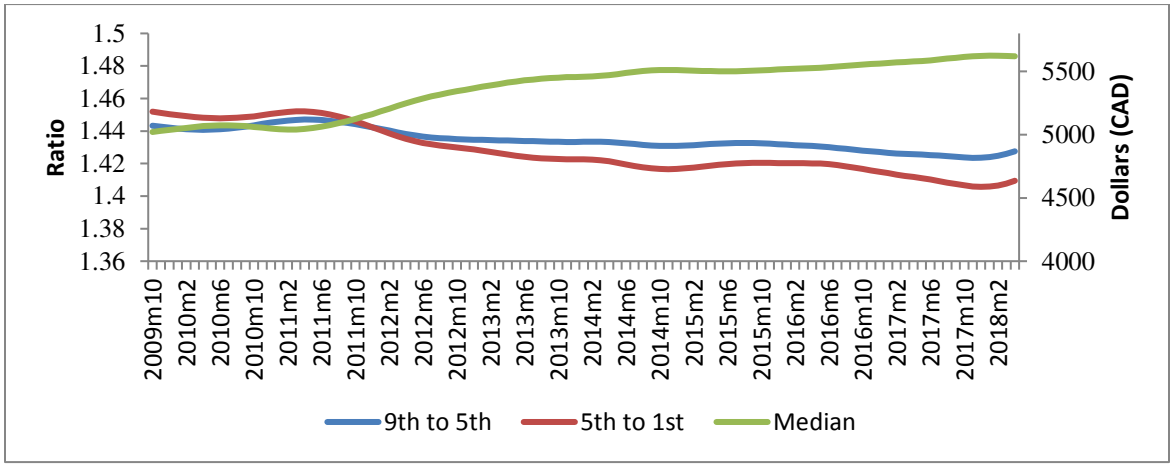


While interesting, this paper is not a narrative on whether or not inequality has improved, but rather what role changes to the income distributions have on monetary policy transmission. Therefore, what is key for us is that there has been movement across the income distribution in the post-crisis period – regardless of direction.

The question then becomes what specific changes to the deciles have led to changes in income distribution. To answer this question, we graph, over the post-crisis period, the 9th to 5th decile ratio, 5th to 1st decile ratio, and median monthly income (Figure 3).

The steady decline in the Gini coefficient post-crisis for monthly income appears to be driven by declines in both the 9th to 5th and 5th to 1st ratios. Since median income increased during this period, the implication is it grew faster than income at the top decile, but slower than income at the lowest decile.

Figure 3: Monthly Income, Residuals – Median, 9th to 5th, 5th to 1st deciles



Consumption Baskets Across the Income Distribution

Why does understanding movements in the different income deciles across time matter for monetary policy transmission? To quote from Cravino et al. (2018): "If the effects of monetary shocks on prices are heterogeneous across types of goods (Boivin et al. 2009), and consumption baskets differ across the income distribution (e.g., Almas 2012), then shocks will differentially affect the prices faced by households of different incomes." In Cravino et al's US study, they find that prices for goods and services in higher-income household consumption baskets are stickier and incur lower volatility. As a result, CPIs for higher income households ought to be less responsive to a monetary policy shock than the CPIs for middle income households. Indeed, that is what the authors find: the responses of CPIs for higher income households to a monetary policy shock are 22% lower than those of middle-income households. Of course, the differences in these volatilities may either reflect differences in marginal propensities to consume across income quintiles, rigidities in the goods/services themselves, from say higher menu costs, or a combination of both.

Key for Canada is whether we can show that a) different income quintiles have different consumption baskets, and b) whether price movements for those different baskets have differed across the post-crisis time period. To perform this exercise we follow the methodology in Cravino et al. (2018) using Canadian data.

Our first step was to collect data from the Survey of Household Spending (SHS). The SHS data details money spent on food, clothing, shelter, and other items to better understand the spending habits of Canadians. Thankfully, for our study, the data is available at different income quintiles. This data allows us to calculate the percentage of money spent on a particular product group by household income quintile. It also allows us to associate a weight to a corresponding expenditure category for a household in a particular income quintile. We label this w_j^h where j is the product category and h is the income quintile.

Another key piece of information is monthly CPI data broken down by product group. This allows us to determine how the prices of different product groups move across time. We label this variable $p_{j,t}$ where j is the product category and t is time.

The final step is to calculate the movement of the prices associated with different consumption baskets across different income quintiles over time. Unfortunately, the categories for the SHS and the CPI data do not match exactly. However, where there are differences we were able to match two categories that were fairly close in description. The formula for the income quintile adjusted consumption-basket CPI is: $p_t^h = \sum_j w_j^h p_{j,t}$.

Like Cravino et al. (2018) in their US analysis, we find a hump-shaped result for volatility in inflation, with high income households in Canada experiencing lower volatility compared with middle-income households (Figure 4). However, the lowest volatility occurs at the lowest income quintiles, unlike Cravino et al.'s study where high-income households experience the lowest volatility. This also reflects itself in average inflation over the post-crisis period, which was lowest for low income households.

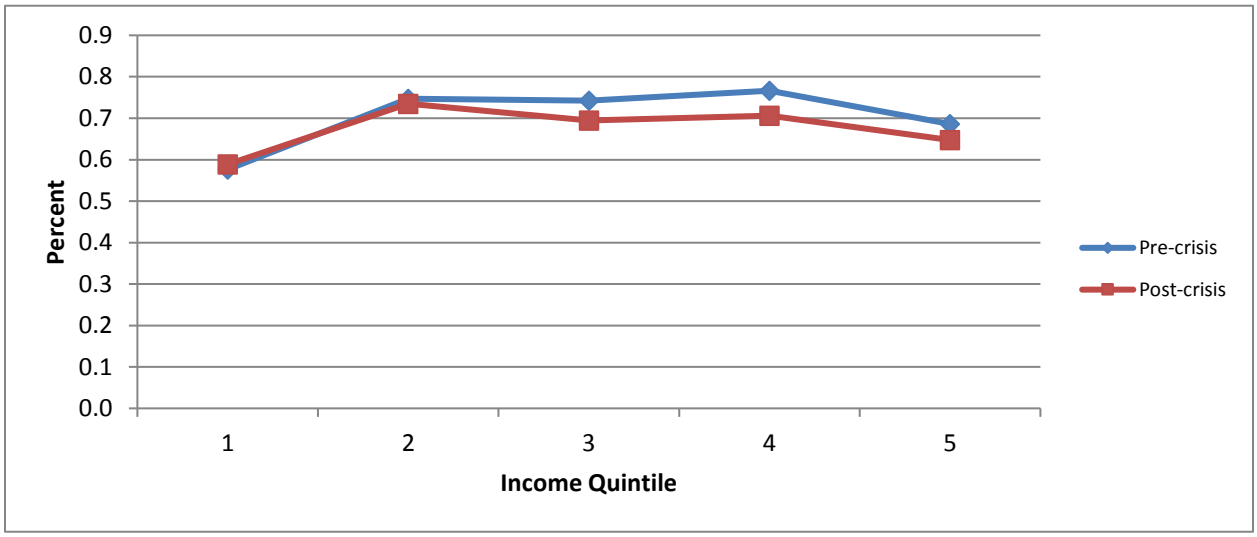
One explanation for this difference with Cravino et al.'s US work comes from Friedrich and Gosselin (2015) who, as we mentioned above, discuss evidence of increased competition in Canada's retail sector, as a result of new and bigger retailers. Walmart, who transformed themselves into a supercenter selling

food and other general merchandise, is but one example of big retailers that have added to the competitive pressures experienced by Canadian retailers. As a result, Canada has experienced lower than normal inflation in food and non-durable goods. The Bank itself estimated that more intense competition in these sectors subtracted around 0.3 percentage points from inflation in 2012-2013.

How does this relate to income distribution? As Argente and Lee (2015) show for the 2004-2010 period, prices of groceries and general merchandise purchased by low income households increased by more than those of high income households in the US. Therefore, if lower income households caught a break in Canada from increased competition for these goods, that might explain their relatively lower inflation and volatility.

In any event, the key point of interest for this paper is the fact that there are different consumption baskets at different income quintiles in Canada, and there are different price sensitivities of the goods that make up these consumption baskets.

Figure 4: Inflation Standard Deviation, CPI by Income Quintile



What we are left with from this analysis is tepid post-crisis inflation in Canada, income distribution that looks different today than it did a decade ago, and consumption baskets that differ across different income quintiles with different price sensitivities across the goods and services that make up these baskets. This begs the question whether monetary policy post-crisis has contributed to changes in the income distribution and if it has, these differences in consumption baskets and price sensitivities might help explain the missing inflation puzzle in Canada.

SVAR Models and Results

In order to estimate whether the change in the income distribution, as a result of monetary policy, can explain Canada's post-crisis missing inflation, we first need a method to identify exogenous monetary policy shocks. To do this, we turn to the work of Champagne and Sekkel (2017).

For many years, one of the common approaches to monetary policy shock identification was to use structural vector autoregressions (SVAR) with a Cholesky decomposition in which a central bank policy rate is ordered last after other macroeconomic variables of interest. The implication of this structure is that monetary policy takes into consideration a set of macroeconomic variables contemporaneously while these other macroeconomic variables are unaffected by contemporaneous monetary policy. If true, the error terms in the SVAR are uncorrelated, and we are able to identify the unique effect of a monetary policy shock on the other variables in the system.

However, this structure has often led to price puzzles in which there is at best a significant lag before prices move in the expected direction following a monetary policy shock, or worse prices move in a counterintuitive direction.[7] This has led to the advancement of different identification approaches including the narrative approach pioneered by Romer and Romer (2004). This is the approach used by Champagne and Sekkel (forthcoming).

The narrative approach involves first estimating a central bank's reaction function. The resulting estimated policy rate changes are then compared with actual changes in the policy rate. The difference between the two changes represents the unexpected, or exogenous, monetary policy shock.

As noted in Kronick and Ambler (2018), the Champagne and Sekkel Bank of Canada reaction function consists of:

- "one- and two-quarter ahead forecasts of real output growth and inflation;
- the now-cast and the real-time one-quarter lag of these variables;
- revisions to the forecasts relative to the previous round of forecasts;
- the intended policy rate two weeks before a Bank announcement; and
- the unemployment rates over the previous three months."

Champagne and Sekkel also control for the lagged levels and changes of the FFR and lagged USD/CAD dollar exchange rate. A big departure from Romer and Romer (2004), this reflects the importance of US economic activity on the Canadian economy. Furthermore, given the big change to Canada's monetary policy framework with the adoption of inflation targeting in 1991, the sample is broken into two subsamples: 1974-1991 and 1992-2015.

Basic SVAR

With this well-identified monetary policy shock series in tow, we turn to estimating its impact on income distribution, and whether these changes to the income distribution have affected the transmission of monetary policy onto inflation.

We start with a simple SVAR where we estimate the impact of monetary policy shocks on inflation in the case where income distribution is controlled for, and the case where it is not.

[7] Kim and Roubini (2000)

More formally, we assume a series of Canadian macroeconomic variables can be modeled using the following structural form:

$$B_o Y_t = c_0 + B_1 Y_{t-1} + \cdots B_p Y_{t-p} + \varepsilon_t,$$

where Y_t is a vector of endogenous variables. For our purposes, when we control for income distribution, the vector is given by $Y_t = [p_t, i_t^{US}, i_t, \pi_t, g_t]$, where p_t is the commodity price index, i_t^{US} is the US Federal Funds Rate, i_t is Champagne and Sekkel's monetary policy shock series, π_t is inflation, and g_t is the Gini coefficient, estimated using the residual method for monthly income, as discussed above. Therefore, B_i is a 5x5 matrix for each $i = 0,1, \ldots p$, and ε_t is a 5x1 vector of error terms or structural shocks. The only difference in the case where the income distribution is not controlled for is we remove the Gini coefficient.

Our shock series is monthly, and our test period using the basic SVAR runs from 1997m1-2015m10. The commodity price index comes from the Bank of Canada, the US FFR comes from the Federal Reserve Economic Data database, we use all-items CPI to calculate year-over-year inflation from Statistics Canada Table 18-10-0004-01, and the Gini coefficient, as mentioned, is from our estimation methodology above using the residual monthly income method.

We note that all variables except the Champagne and Sekkel shock series are integrated of order 1, i.e. are unit root, or non-stationary (Table 1). In order to run the SVAR in levels we need to first turn Champagne and Sekkel's stationary shock series into an I(1) variable, which we do by cumulating it. Then we need to test for cointegration amongst the variables, which we do using Johansen's trace statistic method, which gives us one cointegrating relationship.

We test for optimal lag length using both the Hannan and Quinn information criterion (HQIC) and the Schwarz's Bayesian information criterion (SBIC): for both these criterion, four is the optimal lag length.

Table 1: Unit Root Tests – Test Statistic

	(1) KPSS - Levels	(2) KPSS – 1st Difference
Commodity Price Index	0.687***	0.046
U.S. Federal Funds Rate	1.94***	0.0602
Monetary Policy Shock	0.269***	0.0106
Inflation	0.524**	0..0193
Gini coefficient	1.18***	0.116

All tests are analyzed at lag length 4 given the results of the HQIC and SBIC tests for the SVAR itself.
KPSS null hypothesis is variable is stationary
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In both the case with and without income distribution, we assume a lower triangular Cholesky decomposition for B_0. In other words, the main diagonal of B_0 is scaled to 1, there are zeros above the diagonal, and open contemporaneous coefficients to be estimated below the diagonal. By ordering the Champagne and Sekkel shock series where we do in the Y_t vector, the implicit argument is that the commodity price index and US FFR have a contemporaneous effect on Canadian monetary policy, while inflation and income distribution do not. On the other hand, Canadian monetary policy can have a contemporaneous effect on both inflation and the income distribution.

We present the results following an expansionary monetary policy shock on both inflation where income distribution is controlled for (Figure 5), and when it is not (Figure 6). The magnitude of the shock is a one unit standard deviation.

Figure 5: Impulse response function – expansionary monetary policy shock on inflation controlling for income distribution

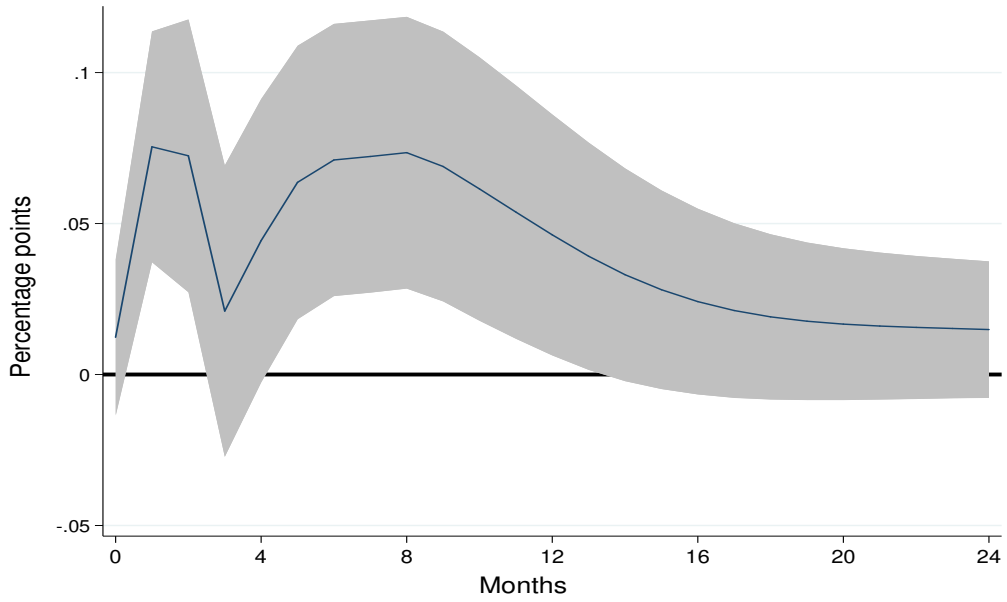
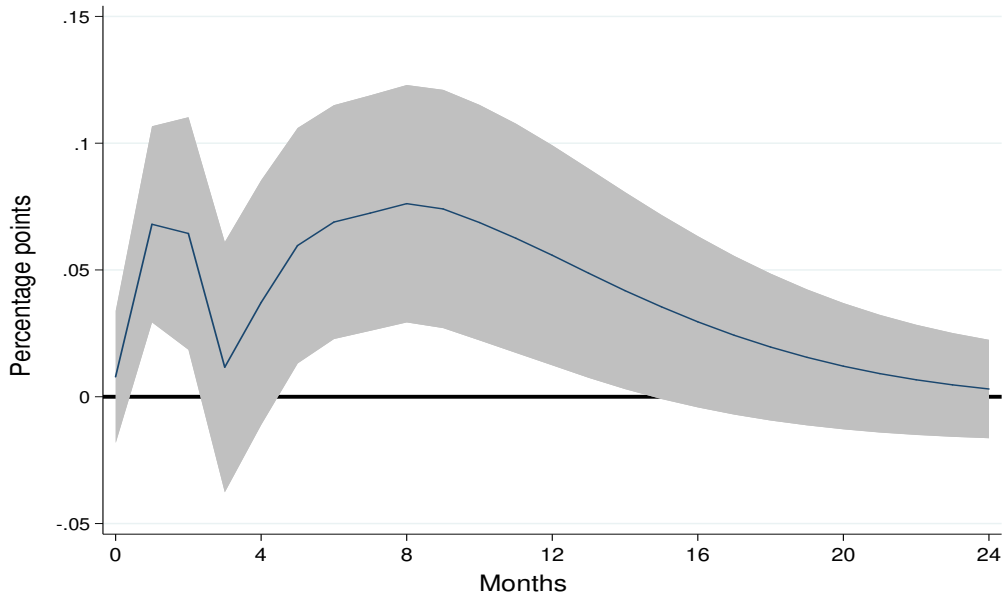


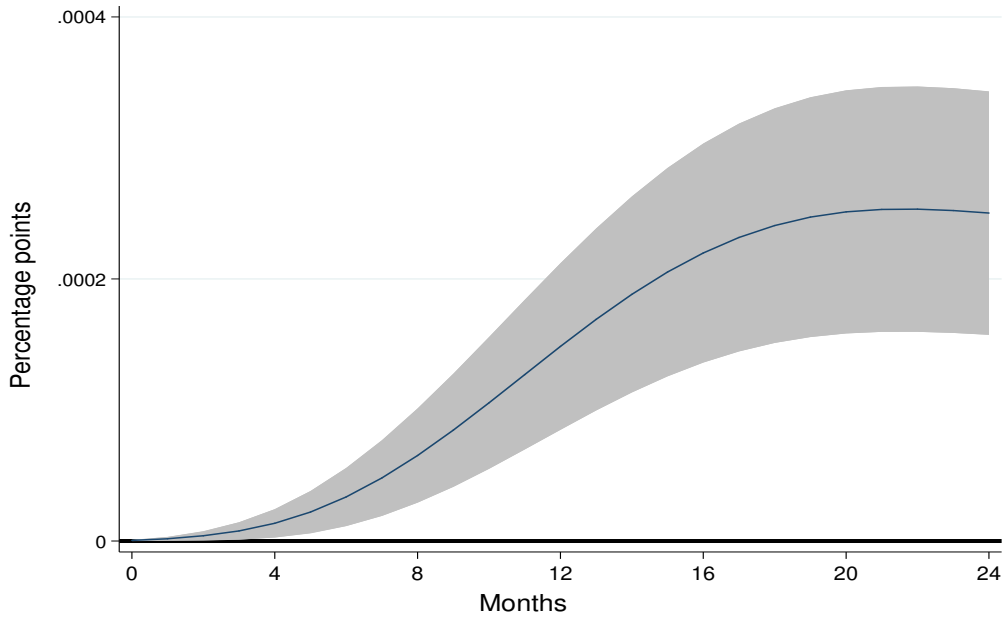
Figure 6: Impulse response function – expansionary monetary policy shock on inflation, no control for income distribution



Expansionary monetary policy has the expected effect of increasing inflation in both cases. The graphs look similar, and certainly, any difference between the point estimates of the two graphs would lie within the confidence interval of the other. Two things stand out, however. First, the peak after month 1 is higher in the case where inequality is controlled for: 7.5 basis points versus 6.8 basis points. Second, the cumulative impact on inflation is larger for the first 12 months after the shock, again, in the case where inequality is controlled for. In other words, when inequality is not controlled for, an expansionary monetary policy shock produces a more tepid inflationary response.

These results suggest a potential role for income distribution in the story of monetary policy transmission on inflation. As indicated in Figure 7, expansionary monetary policy appears to increase inequality.

Figure 7: Impulse response function – monetary policy shock on inequality



The question then becomes why: in other words, what is the transmission mechanism whereby monetary policy affects inequality, and how does that translate to inflation. To answer these questions, we turn to a more detailed SVAR.

Detailed SVAR

According to the results emerging from work on heterogeneous agent models (Kaplan and Violante, 2018), one of the key differences between mainstream quantitative macroeconomic models featuring a representative agent, and richer specifications featuring heterogeneous agents facing uninsurable risks is the relative magnitude of the direct and indirect effects of monetary policy shocks on macroeconomic aggregates.

Focusing on household decisions, direct effects refer to those that impinge upon consumption allocations when households' disposable incomes are held constant. The most important direct effect is the intertemporal effect that occurs as households shift consumption across time, in response to real interest rate changes. In a general equilibrium context, monetary policy also influences other aggregates, which eventually feed back into households' decisions. Salient among these indirect effects is the impact of monetary policy on the income streams that constitute disposable income from which households finance their current and future consumption.

While both effects are present in models with and without household heterogeneity, in the latter, the assumption of a representative household implies that the response of household consumption to monetary policy shocks are dominated by the direct intertemporal substitution effect (Cochrane, 2015). As shown in the literature reviewed by Kaplan et al. (2018), the negligible role of indirect effects on households' consumption is inconsistent with empirical evidence.

Model specification and data

Considering this, to assess the impact of household heterogeneity on the monetary policy transmission mechanism we contrast the responses of selected macroeconomic aggregates to an expansionary monetary policy shock under two alternative specifications. Under both specifications, long-run (Blanchard and Quah, 1989) and sign (Faust, 1998; Canova and Nicoló, 2002; Uhlig, 2005) restrictions are used to identify the responses of the variables in the model to a monetary policy shock, within the context of a structural vector autoregressive model.

The selection of variables is based on the structural general equilibrium model of a small open economy proposed by Lubik and Schorfheide (2007). Considering the relevance of the United States economy for Canada, the United States serves the role of the rest of the world for Canada. Thus, the specification includes US output growth (Δy^*), and US personal consumption expenditures inflation (π^*). Following Cushman and Zha (1997), US variables are assumed to be exogenous with respect to Canadian variables in the long-run, and US output to be exogenous to US inflation in the long run. Domestic variables include the depreciation of the real exchange rate ($\Delta reer$), the evolution of consumption (c) and gross fixed capital formation ($gfcf$), and consumer price inflation (π). As in the previous SVAR, monetary policy shocks (i^{mp}) are assumed to be exogenous, and the shock series identified by Champagne and Sekkel (forthcoming) is employed.

The base specification, which is standard in the analysis of monetary policy in small open economies[8], does not take into consideration the effect of monetary policy on household heterogeneity. Considering the

[8] Recent examples include Cushman and Zha (1997) for Canada, Parrado (2001) for the case of Chile, Villani and Warne (2003) for the case of Sweden, Haug et al. (2013) for the case of Poland, and Carrillo and Elizondo (2015) for the case of Mexico.

relevance of the relationship between household's asset portfolios and their marginal propensities to consume, we introduce the effect of household heterogeneity into the specification by additionally considering the evolution of the gap between compensation of employees and gross operating surplus. A higher value of the gap implies that more of the value added in the economy is distributed as labor compensation, whereas lower values of the gap imply a relatively higher share of value added accruing to capital. Using the gap captures both the main determinants of disposable income, as well as an alternative measure of inequality.

Since the evolution of both the compensation of employees, the gross operating surplus and the difference between them responds to factors beyond monetary policy, we use a residual measure of the gap. A major determinant of the compensation of employees and its relative share in aggregate income, is the composition of the labor force. Considering this, the residual measure of the gap is obtained by regressing the level of the gap, expressed in 2007 prices, on the proportion of the labor force that are male, married, post-secondary graduates, and residents of metropolitan areas. Additionally, the regression considers the distribution of workers across industries[9], as well as their age composition, and the average number of hours worked. The residual gap measure corresponds to the residuals from the regression[10].

Estimation

The model is estimated using quarterly data for the period 1992Q1 through 2015Q3. We go back further than the basic SVAR case in order to make up for lost observations from our forced use of quarterly data, which arises from our more expansive set of macroeconomic aggregates. The start date corresponds to the adoption of an inflation targeting regime by the Bank of Canada. Data on domestic variables comes from Statistics Canada, whereas data on US variables comes from the Federal Reserve Bank of St. Louis' FRED database. Consumption and gross fixed capital formation are expressed as percentage deviations from their trends, which are obtained using the Hodrick and Prescott (1997) filter with a smoothing parameter equal to 1600. The monetary policy shock series is expressed in percentage terms, whereas the residual gap is measured as a proportion of GDP. The remaining variables are measured as the percentage change of quarterly seasonally adjusted series over the same quarter in the preceding year.

In addition to block exogeneity restrictions on US variables, the estimation imposes sign restrictions on the responses of domestic variables to a monetary policy shock, where an unanticipated decrease of the nominal interest rate results in a contemporaneous depreciation of the real effective exchange rate, and contemporaneous expansions of both the consumption and gross fixed capital formation gaps, and inflation. Estimation is carried out using the generalization of the Rubio-Ramírez et al. (2010) algorithm proposed by Binning (2013)[11]. Lag length selection is based on the Bayesian information criterion (Schwarz, 1978), which suggests a single lag for both specifications.

[9] Industries are identified using NAICS'2-digit codes.

[10] While the estimation started with a very general specification, which included all available regressors, the final residual measure was obtained from a reduced model. The reduction was carried out following the procedure of Hendry and Krolzig (2001)

[11] The use of sign restrictions leaves the VAR model under identified (Preston, 1978) implying that, in principle, several decompositions of the reduced-form residuals satisfy the imposed restrictions. The algorithm iteratively simulates decompositions until 10,000 draws that satisfy the imposed restrictions are kept. To select the reported impulse responses, we use the median target criterion proposed by Fry and Pagan (2005, 2011), which can be

Results

Panels (a) through (e) in Figure 8 contrast the responses of, respectively, the nominal interest rate (a), the consumption (b) and gross fixed capital formation (c) gaps, inflation (d), and the real effective exchange rate (e) to an expansionary monetary policy shock of 25 basis points.[12] Solid lines depict the responses of the model specification ignoring the effect of household heterogeneity in the transmission of monetary policy, and dashed lines depict responses considering the effect of monetary policy on the functional distribution of income.

Under both specifications, as a response to a monetary policy shock, there is a contemporaneous increase in the consumption and gross fixed capital formation gap, resulting from the income substitution effect that was discussed previously, which in turn leads to higher inflation and a depreciation of the real effective interest rate.

While the dynamics of the responses under both specifications are qualitatively similar, both the magnitude of the contemporaneous responses, as well as the dynamics of adjustment towards equilibrium are differentiated. Of particular interest is the response of inflation to an expansionary monetary policy shock, where despite inflation on impact being of a higher magnitude when heterogeneity is not controlled for, it is subsequently higher for the SVAR where heterogeneity is controlled for. The higher magnitude after impact, and for the first year or so, is consistent with our findings in the basic SVAR.

The differences in both magnitude and speed of adjustment reflect an omitted variable bias when heterogeneity is not accounted for. The direction of the bias depends on the relationship between the omitted variable and the response we are interested in, as well as between the omitted variable and the other regressors. In our case, an increase in inequality should in principle have a negative contemporaneous relationship with inflation. An increase in inequality shifts resources away from lower income households, which in general have higher marginal propensities to consume. The effect is expected to result in lower aggregate demand and thus lower inflation. Turning to the relationship between monetary policy and inequality, the evidence indicates that an unanticipated reduction of the nominal interest rate increases inequality; in other words, the association between the variables is negative. The negative association between regressors means that when inequality is omitted its negative effect on inflation will be picked up by the monetary policy shocks resulting in a magnitude lower than expected inflation.

As depicted in panel (f), which shows the response of the gap between the compensation of employees and gross operating surplus, in response to an unanticipated decrease in the nominal interest rate, the rate at which gross operating surplus expands is larger than the growth rate of the compensation of employees, which results in a negative response of the gap. The downward spike observed one quarter after the impact likely reflects nominal wage rigidities, which once resolved, exacerbates the response of inflation when heterogeneity is accounted for.

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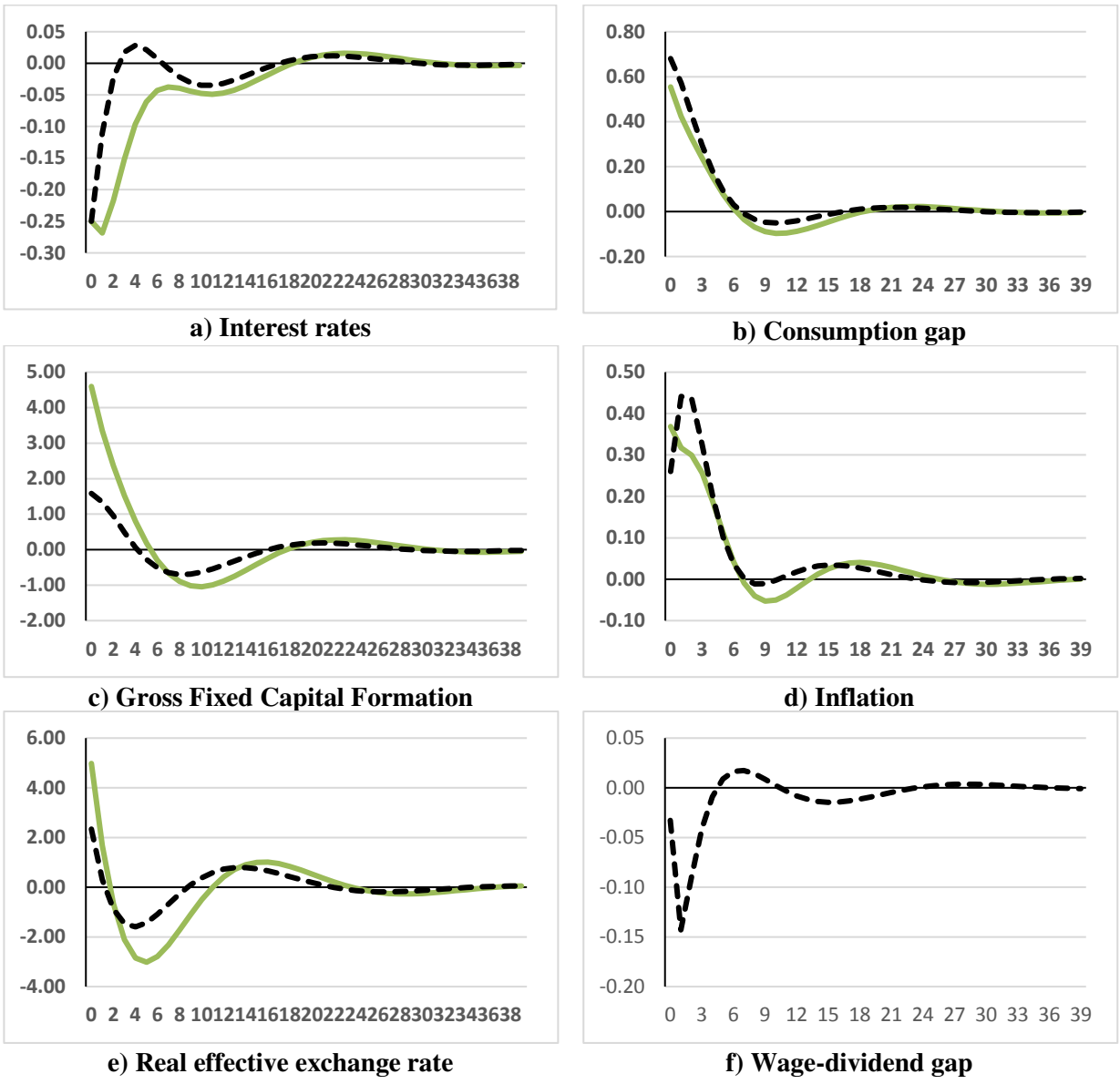
thought of as an optimization procedure which identifies the draw which is closest to the median of the joint distribution of the system's variables.

[12] Note that the 25 basis points used here is marginally higher than the size of the shock in the simple SVAR where using a unit of standard deviation. While quantitatively the impulse responses here will be greater (in absolute terms), qualitatively the results will be the same.

To the extent that capital ownership is concentrated in higher income households, the negative gap means that expansionary monetary policy increases inequality by shifting resources away from lower income households.

The smaller magnitudes in the responses of both gross fixed capital formation and the real effective exchange rate when heterogeneity is considered reflects the faster adjustment path towards equilibrium of the interest rate. This is because if agents are rational and anticipate a faster return of interest rates to equilibrium, the response of gross fixed capital formation would be smaller in the presence of adjustment costs. For the case of the real effective exchange rate, the difference in the responses could reflect the interaction of the dynamics of the short-term interest rate and the rest of the yield curve.

Figure 8: Responses to a 25 basis points expansionary monetary policy shock
(Percentages)



Note: Dashed (solid) lines correspond to responses when heterogeneity is (not) considered

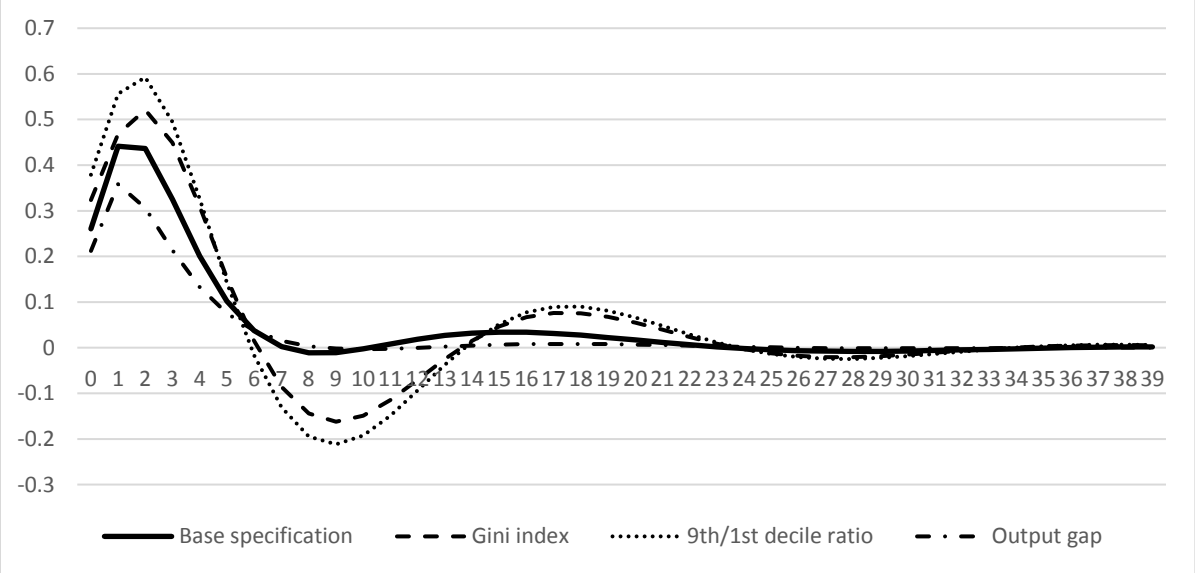
Robustness

To assess the sensitivity of the findings to alternative assumptions, we estimated the model discussed in the previous section under different specifications.

Figure 9 contrasts the evolution of the impulse response of inflation to an unexpected reduction of 25 basis points in the nominal interest rate under our base specification (solid line), with the responses obtained using the residual Gini coefficient (dashed line),the residual income ratio of the 9th decile with respect to the 1st decile (dotted line), and the use of the aggregate output to account for the cyclical position of the economy (dashed-dotted line).

Figure 9: Responses of inflation to a 25 basis points expansionary monetary policy shock under alternative specifications

(Percentages)



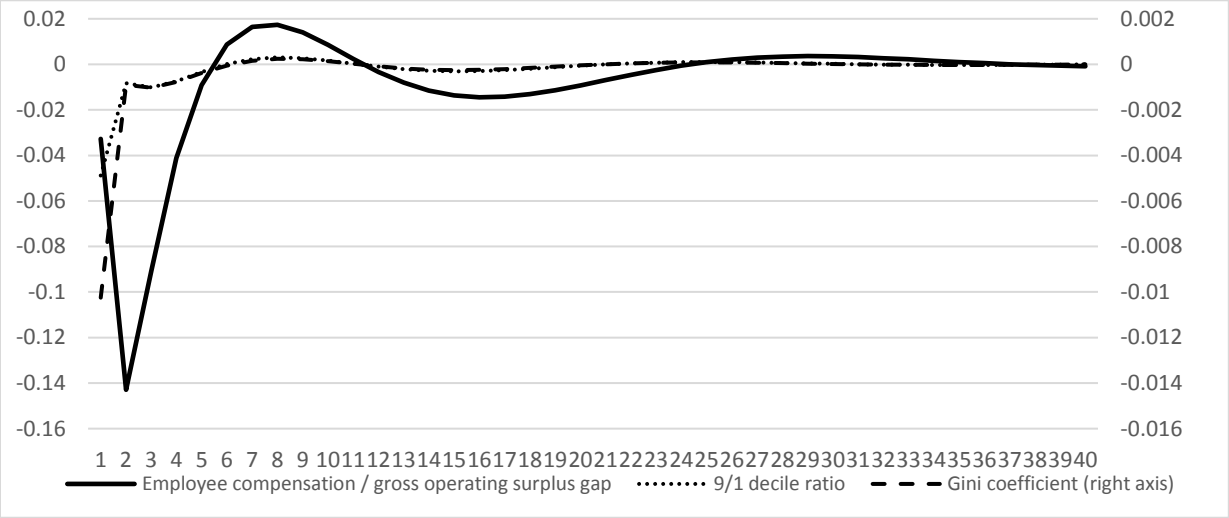
Despite the dispersion in the size of the short-run responses, they are of a similar order of magnitude, and in each case, safe for the output gap, they have a larger response compared with the case where heterogeneity is not controlled for. Moreover, the dynamics towards equilibrium are similar under the considered alternatives. It should be noted that the specifications that use the Gini coefficient and the decile ratio to account for the heterogeneity in household income, are estimated using monthly data from January 1997 through September 2015, which might partially explain the wider fluctuations observed in the responses with respect to the base specification.[13]

Figure 10 plots the responses of alternative measures of household's income inequality to an expansionary monetary policy shock; in particular, the 9th /1st decile ratio, and the Gini coefficient. Although the responses

[13] Impulse responses from monthly sampled data are accumulated at the quarterly frequency to ensure comparability with the base specification.

differ in both magnitude and the speed of adjustment towards equilibrium, reflecting the different nature of the measures used, we observe an increase in inequality regardless of the specification.

Figure 10: Responses of alternative measures of households' income inequality to a 25 basis points expansionary monetary policy.
(Percentages)



Conclusion

We showed in this paper that inequality matters for the transmission of monetary policy in Canada onto the real economy. We focused on the post-crisis expansionary monetary policy environment, which was characterized largely by below-target inflation. Specifically, we found that expansionary monetary policy led to the redistribution of a greater share of resources towards higher income households through its impact on the functional distribution of income. Because higher income individuals are characterized as having lower marginal propensities to consume, a shift of resources towards this group results in a lower response of aggregate demand to a monetary policy shock, depressing the impact on inflation.

These results matter for both central bankers and fiscal policymakers. For the Bank of Canada, their mandate is to target inflation, making inequality, rightfully, of second-order importance. However, it is useful for their purposes to have a complete picture of the transmission mechanism. These results present an argument for factoring heterogeneity into the Bank of Canada's forecasting models.

The conditioning role of household inequality on the transmission of monetary policy is the result of the inability of a proportion of households to insure themselves against the occurrence of idiosyncratic shocks, such as wage or unemployment shocks (Kaplan et al., 2018). Thus, an implication of the results is that the effectiveness of monetary policy would benefit from complementary public policies aimed at addressing the root causes of inequality. As argued by Dávila et al. (2012), depending on the nature of idiosyncratic shocks, alternative fiscal policy instruments could be relevant.

From a broader public policy perspective, the findings highlight the importance of designing and implementing policies aimed at addressing the root causes of inequality among households, as well as broadening the aims of macroeconomic policy beyond maintaining nominal stability to include measures to promote a structural change characterized by higher productivity and an improved distribution of available resources.

In Canada, the debate over a Guaranteed Annual Income (GAI) has renewed since its heyday in the 1960s and 70s. The reason for its return can be traced to a lack of progress in fighting poverty, and the inability of current social policy tools to get things right. However, as Hicks (2017) argues, big GAI programs are unlikely to be the panacea. Instead, given technology and data sources, one approach for fiscal policymakers in Canada could include:

- integrated services to match individual needs, such as skill-enhancement programs that are designed for those persistently poor;
- better access to income supports for those that face occasional low-income periods; and
- a more targeted GAI program that makes incremental changes to existing programs to selected groups, such as children, the working poor, and those with disabilities.

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