Distributional impacts of low for long interest rates

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This publication should be cited as: Jeremy Kronick and Francisco G. Villarreal, "Distributional impacts of low for long interest rates", *Studies and Perspectives series - ECLAC Subregional Headquarters in Mexico*, No. 180 (LC/TS.2019/46-LC/MEX/TS.2019/10), Mexico City, Economic Commission for Latin America and the Caribbean (ECLAC), 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 offset otherwise falling inequality through the shifting of resources 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 overestimation of the magnitude of inflation's response to a monetary policy shock.

Introduction

Inflation targeting has been a relative success in many countries around the globe since its popularity rose in the early 1990s (Parkin, 2016). Leading up to this period, 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 2007-2008 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 (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

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[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.

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 sample period (1992 to 2015). Results are mixed on the behaviour of inequality during our time period, particularly post-financial crisis. For example, Canada's statistical agency, Statistics Canada, produces three annual measures: adjusted market income, adjusted total income, and adjusted after-tax income. In each case inequality increases until the early to mid-2000s, and either remains at this elevated level thereafter or drops.

However, all these measures fail to account for observables, such as experience, which are inherently unequal. We, therefore, calculate a more appropriate 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.

Regardless of the post-crisis direction of inequality, the question is whether monetary policy acted to facilitate declining inequality or acted as more of a brake.

Before answering this question, we investigate whether consumption baskets differ across the income distribution. Following the methodology in Cravino and others (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 United States results in Cravino and others, which answers the question of whether demand responds differently across the income distribution.

We then use two structural vector autoregression (SVAR) specifications to determine whether monetary policy impacts 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 (2018). We use a simple SVAR to first determine the impact of expansionary monetary on inequality, as measured by our preferred Gini coefficient. 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 United States Federal Funds Rate (US FFR), to account for the importance of United States monetary policy on Canadian monetary policy, third, the Champagne and Sekkel monetary policy shock series, followed by inflation, and, last, the Gini coefficient.

We find that expansionary monetary policy does increase inequality. With this result in hand, we estimate a second SVAR, based on a structural model and the Champagne and Sekkel shock series, to: (a) determine whether there is a difference in the impact of an expansionary monetary policy shock in inflation in the case where inequality is controlled for and the case where it is not, and (b) if there is a difference, what is inequality proxying for, i.e. what is the transmission mechanism.

The structural model, in addition to United States output growth and inflation, includes 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 which constitute households' disposable income. 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 upwards. In other words, if central banks were to run the model without accounting for inequality, the response of inflation would be higher than it is in reality.

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: households' income inequality. While some (Cravino and others, 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 (ECLAC), 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 I 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 II 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, the accompanying results as well as a set of robustness checks; section III concludes.

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[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.

I.   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 these changes 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 inflation puzzle.[3] Second, we need to show that there has been some change in income distribution over this period, and that different income percentiles 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.

A.   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; Friedrich, 2016). 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.

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[3]   See Friedrich (2016) for more on this global phenomenon.

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 (see 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

Source: Bank of Canada, on the basis of Statistics Canada [online database] https://www.bankofcanada.ca/rates/indicators/capacity-and-inflation-pressures/, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810000401.
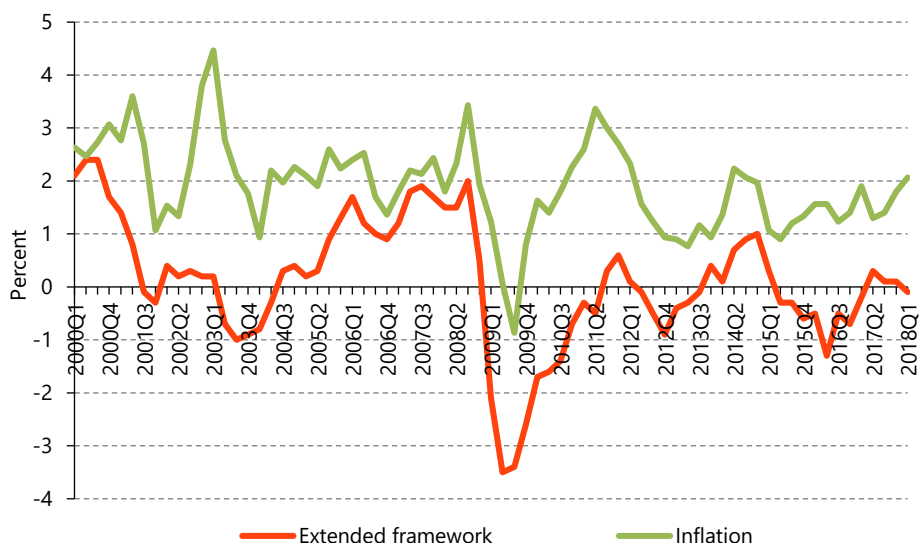
Explanations of these puzzles, both in Canada and abroad, have often focused on the Phillips curve relationship between inflation and some measure of economic slack (either unemployment or the output gap). Over the period in question, estimated inflation, generated using a simple Phillips curve regression 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 (Friedrich, 2016). This suggests omitted variables are at play.

Friedrich (2016), 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 expectations and fiscal policy are critical for explaining the inflation puzzles, and when added to the standard Phillips 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.

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[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 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 add the extent to which economic growth is broad-based as a key driver in explaining Canadian inflation dynamics. 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 average marginal propensity to consume, which, all else being equal, causes a stronger effect on aggregate demand and inflation.

Other potential causes for undershooting of the inflation target in Canada include results from Kronick and Ambler (2018a and 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.

B. Changes to the income distribution

Now that we have established Canada's tepid inflation post-crisis, we turn to the evolution of income inequality, through a study of the Gini coefficient. Critical for this paper, is that inequality has changed throughout our period of analysis: 1992–2015. Regardless of direction, variation in inequality allows us to ask whether monetary policy has acted as a drag or supported an improvement.

There are many measures of income inequality. Canada's statistical agency, Statistics Canada produces three annual measures of income inequality going back to 1976: adjusted market income, adjusted total income, and adjusted after-tax income.[5] As figure 2 shows, income inequality was on a steady rise throughout the 1990s and into the 2000s, and has largely stabilized, or even dropped from its peak since. That said, all three measures are well above where they were when the Bank of Canada became an inflation-targeting central bank in 1991.

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[5] Total income is income from all sources before income taxes and deductions. Market income is total income before tax less income from government sources. After-tax income is total income less income taxes. According to Statistics Canada, "in order to take into account the economies of scale present in larger households, the different types of income are adjusted by dividing the household income by the square root of the household size."

Figure 2
Statistics Canada Gini coefficient measures: adjusted market, total, and after-tax income, 1976-2017
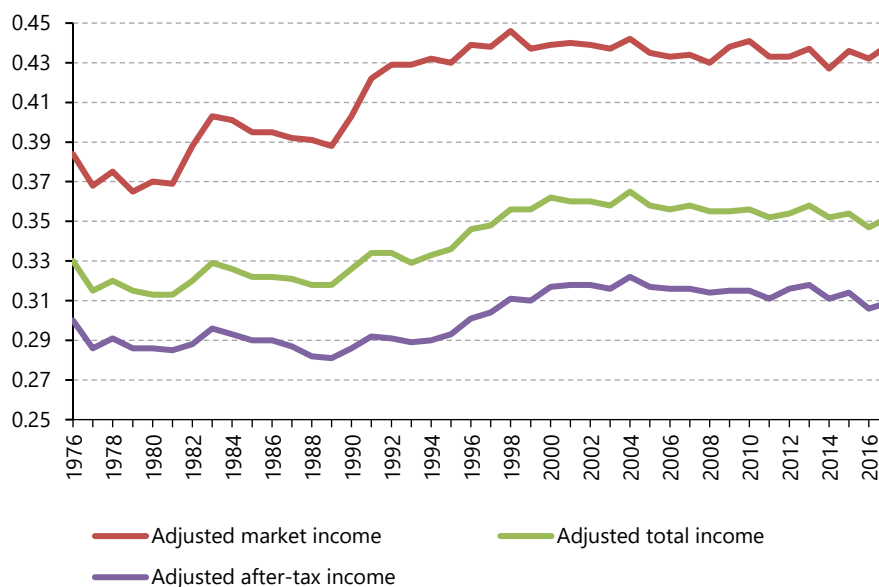
Source: Statistics Canada [online database] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110013401.

The evolution of these measures reflects changes in income inequality across households, as well as changes in key observable households' characteristics, such as schooling and age of the household head. Therefore, to account for the evolution of observables, we focus on the Gini coefficient for monthly income using Labour Force Survey data from Statistics Canada, where 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.

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, sex, geographic area, and industry of employment. We extract the estimated median income, and subtract this estimated variable from actual median income, giving us a set of residuals, which we use to estimate the Gini coefficient across time.

Before turning to the results, a quick detour to explain 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.[6] 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

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[6]   See, for example, Dossche and others (2018).

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."

Going back to the results, we see increasing income inequality in the years leading up to the crisis (see figure 3).[7] However, income inequality improves towards the end of the crisis, and thereafter. The unavailability of LFS monthly pre–1997 prevents us from determining where inequality sits relative to its level when the Bank of Canada became an inflation-targeting central bank.

Figure 3
Gini coefficient: monthly income, residuals, 1997-2017
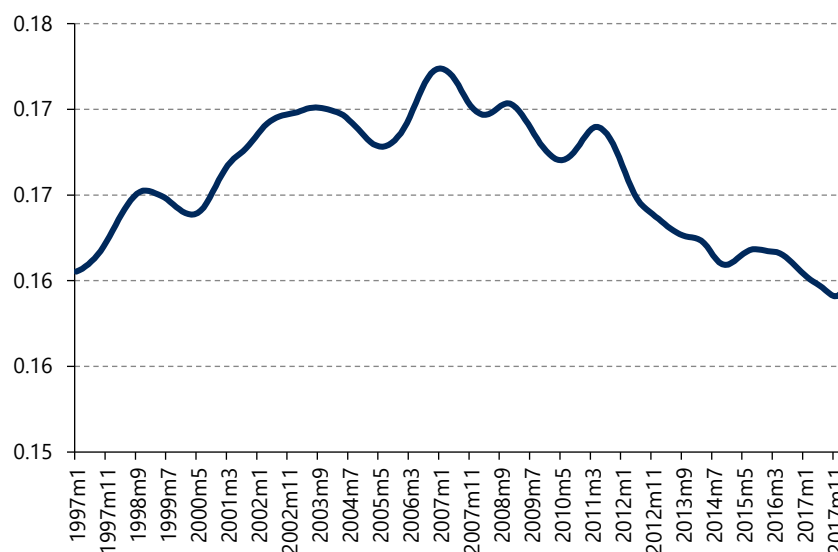
Source: Prepared by the authors, on the basis of Statistics Canada [online database] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110013401.

While the direction of inequality in the economy is interesting, this paper is concerned with the role of expansionary monetary policy on households' inequality. Therefore, what is key for us is that there has been movement across the income distribution in the post-crisis period —regardless of direction.

C. 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 and others (2018): "If the effects of monetary shocks on prices are heterogeneous across types of goods (Boivin and others, 2009), and consumption baskets differ across the income distribution (Almas, 2012), then shocks will differentially affect the prices faced by households of different incomes." In Cravino and others' United States 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's what the author's find: the responses of CPIs for higher income

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[7]   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.

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 period. To perform this exercise, we follow the methodology in Cravino and others (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: $p_t^h = \sum_j w_j^h p_{j,t}$.
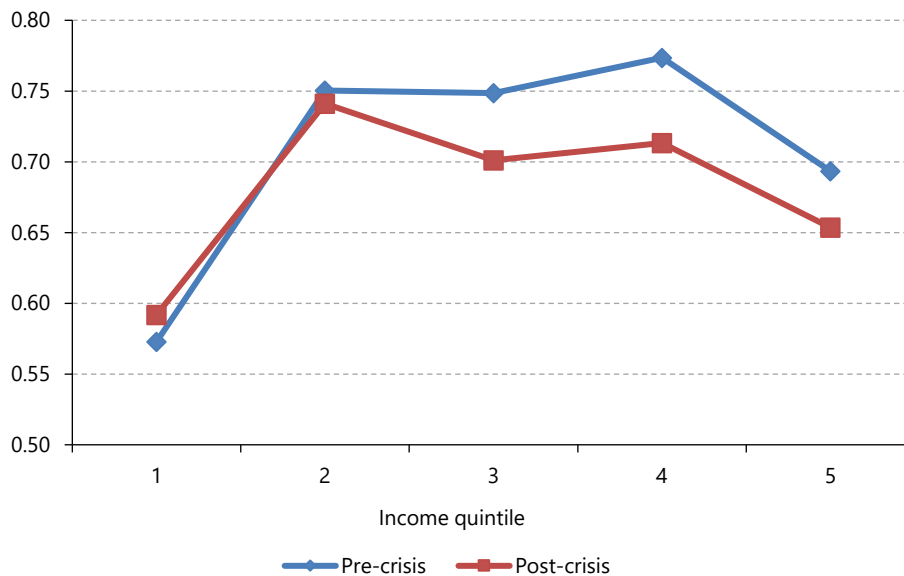
Like Cravino and others (2018) in their United States analysis, we find a hump-shaped result for volatility in inflation, with high income households in Canada experiencing lower volatility compared with middle-income households (see figure 4). However, the lowest volatility occurs at the lowest income quintiles, unlike Cravino and others 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 and others' United States 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 United States. 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

Source: Bank of Canada, on the basis of Statistics Canada [online database] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810000401.

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.

II. 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 (2018).

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. When correctly specified, 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 (Kim and Roubini, 2000). 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 (2018).

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 United States Federal Funds Rates and lagged USD/CAD dollar exchange rate. A big departure from Romer and Romer (2004), this reflects the importance of the United States 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.

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.

A.   Basic SVAR

We start with a simple SVAR where we estimate the impact of monetary policy shocks on our residual Gini coefficient measure as described above.

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, 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 FFR, 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,. Therefore, B_i is a 5x5 matrix for each $i = 0,1,\dots p$, and ε_t is a 5x1 vector of error terms or structural shocks.

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 United States Federal Funds Rate comes from the Federal Reserve Economic Data database, and we use all-items CPI to calculate year-over-year inflation from Statistics Canada Table 18-10-0004-01.

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 (see 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 criterions, 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[a]	0 046
U.S. Federal Funds Rate	1.94[a]	0 0602
Monetary policy shock	0 269[a]	0 0106
Gini coefficient	1.18[a]	0 116

Source: Prepared by the authors.

Note: 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:

[a] 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 United States Federal Funds Rate 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. The magnitude of the shock is a one-unit standard deviation. As indicated in figure 5, expansionary monetary policy appears to increase inequality.[8]

Figure 5
Impulse response function: monetary policy shock on inequality
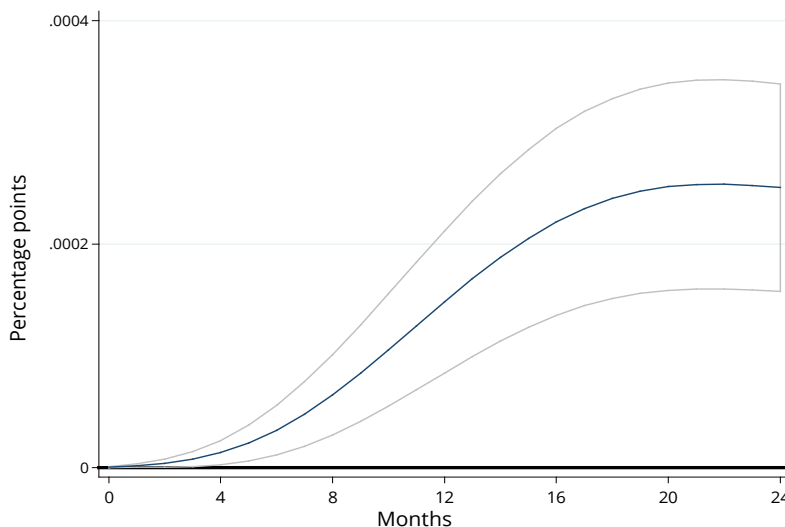
Source: Prepared by the authors.

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[8]   The impact of an expansionary monetary policy shock has the expected effect on inflation. Results available upon request.

The question then becomes what is the transmission mechanism whereby monetary policy impacts inequality, and does this explain the muted inflationary response to expansionary monetary policy post-financial crisis. To answer these questions, we turn to a more detailed SVAR.

B.   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 and others. (2018), the negligible role of indirect effects on households' consumption is inconsistent with empirical evidence.

1.   Model specification and data

Considering this, to assess the impact of household heterogeneity on the monetary policy transmission mechanism we contrast the cumulative 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 the United States output growth (Δy^*), and the United States personal consumption expenditures inflation (π^*). Following Cushman and Zha (1997), the United States variables are assumed to be exogenous with respect to Canadian variables in the long-run, and the United States output to be exogenous to the United States 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 (2018) is employed.

The base specification, which is standard in the analysis of monetary policy in small open economies,[9] does not take into consideration the effect of monetary policy on household heterogeneity. Considering the 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 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.[10] 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,[11] as well as their age composition, and the average number of hours worked. The residual gap measure corresponds to the residuals from the regression.[12]

2. 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 the United States 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 1,600. 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 the United States 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

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[9] 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 and others. (2013) for the case of Poland, and Carrillo and Elizondo (2015) for the case of Mexico.

[10] A test of Granger causality between the residual measures of the wage-gross operating surplus and the Gini coefficient over the period 1998.I–2017.IV indicates that, as expected, the evolution of the gap Granger-causes the evolution of the Gini coefficient.

[11] Industries are identified using the North American Industrial Classification System's (NAICS) 2-digit codes.

[12] 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).

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 and others (2010) algorithm proposed by Binning (2013).[13] Lag length selection is based on the Bayesian information criterion (Schwarz, 1978), which suggests a single lag for both specifications.

3.   Results

Panels (A) through (E) in figure 6 contrast the cumulative responses of, respectively, the consumption (A) and gross fixed capital formation (B) gaps, inflation (C), and the real effective exchange rate (D) to an expansionary monetary policy shock of 25 basis points. Solid lines depict the cumulative responses of the model specification ignoring the effect of household heterogeneity in the transmission of monetary policy, and dashed lines depict cumulative 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 the cumulative effect of inflation is higher when household heterogeneity is not accounted for.

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 two negative associations mean that when inequality is omitted there is an upward bias on the coefficient on inflation. In other words, central banks who do not control for heterogeneity will believe that the expansionary shock will result in a larger change in inflation than is true in reality.

As depicted in panel (E), which shows the response of the gap between the compensation of employees and gross operating surplus, in response to an unanticipated expansionary monetary policy shock, 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. To the extent that capital

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[13]   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 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.

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 cumulative responses of both gross fixed capital formation and the real effective exchange rate when heterogeneity is considered reflects the lower cumulative impact of the monetary policy shock on the nominal interest rate. This is because if agents are rational and anticipate a smaller reduction of nominal interest rates, 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 6
Cumulative responses to a 25 basis points expansionary monetary policy shock
(Percentages)

A. Consumption gap

B. Gross fixed capital formation gap

C. Inflation

D. Real effective exchange rate

E. Wage-gross operating surplus gap
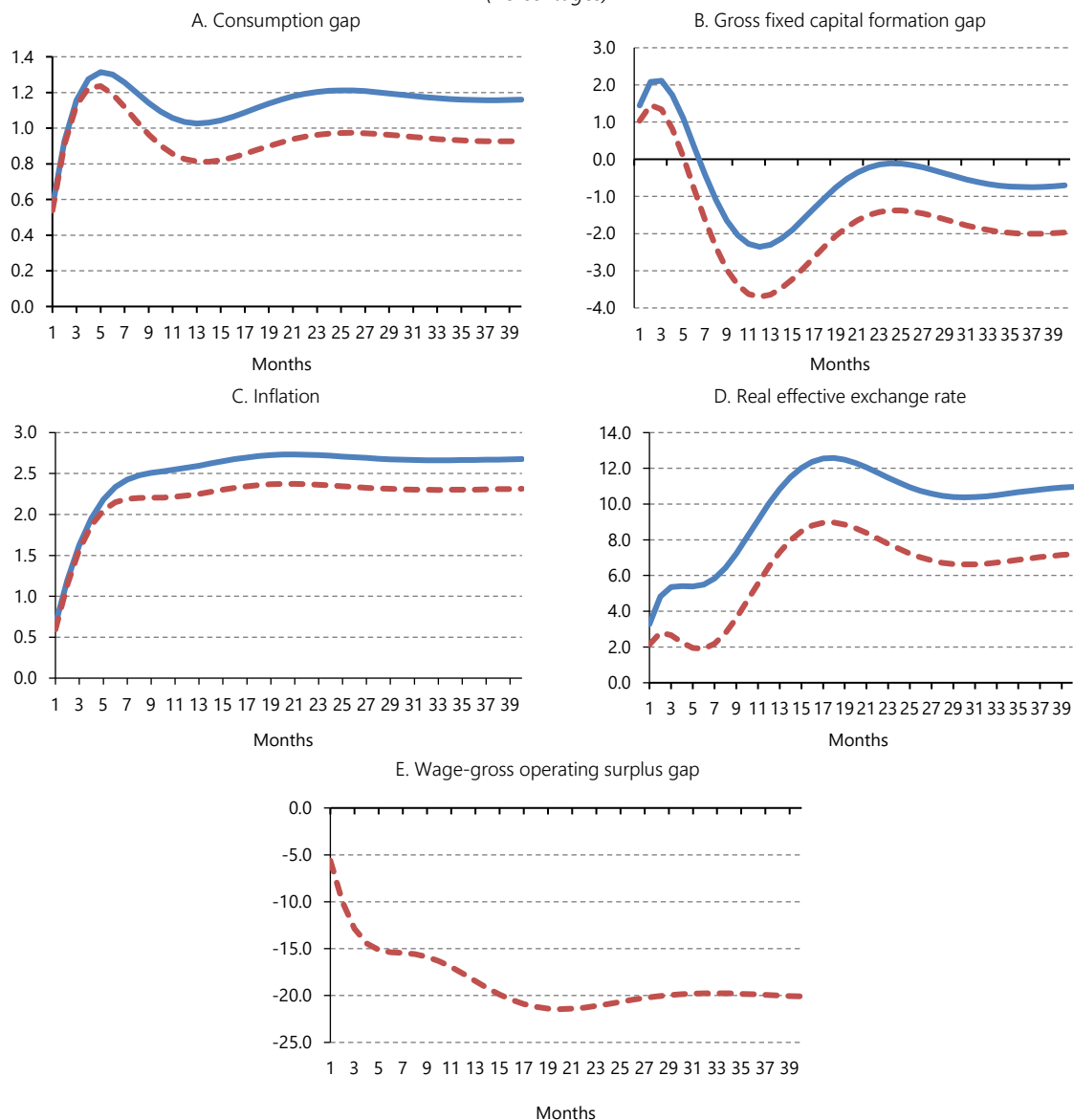
Source: Prepared by the authors.
Note: Dashed (solid) lines correspond to responses when heterogeneity is (not) considered.

4.   Robustness

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

Figure 7 contrasts the evolution of the impulse response of inflation to a negative 25 basis points monetary policy shock under the case where household heterogeneity is not accounted for (bold solid line), with the following alternative specifications where household heterogeneity is controlled for: the base specification used in the previous section (solid line), 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).

Although the magnitude of contemporaneous responses is similar across specifications, the evolution of the cumulative responses highlights that the long-term effect of monetary policy shocks of inflation is always of a larger magnitude when the effect of household heterogeneity is omitted from the model. It should be noted that the specifications that uses 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 larger short-term responses observed with respect to the base specification.[14]

Figure 7
Cumulative responses of inflation to a 25 basis points expansionary
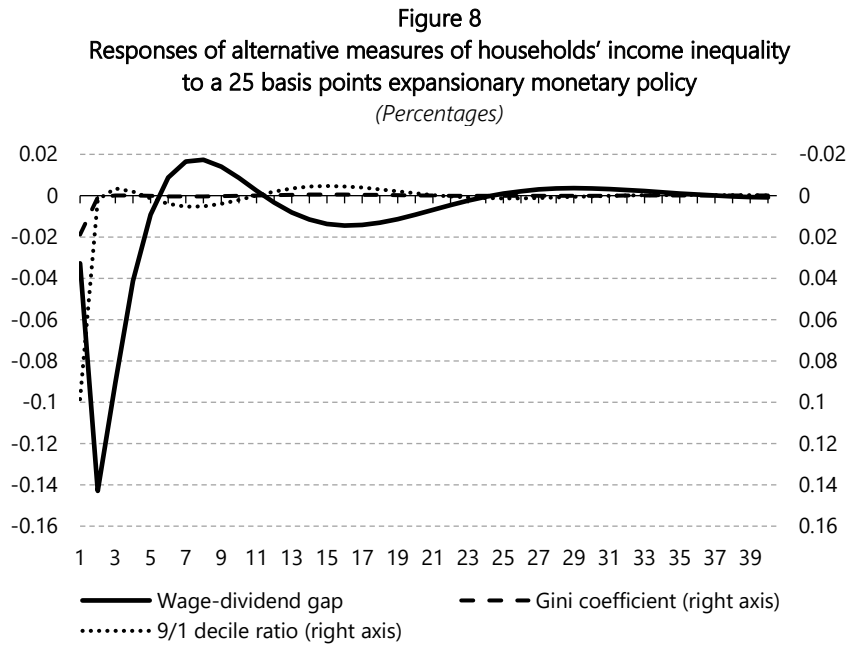### monetary policy shock under alternative specifications
(Percentages)
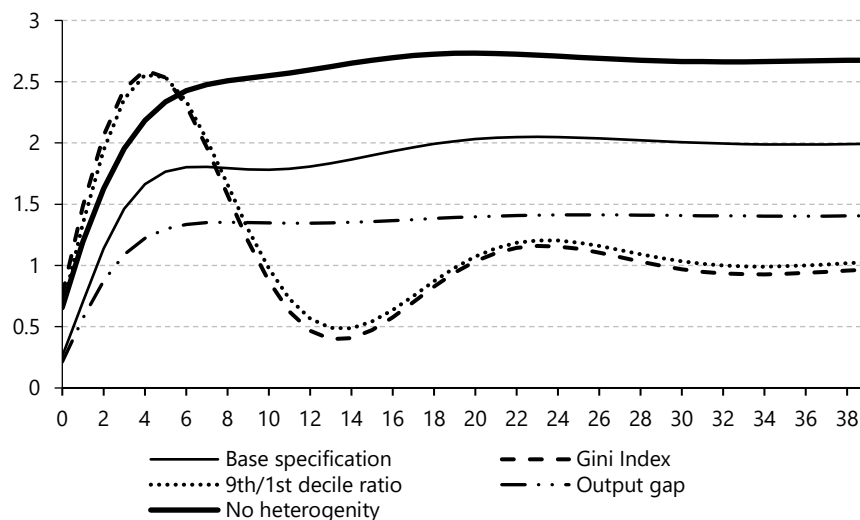
Source: Prepared by the authors.

Figure 8 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,[15]. Although the responses differ in both magnitude and the speed of adjustment towards equilibrium,

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

[15]   Note that for ease of comparison, the values for the Gini coefficient and the 9th /1st decile ratio are plotted in reverse order.

reflecting the different nature of the measures used, we observe an increase in inequality regardless of the specification.

Figure 8
Responses of alternative measures of households' income inequality
to a 25 basis points expansionary monetary policy
(Percentages)

Source: Prepared by the authors.

III. Conclusion

We showed in this paper that inequality matters for the transmission of monetary policy in Canada onto the real economy. We looked at the 1992–2015 period, with a particular focus 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 and others, 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 and others (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 1970s. 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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