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**Working Paper**

## Moving closer or drifting apart: Distributional effects on monetary policy

MAGKS Joint Discussion Paper Series in Economics, No. 21-2017

**Provided in Cooperation with:**

Faculty of Business Administration and Economics, University of Marburg

*Suggested Citation:* Hafemann, Lucas; Rudel, Paul; Schmidt, Jörg (2017) : Moving closer or drifting apart: Distributional effects on monetary policy, MAGKS Joint Discussion Paper Series in Economics, No. 21-2017, Philipps-University Marburg, School of Business and Economics, Marburg

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**No. 21-2017**

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# Moving Closer or Drifting Apart: Distributional Effects of Monetary Policy

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May 15, 2017

## Abstract

Our paper picks up the current controversial debate about increasing (income) inequality due to recent monetary policy measures in major advanced economies. We use a VAR framework identified with sign restrictions to figure out how income inequality related measures react to monetary policy shocks in three different advanced economies with an independent monetary policy regime. We choose the U.S., Canada and Norway. While all economies experience an increase in Gini coefficients of market income in the presence of an expansionary monetary policy shock, only the U.S. and Canada show a significant response in the Gini coefficient of disposable income when facing such shocks. To figure out how the transmission of monetary policy to overall income inequality works we pick up two major channels dominant in literature: The employment channel and the income composition channel. The latter is analyzed by data from national accounts concerning two different kinds of income households receive: Labor related income and capital payments, both net. We find that while in the U.S. as well as in Canada capital income recipients profit disproportionately from expansionary monetary policy, in Norway both types of (net) income benefit similarly from expansionary monetary policy shocks. We conclude that fiscal policy makers can successfully address and mitigate harmful effects of increased market income inequality.

**Keywords:** Income Inequality, Factor Income Distribution, Monetary Policy, VAR, Sign-Restrictions

**JEL classification:** D31, D33, E24, E25, E52, E64

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# 1 Introduction

”All economic policy-makers have some distributional impact as a result of the measures they introduce - yet until relatively recently, such consequences have been largely ignored in the theory and practice of monetary policy.”

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Yves Mersch (ECB), 2014

The financial crisis has set the limit of conventional monetary policy measures for the majority of the advanced economies. To stabilize financial markets and stimulate the economy major central banks around the world steadily lowered their policy rates up to the zero lower bound. To ensure capacity for actions the central banks imposed unconventional measures including i.a. large-scale asset purchase programs and forward guidance. As a consequence, equity and housing prices increased while, at the same time, interest rates and returns on savings remained at an all-time low. In public, this constellation strengthen the perception of rising inequality arguing that such measures benefit already wealthy capital owners disproportionately. The public arousal forces policy makers and academia to discuss the distributional consequences of monetary policy.

However, no central bank pursues equality per mandate.<sup>1</sup> Nonetheless, economic key indicators that are within the scope of central banks like inflation and growth have distributional effects themselves. For example, Doepke & Schneider (2006), Albanesi (2007) and Adam & Zhu (2016) find that unexpected inflation coincides with higher level of inequality. The analyses by Romer & Romer (1999) indicate a positive relation between inequality and both, average inflation and variability of nominal GDP growth. Thus, every policy measure that addresses one or both of the key indicators will have inevitably distributive effects.

Still, policy makers might have an intrinsic interest in moderate levels of inequality: Areosa & Areosa (2016), Auclert (2016), and O’Farrell et al. (2016) ascertain that higher levels of inequality coincide with less stimulating power of monetary policy. However, there are several mechanisms through which monetary policy may affect the distribution of income and wealth. Following chiefly Coibion et al. (2012) the

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<sup>1</sup>Also because it is troublesome to measure a (socially accepted) ”natural level of inequality”. Still, some attempts were made. See for example Rodriguez et al. (2002) or Heer & Maussner (2009). Mankiw (2015) describes anecdotally, why some level of inequality is necessary for prosperity.

discussed channels are:

The *financial segmentation channel*: Williamson (2008) shows in his model that on segmented financial markets, an increase in money supply redistributes wealth from financially excluded to financially included households. Furthermore, the latter benefit from higher prices on financial markets. Since wealthier households are more likely to be financially connected than are wealth-poor households, such monetary policy will increase wealth inequality.

The *portfolio channel*: As households differ in their composition of income, they do so in their portfolios. High-income households hold large shares of stock and estates, while their low-income counterparts holds predominantly deposits. Expansionary monetary policy benefits the former through increasing asset prices to the expense of the latter since they experience decreasing interest earnings and thus, increases wealth inequality.

The *savings redistribution channel*: According to this channel, redistributes unexpected inflation wealth from creditors to debtors. Aforementioned are rich elderly, the latter young and indebted households. Thus, a somewhat more expansionary monetary policy decreases wealth inequality.<sup>2</sup>

The *income composition channel*: Households differ in terms of their primarily incomes. If monetary policy benefits capital income more than labor income, e.g. through a boost in stock prices as it has been caused by quantitative easing (QE), income inequality will increase because capital income receivers are primarily high-income households.

The *employment channel*: Labor income is the major earnings source for the vast majority of households. However, high-skilled and low-skilled households respond different to monetary policy induced fluctuation on the labor market. If low-skilled households are more likely to be affected by unemployment in an economic downturn, a monetary stimulus benefits those households disproportionately and alleviates an increase in income inequality.<sup>3</sup>

Even though the nexus between monetary policy and inequality gains more and more attention, research is still in its infancy. However, outlined below are a number of findings that can already be made as things stand today.

Neither is the transmission of monetary policy to inequality unambiguous, nor the findings in the literature. Mumtaz & Theophilopoulou (2015) and Coibion et al. (2012) discover that contractionary monetary policy shocks increase inequality in earnings, income, and consumption. For the UK, Mumtaz & Theophilopoulou (2015)

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<sup>2</sup>This is the channel through which the results from Doepke & Schneider (2006), Albanesi (2007), and Adam & Zhu (2016) are driven.

<sup>3</sup>Coibion et al. (2012) refer to this channel as the *earnings heterogeneity channel*.

find that this is because low-income households face a decline in wages and especially income. This in turn decreases their consumption. In their analysis for the U.S., Coibion et al. (2012) draw a number of conclusions. In the aftermath of the monetary shock, wage earnings for those in the upper end recover notably faster than for those at the bottom of the wage distribution. The total income effect is smaller because low-income households disproportionately rely on transfers which in turn react countercyclical. Lansing & Markiewicz (2016) and Coibion et al. (2012) state that the distributional effects for the U.S. were mitigated by governmental redistribution.<sup>4</sup> In contrast, Davtyan (2016) find evidence that contractionary monetary policy shocks are associated with lower income dispersion in the long-run in the U.S.

Focusing on the euro area, Adam & Tzamourani (2016) find that a standard 25 basis points expansionary monetary policy shock<sup>5</sup> increases inequality because bond prices adjust faster than housing prices resulting in 4 times higher capital gains for the top 5% of the wealth distribution than for the remaining groups. This effect depends crucially on the price movements of the different assets: While a 10% increase in equity prices exacerbates net wealth inequality, such price movements in bond prices leave inequality unchanged. On the contrary, a 10% increase in house prices reduces net wealth inequality notable. This is because a broader fraction of households in the euro area benefit from positive trends in housing prices rather than changes in bond or equity prices, which are concentrated on wealthier households. This results are in line with O'Farrell et al. (2016) who analyse advanced economies in general and Demary & Niehues (2015) focusing on Germany in special.<sup>6</sup>

Primarily, unconventional policy measures are suspected to be one of the main drivers of increasing inequality in recent years. The argument is that extremely loose monetary policy disproportionately benefits asset holders, because a broad variety of assets grow in value from large-scale asset purchasing programs. Overall, the contribution of unconventional monetary policy measures to increasing inequality is not clear cut and respective research limited.

Mumtaz & Theophilopoulou (2015) gauges an additional effect on inequality from unconventional measures taken by the Bank of England in the aftermath of the

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<sup>4</sup>In addition, redistribution can be pro-growth given the positive effects of lower inequality on growth, as Ostry et al. (2014) show.

<sup>5</sup>Based on the estimates of Peersman & Smets (2003) an expansionary 25 basis points shock induces a temporary boost in stock and housing prices by 1.8% and 0.025%, respectively. The long-term bond price is not affected significantly.

<sup>6</sup>Coherently, Sousa (2010) finds that contractionary monetary policy leads to a fall in both, financial and housing wealth in the euro area. However, financial wealth adjusts faster than does housing wealth. The author argues that this is because households with higher financial wealth are more connected to the financial markets and are thus more able to redeploy their portfolio.

financial crisis. Adam & Tzamourani (2016) find that the ECB’s 2012 announced (but as of today not activated) Outright Monetary Transmissions (OMT) program influenced market prices such that the top 5% wealth group benefited disproportionately.<sup>7</sup> Domanski et al. (2016) find that wealth inequality in advanced economies has risen since the financial crisis. They identify surging equity prices as the key driver. The recovery in house prices in the aftermath of the subprime crisis has offset the effect only partially.<sup>8</sup> Focusing on Japan, Saiki & Frost (2014) find some evidence for increasing income inequality due to unconventional monetary policy by the Bank of Japan. The reason is that asset prices rise disproportionately compared to economic fundamentals like wages and employment indicating that monetary policy contributes to increasing inequality through the portfolio channel.<sup>9</sup>

Looking at the distributional consequences of unconventional monetary policy in the aftermath of the great financial crisis disregards the distributional consequences idleness would have. For example, Bivens (2015) claims that the stimulating effect of the Fed’s large-scale asset purchasing program (LSAP) on the labor market and housing prices prevented even larger distributional consequences.

We want to shed more light on the transmission channels of monetary policy on inequality. With focus on the income composition and employment channel, we follow the procedure by Bernanke & Gertler (1995) and analyze the potential mechanisms that drive the Gini measures after an expansionary monetary policy shock. To gain insight into the income composition channel, we substitute the Gini measures successively by labor income, capital income, and the Capital-Wage-Ratio. For the employment channel, we simply substitute the Ginis by the number of employed people.

To incorporate redistributive effects, we analyze the impulse responses of both, the market Gini and net Gini, i.e. after taxes and transfers. Furthermore, our analysis contains three countries that differ in their scope of redistribution. Namely, the U.S., Canada, and Norway. The latter is known for its ample redistribution measures. The U.S., on the contrary, redistribute only to a limited extend. Canada lies in between.

Our results show an increase in inequality after an expansionary monetary policy

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<sup>7</sup>The wealth-richest 5% experienced an 3.5% increase in capital gains while the other groups (lowest 20%, 20-70% and 70-95%) experianced an increase >1%).

<sup>8</sup>That this finding is not universally valid shows e.g. the German case, where Demary & Niehues (2015) ascertain no evidence for an increase in inequality due to unconventional monetary policy by the ECB, precisely because young, indebted households benefit disproportionately from an overall decrease in interest rates. Adam & Tzamourani (2016) also find controversial results for the euro area.

<sup>9</sup>The portfolio channel is probably the primary channel through which monetary policy transmits to inequality in the context of interest rates at the ZLB.

shock. However, the magnitude of the effect on inequality is damped by governmental redistribution, which is in line with the literature. The positive reaction of inequality to the shock works mainly through the income composition channel. This conclusion can be made because the Gini coefficient shows a significant increase even though employment rises notably. Concerning the income composition channel, our results show that capital owners in the U.S. and Canada benefit disproportionately. This is not true for Norway. We conclude that the income composition channel is the major transmission channel of monetary policy to income inequality.

The remainder of the paper is organized as follows. First, we take a closer look at the composition of income and development of employment in the selected countries. We then shed light on the data and the model incorporated in our analysis. Chapter four deals with the transmission of monetary policy on inequality. Hereby, we differentiate between effects on the income distribution in general and the effects via specific channels. Afterwards, the robustness of the results is checked in chapter five. Finally, chapter six concludes.

## **2 A Closer Look: Income Inequality, the Composition of Income, and Employment in the U.S., Canada, and Norway**

The most common measure to evaluate the distribution of income and wealth is the Gini coefficient. It takes values between 0 and 100. While a Gini of 0 implies absolute equality a value of 100 indicates that income is concentrated on one person.

Figure 1 depicts the evolution of the (a) Gini at market prices, that is income before taxes and transfers, and (b) Gini net, i.e. after governmental redistribution. The first mentioned measure shows an overall increase over the past years. The U.S. show the most unequal distribution of gross income among the selected countries - with upward tendency. Canada and Norway move very closely. The trend of the Canadian Gini coefficient has flattened since the early 90's.

Turning to the distribution of income after governmental intervention, i.e. the net Gini, things look different. Firstly, within all countries has governmental redistribution lowered income inequality notably. Still, the U.S. appear to have the most unequal distributed net income - with upward tendency. Canada and Norway show only a small level effect from 1981 (1991) to 2013. Remarkable is that Norway drifts apart from Canada which indicates a greater redistributive endeavor of the Norwegian government.



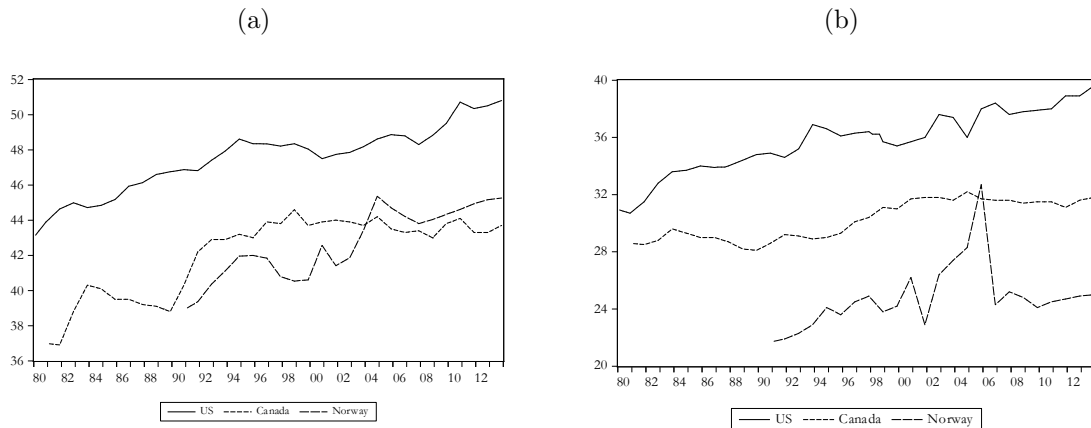


Figure 1: (a) Gini Market and (b) Gini Net

The channels through which monetary policy could have contributed to the development of income inequality has been mentioned above, i.e. the income composition channel and employment channel. Thus, it is worth looking at the composition of income and labor market developments in the past.

Income can be received in form of capital and wages. Thus, figure 2 depicts the Capital-Wage-Ratios (CWR). Two things protrude: Firstly, the CWRs behave similarly over time. Prior to the financial turmoil in 2008 the capital wage ratio increased since 2000 and plummeted eventually in 2008. The reason is the decline in capital income due to sharply falling housing and asset prices while wages are relatively rigid. Secondly, the CWR in the U.S. moves smoother than it does in Norway and especially Canada. Overall, the development of the Capital-Wage-Ratios indicates that capital income grows more than do wages. This, in turn, benefits capital owners disproportionately. This is especially true for the period between the burst of the Dot-Com bubble and the outburst of the financial crisis in 2008.

While the income composition channel is argued to have an inequality increasing effect, the employment channel is expected to have mitigating influence.

Figure 3 shows the unemployment rates for the U.S., Canada, and Norway. For all countries the unemployment rate shows an overall negative trend. The unemployment in U.S. declined from its high in 1982 (10.8%) to 4.4% at the end of 2007. Unemployment was at its lowest of 3.9% at the end of 2000, which is equivalent to a decrease of 6.4 percentage points (pp). Canada and Norway also experienced a notable decline in unemployment by 7pp (12.9% in 1982Q4 to 5.9% in 2007Q4)

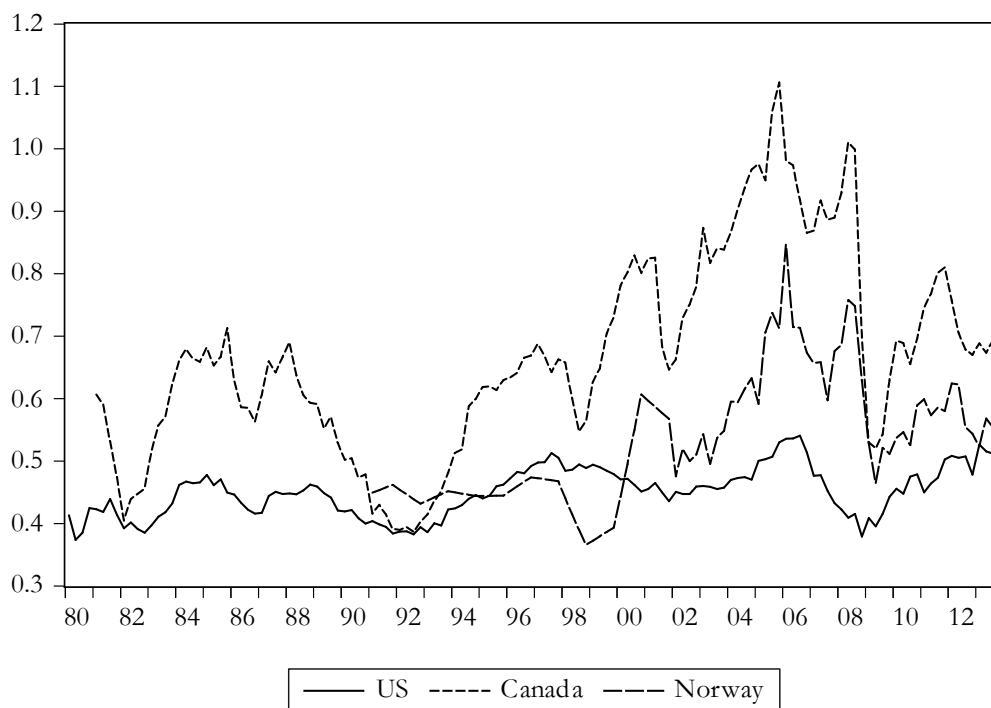


Figure 2: Capital-Wage-Ratios

and 3.4pp (5% in 1995Q1 to 1.6% in 2008Q1), respectively. Figure 3 elucidates furthermore, that the U.S. have been hit the most by the financial crises on the labor market. Yet, they also recovered most rapidly. The unemployment rate in the U.S. fell by 3.2 percentage points from 9.9% at the end of 2009 to 6.7% in 2013. The unemployment rate in Canada reached its high of 8.6% in 2009 and fell afterwards to 7.1% in 2013. This is a decline by 1.5 percentage points. On the contrary, the unemployment rate in Norway barely moved in the aftermath of the financial crises (2.9% at the beginning of 2010 vs. 2.7% at the end of 2013).

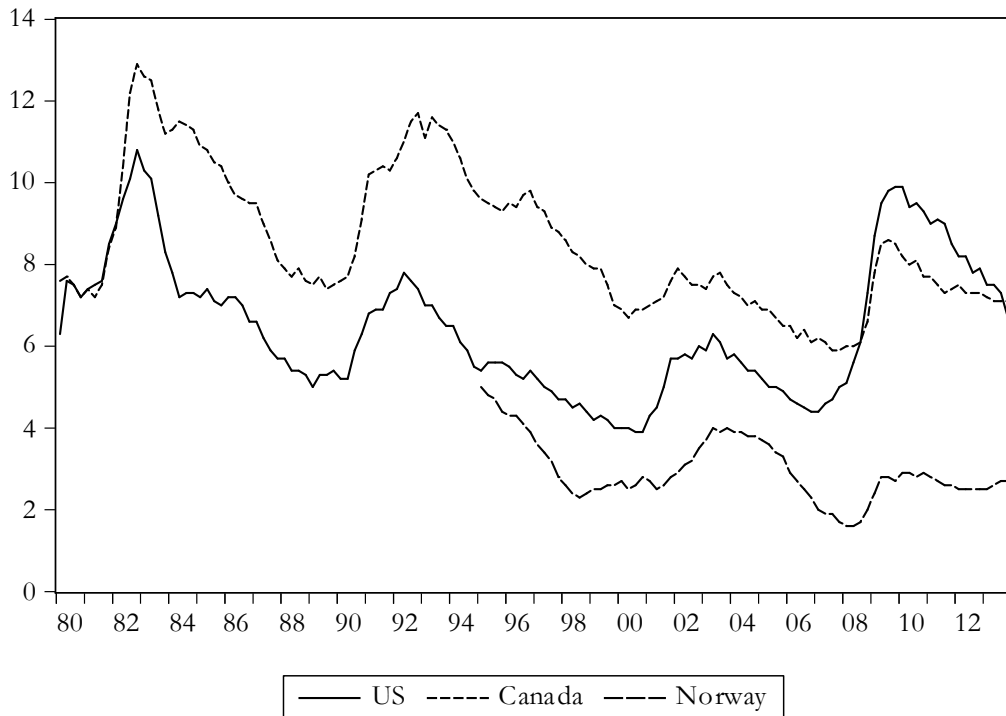


Figure 3: Unemployment Rate

In brief, three conclusion can be made so far: Firstly, governmental intervention aligns the dispersion of income. Secondly, capital owners benefit in the phase between the burst of the Dot-Com bubble and the outbreak of the financial crisis disproportionately. This, in turn, causes an increase in income inequality. Yet, the Capital-Wage-Ratio is very volatile such that capital owners are also harmed more by turmoils on the financial markets. Thirdly, the overall beneficial development on the labor market might have attenuated the positive trend in income inequality.

### 3 Monetary Policy and Income Dispersion

In this section we analyze the effects of monetary policy shocks on two common income dispersion variables: The Gini coefficient of market incomes and the Gini coefficient of net incomes.

We want to compare the reaction of these two variables across selected countries which are distinguishable in regard to the level of inequality as well as the degree of governmental intervention and redistribution. We select three representative countries by picking up the actual ranking in Gini of *disposable income*, provided by the

OECD and displayed in figure 8. We use the Gini of disposable income as selection criteria because for households this type of perceived inequality matters most. Additionally, we are primarily interested in advanced economies with an independent monetary policy regime. Thus, we use the U.S. who lead the table of net income inequality, Canada, located in the middle of the list, and Norway, which is on the bottom side.

### 3.1 Data

#### Gini coefficients

In a first step we want to capture the reaction of various Gini coefficients of market incomes, Gini market hereinafter, to monetary policy. To consider that for Norway Gini market is not available we use the corresponding mean estimators of the Standardized World Income Inequality Database dataset (SWIID) of Solt (2016) for all countries included in this paper. As we can see in figure (1(a)) there is a positive trend in the Gini market indicating that the dispersion of the market income has increased during the recent decades until its current prevailing peaks.

Second, we want to evaluate in how far monetary policy shocks propagate to the dispersion of net incomes of households, to which we refer to as Gini net. Data regarding Gini net is available from the corresponding national statistic providers: The United States Census Bureau, Statistics Canada and Statistics Norway supply selected measures of household income dispersion including a calculation of net income Gini coefficients.<sup>10</sup> Figure (1) shows these data and the corresponding historically high levels of net-income-inequality.

### 3.2 Methodology

We conduct baseline vectorautoregressions (VAR) that include the Gini market or Gini net coefficients for each of the three different countries, additional to the standard macroeconomic variables real GDP, consumer prices and an interest rate.<sup>11</sup> For the U.S., the interest rate variable is the shadow rate by Wu & Xia (2016), available since 2003, and the effective Federal Funds Rate for previous periods. For Canada,

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<sup>10</sup>U.S.: *Current Population Survey, 1968 to 2016 Annual Social and Economic Supplements*, Canada: *Table 206-0033 - Gini coefficients of adjusted market, total and after-tax income, Canada and provinces, annual*, Norway: *Measures of income dispersion. Household equivalent income (EU-scale) between persons, by person, time and contents*.

<sup>11</sup>To account for non-stationarity we take the natural logarithm of real GDP and consumer prices.

we use a shadow interest rate estimated by MacDonald & Popiel (2016)<sup>12</sup> We use these shadow rates to account for the long-lasting periods of the constraining ZLB and the resulting unconventional measures linked to it which are not sufficiently reflected in key policy or money market rates.<sup>13</sup> Unfortunately, shadow interest rates are not available for Norway so we use the Key Policy Rate of Norges Bank. We also include a trade-weighted real exchange rate in all models. The motivation for this inclusion is that Canada as well as Norway are small open economies and for the sake of comparability we include it also in the U.S. baseline VAR-model. We use quarterly end-of-period data. Gini variables had to be interpolate because they are only available on a yearly frequency. With this approach we want to check if monetary policy affects various Gini measures at all and if there are notable differences in the impact of monetary policy on them. The resulting reduced form VAR-model of the form

$$Y_t = A_p(L)Y_{t-p} + C + \varepsilon_t \quad (1)$$

is estimated equation-by-equation via OLS.  $A_p(L)$  is a lag-polynomial matrix of order  $p$  in lag-operator  $L$ ,  $C$  captures deterministic components (here: an included constant) and  $\varepsilon_t$  is a column vector of reduced-form white noise error-terms and covariance matrix  $\Sigma_\varepsilon$ . The lag-length is determined by Akaike criterion. We estimate the model with quarterly data and use interpolated data for our Gini variables because they are only available on yearly frequency.<sup>14</sup> For the U.S. and Canada our dataset covers Q1 1980 - Q2 2015, for Norway we can only consider Q1 1991 - Q2 2015 due to data availability.

Identification of our underlying, unknown structural model of the form

$$B_0 Y_t = B_p(L)Y_{t-p} + D + u_t, \quad (2)$$

and the respective shocks linked to it is conducted via sign restrictions.

Identification via sign restrictions requires a priori assumptions about the specific relations between the variables included in the VAR. These assumptions can root in theoretical considerations as well as in empirically robust common wisdom.<sup>15</sup>

First, a decomposition of our estimated reduced form covariance matrix  $\hat{\Sigma}_\varepsilon = u_t B_0^{-1}$  with its contemporaneously correlated error term estimators need to be conducted.

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<sup>12</sup>We want to thank the authors for the provision of the data.

<sup>13</sup>The estimated shadow rates summarize the effects of unconventional monetary policy measures when policy rates are at their ZLB.

<sup>14</sup>The robustness section also contains estimates with yearly frequency, the major results of this paper remain unchanged.

<sup>15</sup>A detailed description of the idea and methodology can be found in Uhlig (2005), we only lay out the basic principles and procedures.

Thus, we use Cholesky-factorization that yields a lower triangular matrix  $C$  and its transpose  $C'$ . Next we generate an orthonormal matrix  $E$  with inverse wishart-distributed entries based on the covariance matrix, such that  $E'E$  equals the identity matrix and thus satisfying the requirements for shocks of the structural VAR-model, especially no correlation between error terms and unitary variance. Further on, we compute  $\hat{B}_0 = C'E'$  which captures the immediate effects of shocks to the structural VAR model, based on reduced form error term correlations. Multiplying the reduced form  $\hat{A}_p$  from equation (1) with  $\hat{B}_0^{-1}$  results in  $\hat{B}_p$ . We then conduct structural analysis with impulse response functions to figure out how shocks propagate through the system. We multiply the assumed shocks with the resulting  $\hat{B}_p$  matrices and check if the results fit the a priori imposed restrictions. Discarding the non-fitting and storing the fitting results after sufficiently often iterated draws in a set of equally likely models. Of these models, we show the median model and the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

As we are interested in interpreting the effects of monetary policy shocks in a sensible manner, we only focus on the identification of the monetary policy shock and ignore other structural innovations to the model. For a more detailed discussion why it is sufficient to only identify the shock of interest instead of fully identifying the model, see e.g. Christiano et al. (1999). The following table (1) shows the assumed restriction scheme.

Table 1: Sign restrictions for an expansionary monetary policy shock.

Variable	Gini	GDP	Prices	Policy Rate	REER
Imposed restriction	unrestricted	+	+	-	-

Notes: The imposed restrictions hold for four periods, but the results are not very sensitive to alternative durations.

We justify these assumptions as follows:

Expansionary monetary policy lowers overall market interest rates, either via policy rate cuts or monetary base expansion. This results in an stimulus of overall demand or at least does not cause demand to fall simultaneously. Overall prices should also adjust due to excess demand, or at least can not be expected to decrease. The real exchange rate reaction is assumed to be negative because of capital outflows caused by overall lower yields in the economy.<sup>16</sup> To capture the research question of this paper and to pick of the controversy outlined in the literature discussion we leave the variables related to income inequality unrestricted. All restrictions are theory-implied and also confirmed in many empirical applications.

<sup>16</sup>In the robustness section we nevertheless leave the exchange rate unrestricted.

### 3.3 Results of the baseline model

We now turn to the results of the VAR-model described in the previous chapter. Based on the mentioned restrictions on GDP, prices, the policy rate, and the real exchange rate, we are able to evaluate the effect that monetary policy shocks have on the overall distribution of income. In this respect, we distinguish between the Gini of market income and net income. Since the discrepancy of market and net incomes stems from (income-) taxes and transfers, we are thus able to tackle the question of their redistributing role.

#### Gini of Market Income

We start by evaluating the effect that expansionary monetary policy has on the distribution of market income. For the U.S. and for Canada the Akaike Criteria suggests a lag length of two quarters. In the model for Norway, this criteria proposes a lag length of three periods. For sake of comparison we estimate our VAR-model with a lag of two periods for Norway as well. This lag-length is also proposed by the Hannan-Quinn and the Schwarz Criteria. However, as will be shown in chapter 5, the results of all four countries are robust to a set of different lag-lengths, time frames and restriction duration.<sup>17</sup>

Before we present the outcome of our baseline model we check for stationary of our considered macroeconomic variables. Table (2) summarizes the results of Augmented DickeyFuller tests for the four variables throughout all three countries. In this respect the null hypothesis indicates that the variable has a unit root and is thus non-stationary. If we only consider a constant in our estimation, we can reject the null for the monetary policy rate and the real exchange rate throughout all three countries for all common level of significance. In contrast, the null for  $\ln$  of GDP and  $\ln$  of CPI cannot be rejected in all three cases. However, once we include a linear trend, we are able to reject null on those variables as well. In line with our expectations we conclude that these two variables happen to be trend-stationary.

The outcomes of the baseline models for the three considered countries are presented in figures (9) through (11). The restricted variables behave as expected in the long run throughout all three countries. While a mean reverting process in the stationary variables, i.e. interest rate and the real exchange rate, can be found, long-run level effects in the tend-stationary variables, i.e. the GDP and the CPI, occur.

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<sup>17</sup>A VAR-model with yearly data leads to similar results, so that the interpolation of the Gini coefficient happens to be accurate.

Table 2: Augmented Dickey-Fuller Tests

Variable	Model	U.S.A.	Canada	Norway
ln of GDP	intercept	-1.05 (0.73)	-3.30 (0.02)	-1.01 (0.75)
ln of CPI	intercept	-3.04 (0.03)	-1.01 (0.74)	-3.11 (0.03)
Shadow Rate	intercept	-2.27 (0.18)	-2.28 (0.18)	-2.50 (0.12)
Real Exchange Rate	intercept	-1.96 (0.30)	-1.61 (0.47)	-2.11 (0.24)
ln of GDP	intercept & Trend	-1.25 (0.90)	-2.35 (0.40)	-1.06 (0.93)
ln of CPI	intercept & Trend	-1.72 (0.74)	-2.77 (0.21)	-1.75 (0.72)

Notes: The null hypothesis of the ADF test is non-stationary. The table shows the results of the t-Statistic and the corresponding significance level in brackets.

This indicates that in the long run the macroeconomic variables are independent from monetary policy.

Our variable of interest, the market Gini coefficient, increases notably in all three countries after an expansionary monetary policy shock. Although the overall reaction is similar throughout the considered countries, the response in the U.S. (Norway) is the most (least) pronounced. The peak responses are in between 0.036 and 0.063 and all occur 5 to 10 periods after the shock. In the medium and long run, the probability of a positive impact of the expansionary monetary policy shock on the median Gini response is above 68%. The corresponding bands in figures (9) to (11) are wider the shorter the sample size is. Thus, in Norway it takes 25 periods until the 16<sup>th</sup> percentile of the median Gini response is above zero.<sup>18</sup>

Based on our baseline results we come to the conclusion that in all three countries, expansionary monetary policy leads to an increase in the inequality of market income. While the effect in Canada and Norway are of a similar magnitude, the influence in the U.S. is more pronounced. In the following subsection we will evaluate in how far the results change, if we consider net income effects instead of market income effects.

### Gini of Net Income

Focusing on net income Gini coefficients brings several advantages. First, the general debate about equitable income distribution is also based on net values, so that mitigating effects through governmental redistribution is incorporated. Furthermore, wealth is preliminary accumulated by savings that stem from net income. Thus, analyzing net income inequality also sheds light on changes in the wealth distribution. Finally, we can show in how far taxes and transfers dampen the observed

<sup>18</sup>As mentioned before, the Gini coefficient is a sticky variable which becomes even more sticky as values are interpolated here. Hence, it does not come as a surprise that the response of the Gini dies out very slowly.



distributional effects of monetary policy.

Figures (12) to (14) outline the results of the baseline model including the net Gini index. The response of the Gini coefficient varies throughout our sample consideration. While akin responses in Canada and the U.S. can be found, the estimated median effect in Norway shows no clear pattern. However, the 16<sup>th</sup> percentile of the median Gini response is above zero for the U.S. (Canada) from period 8 (18) onward. Additionally, the magnitude of the response is similar in both countries, e.g. a peak median response in the U.S. of 0.046 and in Canada of 0.042 can be observed, while the Norwegian peak response is only 0.004. Altogether, our results indicate that in the two countries with a relative high level of income inequality expansionary monetary policy increases the net Gini index, as opposed to Norway, where no effect of monetary policy on net income dispersion can be found.

In comparison with the market income Gini, it stands out that in all three countries the median peak response is somewhat smaller. This hints at the dampening effect of transfers and taxes. This dampening effect can be further investigated by looking at country specific effects. In this respect it does not come as a surprise that only in the welfare state Norway the significant impact on market income disappears once we consider net income distributions. Although the magnitude of the impact become smaller in the U.S. and Canada, monetary policy still has a substantial effect on net income inequality here.

These results indicate that a welfare state is a possibility to overcome distributional effects of monetary policy. However, this conclusion is solely based on overall impacts of monetary policy. A more precise picture can be derived once we look at the channels that drive the income inequality. The influence through the possible channels will be estimated in the succeeding chapters.

## 4 Transmission of Monetary Policy on Inequality

In this section we want to elaborate what channel-related variables are involved in the transmission of monetary impulses to the overall income dispersion. As outlined in the introduction we focus on the employment channel and the income composition channel. We pick up the ideas of Bernanke & Gertler (1995) who disentangle overall transmission of monetary policy shocks to real economy by taking a closer look at variables assumed to be involved in various transmission channels. With this approach they shed light on major driving forces and related channels of monetary transmission linked to them. Similarly, we use variables related to the channels outlined previously to account for the variety of possible mechanisms that drive the

movement observed in the overall Gini coefficients presented in chapter 3.3. These variables replace our Gini coefficient in the baseline VAR-model while identification assumptions remain the same. We proceed as follow: First, we check in how far the employment channel is involved in the transmission of monetary policy. Second, we separately include both components of the income composition channel in our VAR-model. Third, we relate them to each other to figure out in how far their ratio is affected by monetary policy, or, in other words: Does the reaction of one income component dominate the reaction of the other. Thus, we need variables that can be assigned to the channels to assess the importance and overall role each channel play in the three countries. We describe them in the following in more detail. These variables are then incorporated in our VAR framework to clarify their behavior in the presence of monetary policy shocks.

## 4.1 Employment Channel

### Data

To investigate the employment channel we check in how far employment reacts to monetary policy shocks. In contrast to most literature, we do not use unemployment rates but overall employment instead because the officially reported rates are often biased due to the fact that not every unemployed person registers. Additionally, we use long-run data so that changes in the labor force participation might distort unemployment rates although overall employment remains less affected or even unchanged. Thus, our measure captures more precisely the real utilization of the factor labor in the three economies. For the U.S., we use employment in the non-farm sector, for Canada the number of employed persons older than 15 years and for Norway employed persons between 15 and 74 years, all Data obtained from FRED.

### Response of Employment

According to the employment channel, an expansionary monetary policy shock lowers income inequality. This is at odds with the findings in chapter 2.3 for the U.S. and Canada. We nevertheless estimate the transmission through employment, as it is crucial to properly disentangle the set of policy transmission channels. In this respect, the employment channel might be at work, but be overcompensated by other channels working in the opposite direction.<sup>19</sup>

As outlined in chapter 3.2, we follow Bernanke & Gertler (1995) in order to evaluate the existence of the particular channel. So we replace the Gini variable by the

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<sup>19</sup>In the case of Norway those channels might cancel each other out.

ln of total employment in the respective country.<sup>20</sup> The results in figure (4) indicate that an expansionary monetary policy increases employment. Hence, based on the impulse responses the existence of the employment channel in all three investigated countries can be confirmed.

Again, the size of the effect turns out to be smaller for Norway, while the employment in Canada and the U.S. show a more similar behavior. The modest increase in the Norwegian employment in comparison with the other two countries might be caused by a higher degree of unionization, so that the employment cannot react as early and as intense.

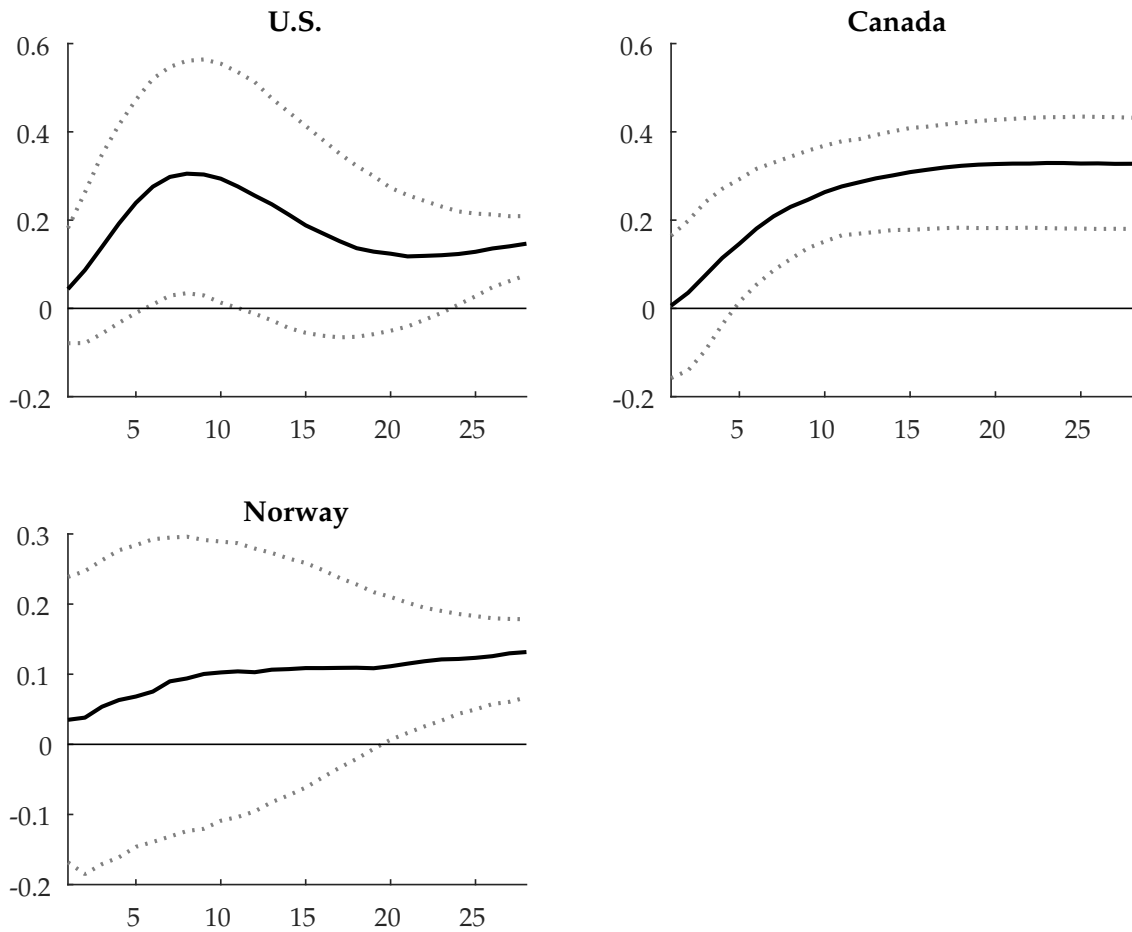


Figure 4: Response in employment to an expansionary monetary policy shock. Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

<sup>20</sup>Due to data issues in the U.S. we proxy the total number of employed persons by the employed workers according to the non-farm payroll.

## 4.2 Income Composition Channel

### Data

As outlined above, the income composition channel distinguishes between major sources of households' overall earnings: labor related income and capital pay-offs. Thus, we include these different sources in a more specific way into our analysis. As we are primarily interested in net-effects, we focus on disposable income. National accounts and (personal) income statistics provide detailed data to construct different variables based on the subcomponents related to the production factors capital and labor. More precisely, capital income consists of net interest income, dividends after taxes and net rental income. It is computed as the sum of net-operating surplus and net mixed income<sup>21</sup>. Labor income incorporates solely (net) compensation of employees, i.e. wages, salaries and employers' social contributions.<sup>22</sup> Relating net-capital-payments to net-labor-payments yields a capital wage ratio which is depicted in figure (2).

### Response of Labor Related Income

We start by estimating the effect of monetary policy on the development of net labor income. Therefore, we replace the Gini variable in the baseline model by the ln of labor related income. Since labor income and employment are highly correlated, their outcomes are expected to be similar, too.

The results are represented in figure (5). In the medium to long run we observe an increase in labor related income in all three countries, as indicated by the 16<sup>th</sup> percentile of the median response which is in the long run above zero. The strongest and earliest response can be found in Norway. In contrast, in Canada the initial response turns out to be negative before the expected can be observed.

Altogether, the results on labor related income indicate that employees profit from an expansionary monetary policy shock. This is in line with the employment channel so that we again find support for the existence of this channel. However, in order to evaluate the income composition channel, the degree of benefit in the labor sector has to be compared to the one in the capital sector.

### Response of Capital Income

In order to receive aggregate net capital income, we sum up net operating surplus and net mixed income. We then estimate the VAR-model with the ln of capital

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<sup>21</sup>Gross operating surplus less consumption of fixed capital for the corporate sector.

<sup>22</sup>Including transfers, for some households the major income source, would have been an option if all countries collect and process data on a similar approach and provide them for sufficient long periods. Unfortunately, for the sake of inter-country-comparability, we can not include them here in a meaningful manner.**Literature Coibon usw...**

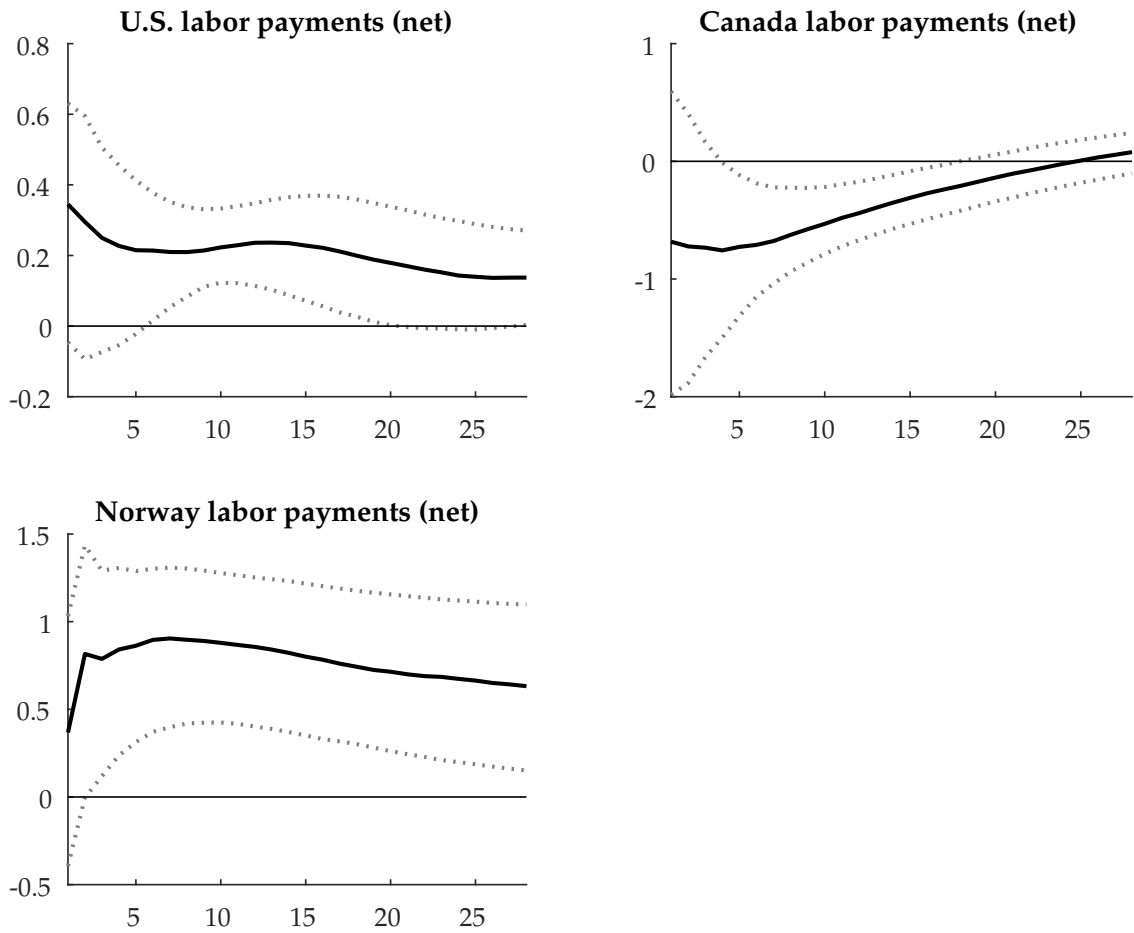


Figure 5: Response of labor related net payments to an expansionary monetary policy shock..

Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

income as the inequality measure.

Figure (6) shows the impulse responses for all three countries. While an increase in capital income in Canada and the U.S. can be observed, no clear patterns for Norway occur. The impact of an expansionary monetary policy is the strongest in Canada. Here, a shock leads to a peak increase of 1.39% in capital income. From the 4<sup>th</sup> period onward the probability of a median increase to be greater than zero is above 68%. In comparison with labor related income from figure (5) the increase in capital income appears earlier and is stronger.

For the U.S. a rather moderate increase in the capital income can be found. In the long run, the 16<sup>th</sup> percentile of the capital income response is nevertheless above zero. Although the peak response is slightly higher for the capital income than for the labor related income (0.49 as opposed to 0.43), it remains unclear which group in particular profits more from expansionary monetary policy.

In Norway, no clear impact of monetary policy on the capital income can be perceived. In particular, the 16<sup>th</sup> and 84<sup>th</sup> percentile bands cross the zero line at no point in time. However, the median peak response is in range of the one from the labor related income. Thus, the question whether the income composition channel is present or not cannot be answered completely. We will ultimately tackle this question in the following sub-chapter.

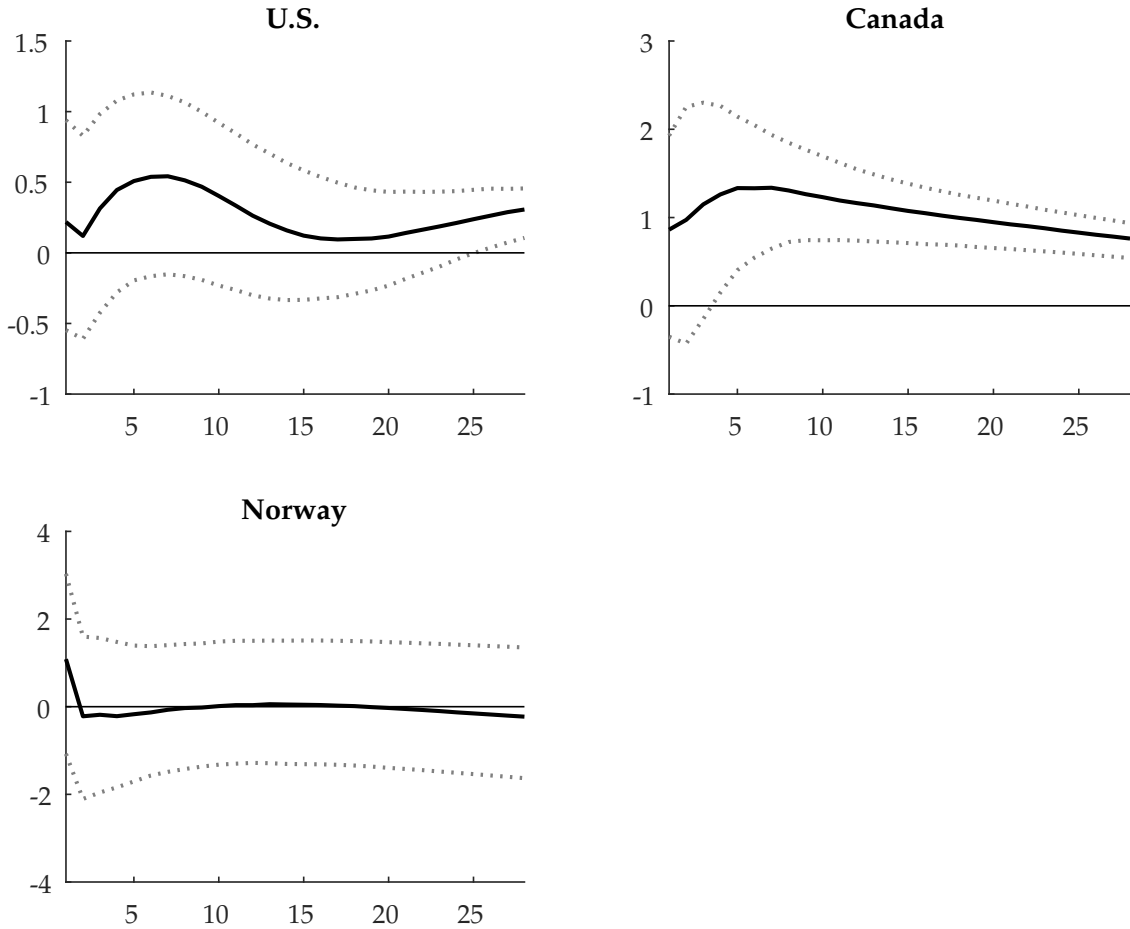


Figure 6: Response of net capital related earnings to an expansionary monetary policy shock.

Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

### Response of the Capital-Wage-Ratio

As has been shown in above, an expansionary monetary policy shock can lead to an increase in both, the capital income and the labor related income. The income composition channel states that capital income increases disproportionately. Hence, we finally evaluate its existence by the behavior of the Capital-Wage-Ratio after a monetary policy shock. Since labor related income also represents changes in the employment, the CWR is not only suited for the evaluation of the income composition channel. It also indicates, if the income composition channel is dominating the employment channel.

The respective impulse responses are presented in figure (7). In general, the outcomes fit with the results found above. In Canada, where we found only a small impact on labor income, but the greatest impact on capital income, the Capital-Wage-Ratio shows the strongest increase. From period 5 onward the probability of an increase in the median response above zero is higher than 68%.

For the U.S., we also observe an increase in the response of the mean model. However, the effect is smaller in size.<sup>23</sup> We can nevertheless confirm that an expansionary monetary policy leads to an over-proportional increase in capital incomes in Canada and the U.S.

Contrary, in Norway the response of the Capital-Wage-Ratio is unclear. Neither the 16<sup>th</sup> percentile of the median response nor the 84<sup>th</sup> percentile crosses the abscissa at any point in time.

The fact that in the two countries, where we can obtain a positive effect of monetary policy on income inequality, are also those two countries where we solely see an influence on the Capital-Wage-Ratio, underpins the dominating role of the income composition channel. This channel also helps to explain why the effect on market income inequality in Norway does not translate into an effect on net income inequality. In this respect, the higher transfers to the labor force in Norway in comparison to the U.S. and Canada lead to lower movements in the Capital-Wage-Ratio after monetary policy shocks.<sup>24</sup>

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<sup>23</sup>The peak response of the mean model is 0.012 higher in the Canadian case.

<sup>24</sup>According to the OECD the public social expenditure amount to 23.9% of GDP in Norway. In the same year Canada and the U.S. both had lower share with 17.2% and 19%, respectively.



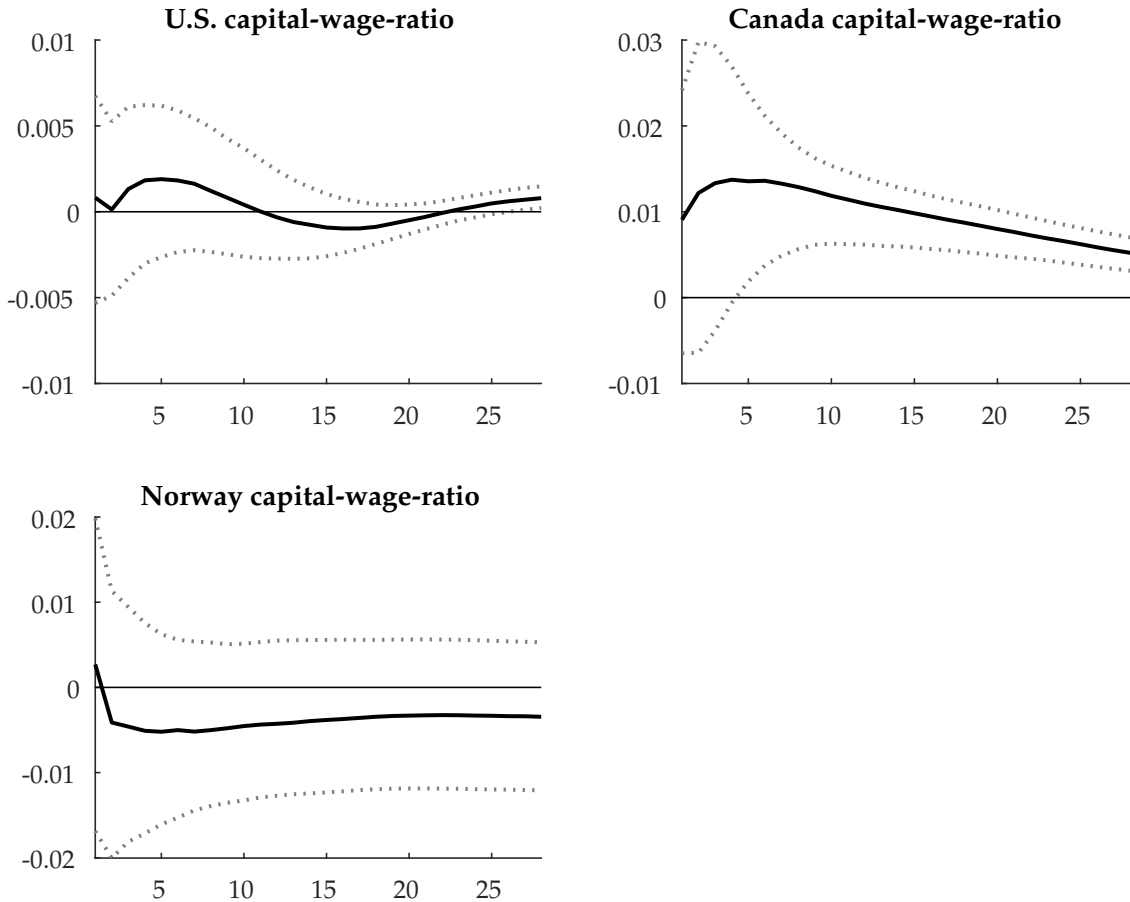


Figure 7: Response of Capital-Wage-Ratio to an expansionary monetary policy shock.

Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

## 5 Robustness

To be completed.

## 6 Conclusion

In the recent decade, the problematic issue of rising income inequality gained more and more attention in the public perception as well as in the political debate. The today observable historically high levels of income dispersion, as outlined in figure (1), are accompanied by an environment of very expansionary monetary policy. In this respect, we add new empirical evidence to the current controversy. More precisely, our contribution is as follows:

- i We assess the impact of monetary policy shocks on market as well as disposable

income inequality.

- ii By exploiting national income statistics we shed light on the varying relevance of different channels involved in transmitting monetary policy shocks to inequality.
- iii Based on differences between market and on net income and cross country discrepancies we draw conclusions about the impact of governmental redistribution and the role of the welfare state.

To assess the effects of monetary policy shocks, we incorporate Gini coefficients in a standard macroeconomic VAR-model consisting of GDP, consumer prices, a monetary policy variable and the corresponding trade-weighted real exchange rate. Identification is conducted via sign restrictions. All Gini coefficients of market incomes increase when facing an expansionary monetary policy shock. The reaction of the net income dispersion varies between the three countries: The U.S. and Canada also show a notable positive reaction in Gini net in the presence of expansionary monetary policy shocks. However, this variable seems to be not affected anymore in the case of Norway.<sup>25</sup>

To take a more detailed look on the importance of two major transmission channels, the employment channel and the income composition channel, we use total employment as well as various national accounts and national income statistics, respectively. The reaction of employment, captured by the total number of employed people, shows the expected positive and significant sign for all three countries, indicating that the employment channel is at work. By splitting the composition of net national income in its major parts, labor related income and capital related income,<sup>26</sup> we can evaluate which of these income categories profits disproportionately. While both components are generally affected positively, their ratio indicates that in the U.S. and Canada capital owners benefit disproportionately. As an increase in labor related income also goes in hand with an increase in employment, we conclude that the income composition channel is the major transmission channel of monetary policy to income inequality. In contrast, Norway's Capital-Wage-Ratio does not show clear reaction patterns to monetary policy shocks. Thus, in Norway both income sources seem to profit in a similar manner. This conclusion is in line with the insignificant reaction of Gini net that is solely observed in Norway.

In the context of monetary policy shocks, only Norway appears to be successful in absorbing the negative propagation of market income effects on net incomes. The

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<sup>25</sup>The results are robust with regard to restriction duration, imposition of the "price puzzle", alternative lag-lengths or estimation periods.

<sup>26</sup>We do not account for one-time valuation effects of wealth.

most plausible explanation lies in the high share of income redistribution via welfare state, fiscal and tax policy. This interpretation is also supported by the fact that the magnitude of the Gini market response in the U.S. and in Canada is higher than the Gini net response. Nevertheless, also the Gini net effects remain notable.

The resulting implications of this paper are the following:

- i Monetary policy affects income inequality. Yet, the paper shows that fiscal policy makers can effectively dampen side effects of monetary policy on income inequality. As a result, there is no need to amend the Central Banks' objective function towards an inequality related criterion.
- ii As capital income recipients seem to profit disproportionately from an ease in monetary policy, adjustments in taxation might be one solution to thwart increasing income inequality.

Further on, wealth inequality was not addressable in this paper due to the lack of comparable and sufficiently processed data. We think that especially this type of inequality is an even bigger issue for the ongoing socio-economic debate and future policy makers. Additionally, the role of transfer payments was captured only superficially to make the collected data comparable. Thus, some channels listed in the introduction remain not evaluable within an inter-country-approach.

Additionally, the relevance of the distinct channels is probably changing over time as well as state-dependent, i.e. if we face an expansionary monetary policy environment during conventional or unconventional times. We leave this for future research.

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# Appendix

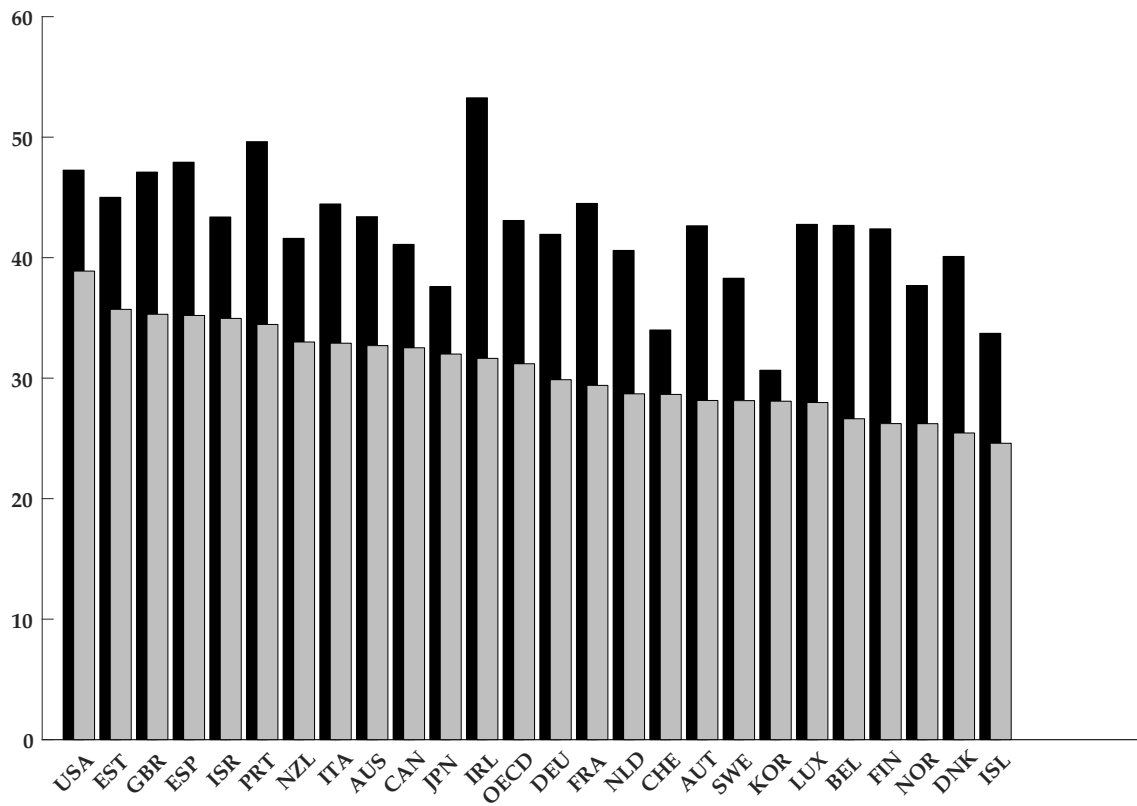


Figure 8: Ginis

Notes: Data sorted by Gini net values in descending order. Black bars show the corresponding Gini at market prices.

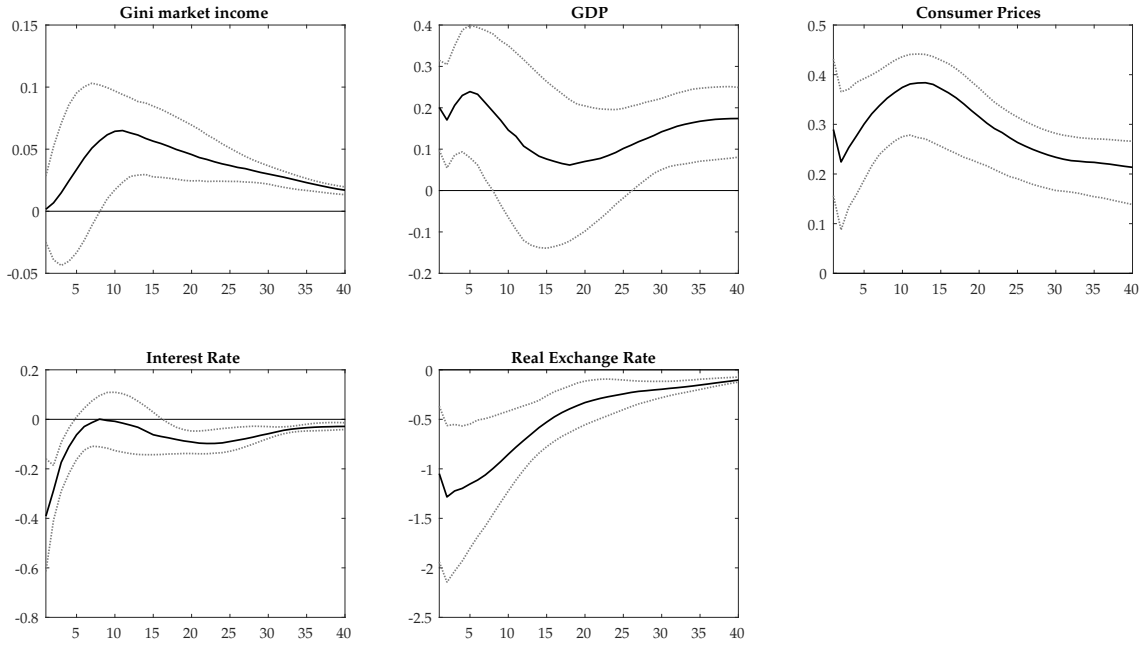


Figure 9: Baseline model U.S. with Gini market income, responses to an expansionary monetary policy shock.  
 Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

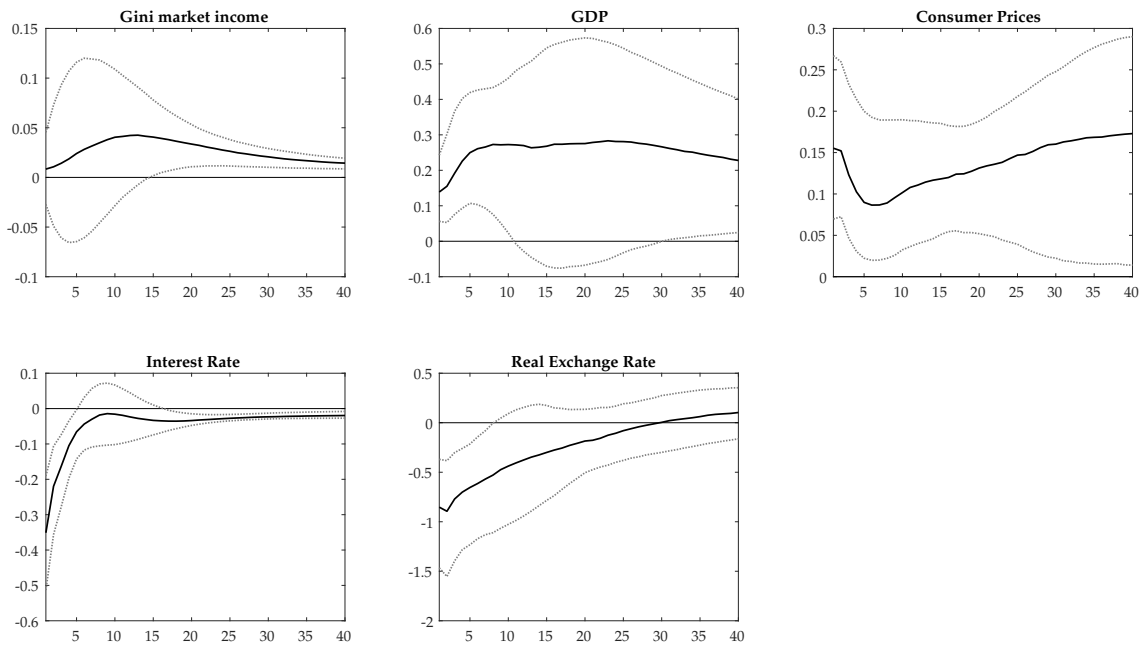


Figure 10: Baseline model Canada with Gini market income, responses to an expansionary monetary policy shock.  
 Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.



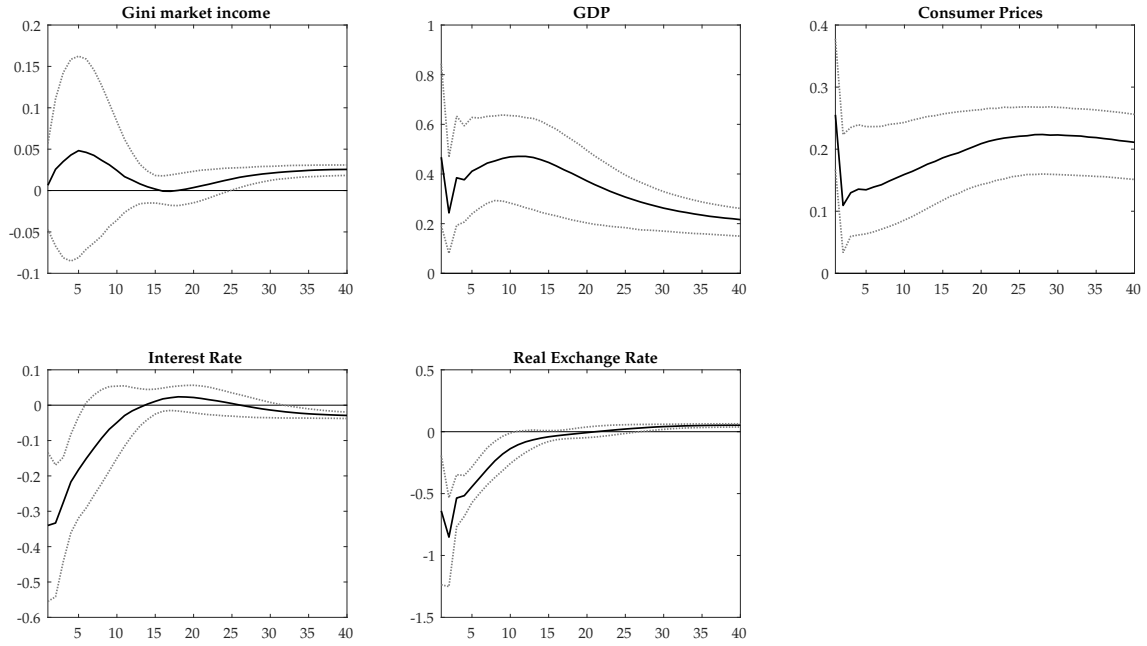


Figure 11: Baseline model Norway with Gini market income, responses to an expansionary monetary policy shock.  
 Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

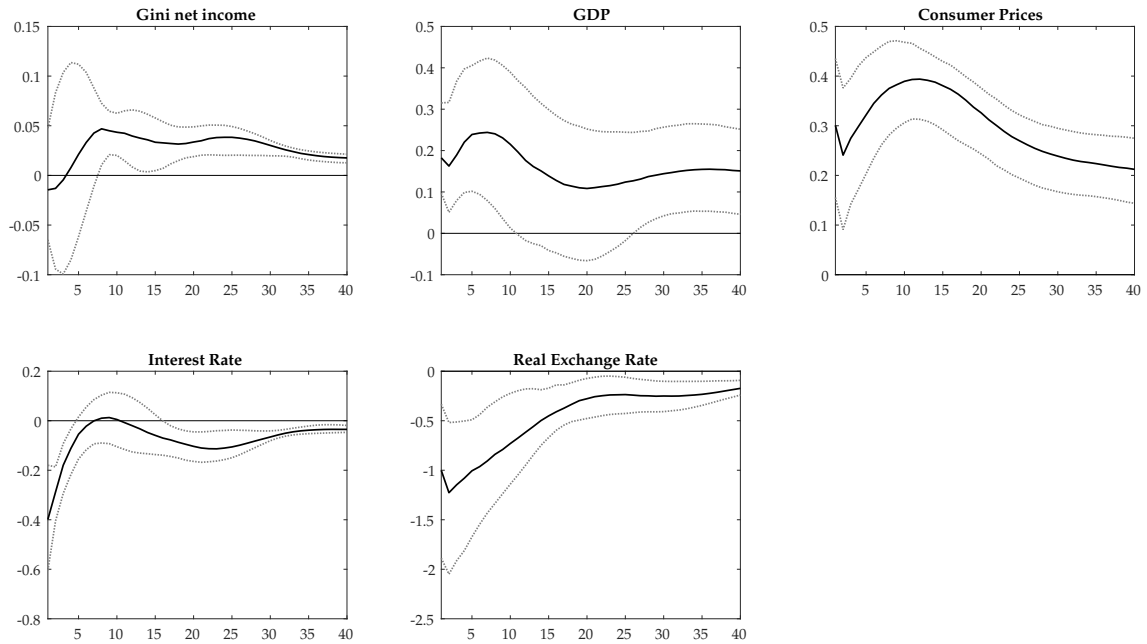


Figure 12: Baseline model U.S. with Gini net income, responses to an expansionary monetary policy shock.  
 Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

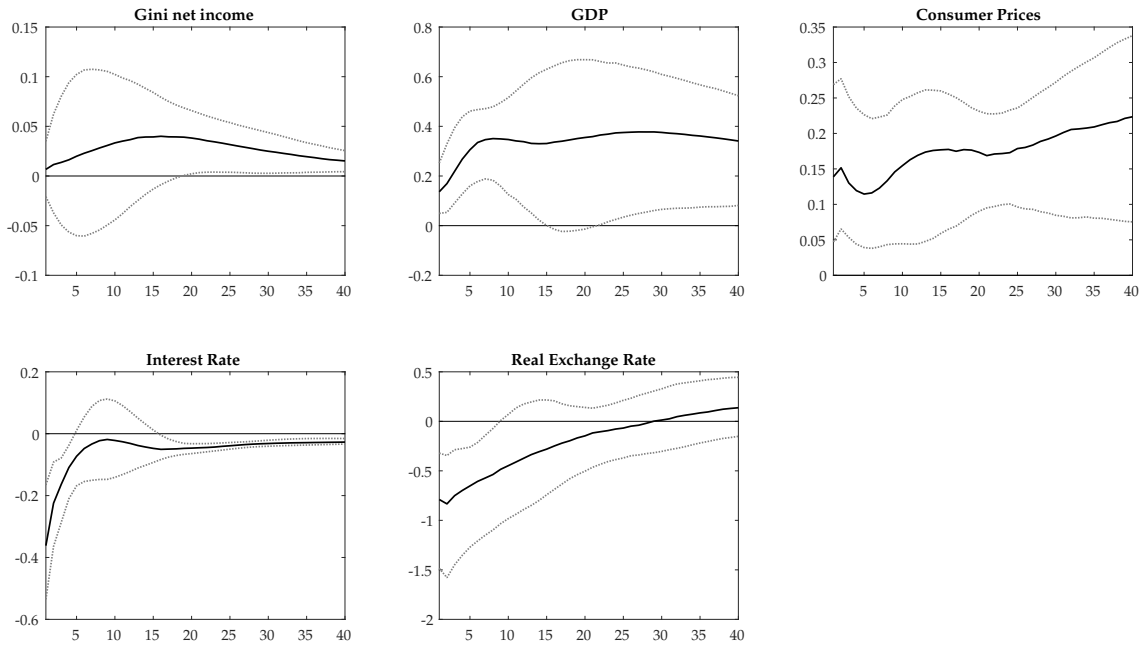


Figure 13: Baseline model Canada with Gini net income, responses to a expansionary monetary policy shock.

Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

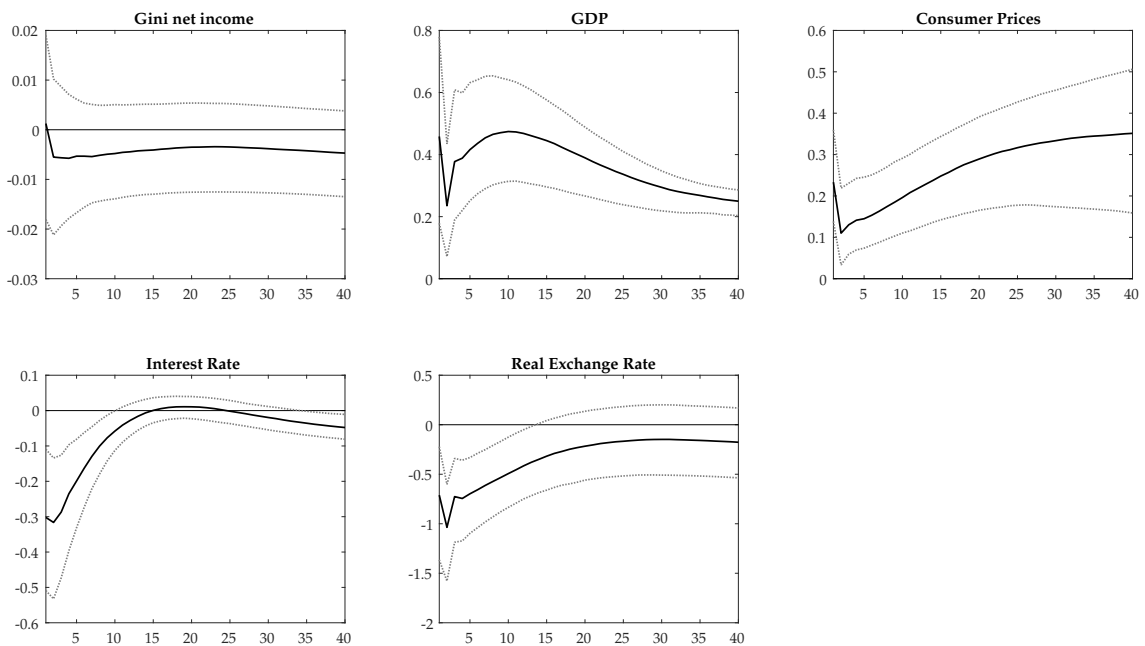


Figure 14: Baseline model Norway with Gini net income, responses to a expansionary monetary policy shock.

Notes: The solid line reflects the median model reaction, the dotted lines show the 16<sup>th</sup> and 84<sup>th</sup> percentiles.